Air Pollution Aspects of Emission Sources:

SULFURIC ACID MANUFACTURING

A Bibliography with Abstracts

U. S. ENVIRONMENTAL PROTECTION AGENCY

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AIR POLLUTION ASPECTS OF EMISSION SOURCES: SULFURIC ACID MANUFACTURING— A BIBLIOGRAPHY WITH ABSTRACTS

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AIR POLLUTION ASPECTS OF EMISSION SOURCES: SULFURIC ACID MANUFACTURING— A BIBLIOGRAPHY WITH ABSTRACTS

INTRODUCTION

Sulfuric acid manufacturing contributes significantly to the overall air pollution level in the United States. To aid efforts to improve air quality, the Air Pollution Technical Information Center (APTIC) of the Office of Technical Information and Publications, Office of Air Programs has compiled this bibliography relevant to the problem and its solution.

Approximately 200 abstracts have been selectively screened from the contents of APTIC's information storage and retrieval system to cover the 14 categories set forth in the table of contents. The compilation is intended to be representative of available literature, and no claim is made to all-inclusiveness.

Subject and author indexes refer to the abstracts by category letter and APTIC accession number. Generally, higher accession numbers, representing the latest acquisitions, cover the most recent material.

All documents abstracted herein are currently on file at the Air Pollution Technical Information Center, Office of Air Programs, Environmental Protection Agency, P. O. Box 12055, Research Triangle Park, North Carolina 27709. Readers outside the Environmental Protection Agency may seek duplicates of documents directly from libraries, publishers, or authors.

A. EMISSION SOURCES

02235

SULFURIC ACID MANUFACTURE, REPORT NO. 2. J. Air Pollution Control Assoc. 13, (10) 499-502, Oct. 1963.

This report, published as Informative Rpt. No. 2 of the Air Pollution Control Association's TI-2 Chemical Committee, rr-presents the 'best thinking of the Association' on the subject of Sulfuric Acid Manufacture. Of all the chemicals made in the U.S., sulfuric acid is probably produced in the greatest quantity. In 1961 the U.S. Department of Commerce reported production of 17,847,812 short tons. Inasmuch as one ton of sulfur produces nearly three tons of sulfuric acid, the large proportion coming from sulfur is apparent. The following processes are reviewed in regard to operations and air pollution aspects: Contact Process, Chamber Process, Acid Recovery Processes.

04946

A. F. Snowball

DEVELOPMENT OF AN AIR POLLUTION CONTROL PROGRAM AT COMINCO'S KIMBERLEY OPERATION. J. Air Pollution Control Assoc. 16, (2) 59-62, Feb. 1966.

During the concentration of lead and zinc sulfides from Cominco's Sullivan Mine at Kimberley, British Columbia, there is also produced an iron sulfide concentrate as a byproduct. A portion of these iron concentrates is roasted and the resulting calcine is treated in electric furnaces to produce 300 tons of pig iron per day. The sulfur dioxide produced in the roasting process is used to make sulfuric acid which is employed in the manufacture of ammonium phosphate fertilizers. Problems in the control of air pollution resulting from the iron sintering, iron smelting, and fertilizer operations at Kimberley are discussed, including those arising as a result of almost continuous expansion of these facilities since their establishment 12 years ago. (Author abstract)

10749

Gobson, F. W.

NEW BUICK LEAD SMELTER INCORPORATES FORTY YEARS OF TECHNICAL ADVANCES. Eng. and Mining J., 169(7):62-67, July 1968.

Four significant innovations in the design and operation of lead smelters will be combined for the first time when the new Buick complex goes on stream this year near Bixby, Mo. The plant, designed to produce 100,000 tpy of 99.99% lead, will feature: updraft sintering, air pollution control through production of sulfuric acid, continuous tapping of molten lead, and vacuum dezincing. While none of these processes is new, this will be the first plant to utilize all four.

12633

F. E. Ireland

POLLUTION BY OXIDES OF SULPHUR. Chem. Eng., No. 221, CE261 -262, Sept. 1968.

The sources of sulfur oxide pollution include the combustion of sulfur-bearing fuels such as coal, coke, and fuel oil, the manufacture of sulfuric acid, miscellaneous uses of sulfur dioxide, and the combustion of sulfur compounds in waste gases from manufacturing processes. This is a brief report of these pollution sources made to the Working Party on Air Pollution of the European Federation of Chemical Engineering.

12751

McKee, Arthur G. and Co., San Francisco, Calif., Western Knapp Engineering Div.

SYSTEMS STUDY FOR CONTROL OF EMISSIONS. PRIMARY NONFERROUS SMELTING INDUSTRY. (FINAL REPORT). VOLUME II: APPENDICES A AND B. Contract PH 86-65-85, Rept. 993, 88p., June 1969. 72 refs. CFSTI: PB 184 885

A systems study of the primary copper, lead, and zinc smelting industries is presented to make clear the technological and economi factors that bear on the problem of control of sulfur oxide emissions. Sulfur oxide emissions for various types of smelting operations are tabulated, including gas flows and compositions and an analysis of sulfur oxides generation and recovery. Smelter flow diagrams are presented for the control methods of contact sulfuric acid, absorption, reduction to elemental sulfur, lime wet scrubbing, and limestone wet scrubbing. Sulfur oxide recovery processes that were investigated and rejected as not being suitable for economic analysis are listed. Cost estimates for various control processes are given.

12823

McKee, Arthur G. and Co., San Francisco, Calif., Western Knapp Engineering Div.

SYSTEMS STUDY FOR CONTROL OF EMISSIONS. PRIMARY NONFERROUS SMELTING INDUSTRY. (FINAL REPORT). VOL I. Contract PH 86-65-85 Rept. 993, 188p., June 1969. CFSTI: PB 184 884

A systems study of the primary copper, zinc, and lead smelting industries is presented to make clear the technological and economic factors that bear on the problem of control of sulfur oxide emissions. The nature of smelting practice is described, and potential air pollution problems in smelter areas are revealed. Five processes for the control of sulfur oxides are presented, including contact sulfuric acid, absorption, reduction to elemental sulfur, lime wet scrubbing, and limestone wet scrubbing. Current sulfur oxide emissions from U. S. smelters are given, and forseeabl emission trends are discussed. Markets for sulfur byproducts are mentioned, the costs of control by available methods are tabulated, and control method evaluation with plant models is considered. A research and development program for control methods and smelting process technology is recommended.

13403

Ganz, S. N., I. Y. Kuznetsov, V. A. Shlifer, and L. I. Leykin

REMOVAL OF NITROGEN OXIDES, SULFUR DIOXIDE, AND SULFURIC ACID MIST AND SPRAY FROM INDUSTRIAL EXHAUST GASES USING ALKALINE PEAT SORBENTS.

(Ochistka vykhlopnykh gazov ot okislov azota, sernistogo gaza, tumana i bryzg sernoy kisloty torfoshchelochynymi sorbetami v zavodskikh usloviyakh.) Text in Russian. Zh. Prikl. Khim., 41(4):720-725, 1968. 1 ref.

Studies on the purification of exhaust gases from the Mills-Packard process under industrial conditions revealed that the most effective additive to the peat sorbents was ammonia, the sorption of gases producing a useful organomineral fertilizer. Addition of the ammonia directly to the boiling layer of sorbent was the most efficient method, and three sorbent layers were used. Successive layer thicknesses were 200-300, 300-400, and 400-450 mm with moisture content 35-40, 40-45, and 45-55 percent, respectively. Raw material requirements for sanitary purification of 60,000 cu m/hr are (in tons per hr): 0.294 ammonia, 1.5 dry peat, and 3 peat with 50 percent moisture. The ton-per-hour trapping rate was: 0.318 nitrogen oxides, 0.405 sulfur dioxide, and 0.012 sulfuric acid. Data are given for the effectiveness of the resultant fertilizer determined from agricultural study.

13596

Cunningham, George H. and Allen C. Jephson

ELECTROLYTIC ZINC AT CORPUS CHRISTI, TEXAS. Trans AIMEE (Am. Inst. Mining Metallurgical and Petroleum Engrs.), Vol. 159, p. 194-209, 1944.

The design of the plant includes the use of Trail suspension roasting equipment, contact acid equipment, and batch leaching in mechanically agitated tanks. Pressure filtering and washing of leach pulp and batch purification are followed by clarification in filter presses and cooling of purified solution by evaporation. Electrolysis is carried out in cells using Tainton alloy anodes and aluminum cathodes. Cell temperatures are held within desired limits by circulating cell solution through cooling towers. Steam-driven generators are used to provide direct current for electrolysis. The cathode zinc is melted and cast into slabs for shipment. Plant roasting capacity is 140 to 240 tpd. Steam is generated in three boilers, each with a capacity of 6000 to 12,000 lb of steam per hr at 150 psi, and amounts to about 0.7 lb per lb of concentrate roasted. Boiler gas at 8500 to 10,500 cu ft per min and 320 C is fed to separate cyclone units. The gas is passed from the cyclones to two cottrell precipitators, each with a capacity of 18,500 cu ft per min at 250 C, and on to the acid plant. The H2S04 section consists of a standard Leonard Monsanto contact unit using vanadium mass converters to produce 125 tons of 100% acid daily.

13841

Lewis, W. K. and E. D. Ries

INFLUENCE OF REACTION RATE ON OPERATING CONDITIONS IN CONTACT SULFURIC ACID MANUFACTURE. II. Ind. Eng. Chem., 19(7):830- 837, 1927. 7 refs.

Using the data of Knietsch, the authors had previously calculated correct operating conditions for the catalytic oxidation of sulfur dioxide to sulfur trioxide in the presence of platinum. Further reaction rate data were obtained under strictly isothermal conditions simulating plant practice. From these data, a new equation was developed. While it does not explain the mechanism of the reaction, it accurately predicts conversion under any given set of circumstances. It applies equally to SO2 and O2 runs. Optimum operating temperatures calculated by means of the equation are found to correspond closely with good plant practice. A comparison is made between existing equations and the new one, and the shortcomings, both practical and theoretical, of the earlier forms are discussed in detail.

13850

Thompson, A. Paul

PLATINUM VS. VANADIUM PENTOXIDE AS CATALYSTS FOR SULFURIC ACID MANUFACTURE. Trans. Am. Inst. Chem. Engrs., vol. 27:264-309, Dec. 1931.

Platinum catalysts, including platinized asbestos, platinized magnesium sulfate, and platinized silica gel, are compared economically and technically with vanadium catalysts on the basis of data derived from sulfuric plant operations. The catalysts are evaluated by such factors as initial costs, cost of catalyst per daily ton of 100% acid per year, ultimate cost, ability to handle gas with a low oxygen to sulfur dioxide ratio, converter space required, relationship of gas loading or space velocity to conversion, and life expectancy. Platinized contact masses are shown to be cheaper from every standpoint than vanadium masses. The 1931 cost of an ounce of platinum is only 8.57 cents per ton of acid produced. The costs for vanadium masses are 2.8 to 5.1 times higher, with one vanadium catalyst costing nearly 46 cents per ton of acid produced. With regard to relative effectiveness, platinized catalysts have a lower kindling temperature, a greater activity over a much wider temperature range, and they excel in handling gases whose sulfur dioxide content varies from time to time. Their greater activity with gases of varying sulfur dioxide content over broad temperature ranges simplifies converter design and operation. Like vanadium catalysts, platinized silica gel is not poisoned by arsenic present in the gas being treated. Additional cost and purification data on contact sulfuric acid catalysts are given in a discussion appended to the article.

15517

Public Health Service, Washington, D. C., National Air Pollution Control Administration

CONTROL TECHNIQUES FOR SULFUR OXIDE AIR POLLUTANTS. NAPCA Publ. AP-52, 122p., Jan. 1969. 274 refs.

About 75% of sulfur oxide emissions in 1966 resulted from the combustion of sulfur-bearing fuels, with coal combustion accounting for the largest part. The economic and technical aspects of various techniques for controlling these emissions are examined in detail; they are categorized as (1) change-over to fuels with lower sulfur content or to another energy source, such as hydroelectric or nuclear power; (2) desulfurization of coal or residual fuel oil; (3) removal of sulfur oxides from flue gas by various processes, including limestone-dolomite injection and alkalized alumina sorption; and (4) increase in combustion efficiency. Of the industrial sources of SO2 emissions, nonferrous primary smelting of sulfide-containing metallic ores such as copper, zinc, and lead is the largest emitter. About half of the primary smelters in the U. S. now use sulfuric acid recovery to reduce emissions and at the same time offset smelter operating costs. Smelters, oil refineries, pulp and paper mills, steel plants, sulfuric acid plants, waste disposal processes, and a number of other industrial sources are considered in terms of present technology for reducing emissions. The costs of dispersion of sulfur oxides by tall stacks are briefly discussed as an approach toward reducing the frequency of high concentrations at ground level in some areas, and an extensive bibliography on gas dispersion is included. An appendix on chemical coal processing describes the current state of development of such methods as gasification and liquefaction for reducing the sulfur content of high-sulfur coal.

18305

Lindau, L.

AIR POLLUTION AND THE MANUFACTURE OF INORGANIC CHEMICALS. (Luftfororening vid framstallning av

oorganiska baskemikalier.) Text in Swedish. Statens Naturvardsverk, Stockholm, Publikationer No. 4, 66p., 10 refs.

The investigation deals with air pollution problems in connection with the manufacture of basic inorganic chemicals such as sulphuric acid, hydrochloric acid, phosphoric acid, ammonia, nitric acid, chlorine and sodium hydroxide. The report contains a survey of present conditions, an analysis of various technical methods to reduce the emissions, and a discussion of the economic consequences of these methods. The purpose of the survey is to supply information to the Swedish authorities dealing with air pollution control. The rates of emission from the chemical plants are described as kg/ton product. The costs of air pollution abatement vary. In certain cases, e.g., the recovery of sulphur in connection with the production of ammonia, the necessary investments can be written off. In other cases, e.g., introduction of the double-contact process for the manufacture of sulphuric acid, the increasing yield can only partially motivate the investments required. There are also cases when the costs entirely belong to the air pollution account. A comparison between Swedish and foreign plants indicates that emissions are of the same magnitude. Essential improvements are possible to obtain in new plants and the latest Swedish production units have applied this to a great extent.

21221

Fels, M. and H. L. Crawford

FEASIBILITY STUDY OF CENTRALIZED AIR-POLLUTION ABATEMENT. (FINAL REPORT). Battelle Memorial Inst., Columbus, Ohio, Columbus Labs. NAPCA Contract PH-86-68-84, TAsk 12, 51p., Nov. 17, 1969. 35 refs. CFSTI: PB 190486

The technical and economic aspects of a centralized air-pollution control plant located a distance from seven industrial plants were investigated. The plants chosen were as follows: lime, 200 tons/day; cement, 4500 barrels/day; sulfuric acid, 400 ton/day; power, 25 Mw; fertilizer, 570 tons/day; gray iron, 1440 tons/day; and electric arc, 2600 tons/day. Gaseous and particulate-emission levels were taken from literature sources, and as far as possible, average values were used for each industry. The total amount of gases from the plants was 627,000 cfm at 320 F and after mixing. While the centralized control facility is less expensive to build and operate than individual control devices, transportation costs are so high as to make the centralized concept unattractive. The economics would favor centralized abatement only if each of the seven plants were located at about 1/2 mile from the central facility. This distance is considered to be unrealistically close from the standpoint of an individual plant's land requirements. In addition to transportation costs, the centralized plant would render emissions from lime, cement, and sulfuric acid plants valueless, and any equipment malfunction would release large quantities of pollutants over a relatively small area. Finally, vegetation growth over buried pipes would be inhibited, leading to potential esthetic problems. (Author summary modified)

23044

Ireland, F. E.

POLLUTION BY OXIDES OF SULPHUR. Chem. Engr. (London), 46(7): CE261-CE262, Sept. 1968.

Sulfur oxides arise from the combustion of sulfur-containing fuels such as coal, coke, and fuel oil; from sulfuric acid plants and miscellaneous uses of sulfur dioxide; and from the combustion of sulfur compounds in waste gases from manufacturing processes. Many investigations have been carried out on the removal of sulfur from fuel and on the removal of sulfur oxides from waste gases, but no generally practical methods have been developed. Thus, recourse is made to dispersion from suitably tall chimneys to reduce ground-level concentrations to acceptable limits. By controlling burner conditions to limit excess air in the gases, large users of fuel oil and electric power plants can reduce sulfur trioxide in waste gases from 40-50 ppm to about 5-10 ppm. In most countries, sulfuric acid is produced by contact processes that give a final acid emission to not more than two percent of the sulfur burned. Provided contact plants are equipped with adequate facilities for preheating, there should be no adverse local conditions produced by emissions. However, there is scope for research into acid mist formation and methods for its prevention at the source. Emissions from some chemical processes are often more concentrated than those from the combustion of fuel. It is common practice to remove the sulfur dioxide in these emissions by scrubbing with alkali solutions.

23972

Weissenberger, G. and L. Piatti

RECOVERY OF SULFUR DIOXIDE FROM WASTE GASES BY MEANS OF CYCLICAL KETONES I. (Ueber die Gewinnung von Schwefeldioxyd aus Abgasen mit Hilfe cyclischer Ketone. I.). Text in German. Chemiker Z., 53(25):245-247, March 27, 1929. Part II. Ibid., 53(26):266-267, April 10, 1929.

Sulfur dioxide present in waste gas from a sulfuric acid plant (contact process) in a quantity of 6-7 g per cu m was absorbed in laboratory experiments by clear technical cyclohexanone (boiling begin 150/152 C) and by clear technical methylcyclohexanone at 15 to 20 C in wash bottles and the absorbed SO2 was subsequently recovered by heating the solvents to 80 C. The absorbed SO2 was determined by titration with an iodine solution. The quantity of SO2 absorbed by the two solvents varied with temperature, at a practical operating temperature of 15-20 C approximately 0.25% by weight SO2 was absorbed. The addition of metallic mercury to the solvents had a marked positive or negative effect on the SO2 absorption capacity of both solvents depending on temperature. The percentage of SO2 in the waste gas affected positively the absorption capacity of the two solvents from 0 to 5% SO2.

25178

Teworte, W. M.

SPECIFIC AIR POLLUTION CONTROL ARRANGEMENTS AT NON-FERROUS METAL WORKS. Preprint, International Union of Air Pollution Prevention Associations, 41p., 1970. 20 refs. (Presented at the Internationa Clean Air Congress, 2nd, Washington, D. C., Dec. 6-11, Paper EN-28B.)

Information on the cost problem and on the necessity for air pollution control technology in the field of non-ferrous metals production is presented. Their price, high in comparison with that of steel, is an incentive to developing any means of increasing the yield and, thus, to recovering the metals from flue dusts. Therefore, the center of air pollution control arrangements shifts to the side of extracting accompanying elements in the ores, auxiliary materials, and highly volatile compounds. The negative biological effects of a large number of metals require particularly effective arrangements for waste gas purification. More recent specific methods of air pollution control are illustrated by several examples. Fluorine emissions from the flux are fought in aluminum works by means of effective wet purification processes; dry absorption methods are also being tried. Fluorine levels of 0.5-1.5 ppb were detected even in industrial areas where there was no aluminum production at all. Waste gas purification at aluminum re-melting works presents a particularly difficult problem with regard to

the extraction of very fine salt fumes. The utilization of the sulfur content in the non-ferrous metal ores is discussed in detail. Here, the solution to the economic problem of marketing a sulfuric acid, aptly called 'acide fatal' by Belgian smelting works, is as important as the solution to the process technical problem. The latter was dealt with very successfully by means of the development of a double-contact process with intermediate absorption for roasting gases poor in sulfur dioxide. The final gases contain less than 0.5% of the SO2 charge. More and more processes favorable to air hygiene are being used by zinc metallurgy. Methods of recovery that cannot be controlled by waste gas technology, will be discarded. General and particular information is given on the cost problem of air pollution control. Frequently, the wrong conclusions are drawn from the fact that only 0.2% of the value of industrial production are required for direct steps, with secondary injurious effects, amounting to 1-2%, being prevented in this manner. Production at some works is hard hit by specific costs of 1-5% of the proceeds from sales. (Author abstract)

25605

Fulton, Charles H.

METALLURGICAL SMOKE. Bull. Bureau Mines, no. 84:7-94, 1915. 44 refs.

The problem of metallurgical smoke (defined as gases and vapors, an the fine dust entrained by them) that issues from stacks of smeltin and ore roasting plants is considered. Sulfur dioxide and trioxide are two of the major gases in this case. They can combine with atmospheric water to form sulfuric and sulfurous acid. The dust that is carried by the gases consists of small particles of the different ores, fluxes, or fuel. These emissions can, when combined with certain meteorological conditions, cause extensive plant damage, as well as injury to animals and humans. The physica and chemical properties governing the actions of stack emissions ar discussed. The effect of the effluent flow speed on the compositio of the flue dust is considered, and design practices for dust chambers and stacks are related. Methods for the control of dust emissions include settling chambers, bag-houses, and electrostatic precipitation. Several operating examples of these controls are presented. Several processes for the removal of SO2 from stack gases and its conversion to H2SO4 are given, including absorption and alkaline additives. Some legal aspects of smelter emissions problems are discussed in terms of actual litigation.

B. CONTROL METHODS

00587

J.A. Brink, Jr., W.F. Burggrabe, L.E. Greenwell

MIST REMOVAL FROM COMPRESSED GASES. Chem. Eng. Progr., 62(4):60-66, April 1966.

Fiber mist eliminators have been successfully used to purify gases and solve difficult air pollution problems involving: methanol synthesis gas, sulfonation and chlorination process gases, nitric acid process gases, chlorine, and compressed air. Extensive research and development work resulted in the development of fiber mist eliminators for the collection of submicron mist particles. The first plant-scale installations were made for the control of air pollution from sulfuric and phosphoric acid plants. After full-scale units had been proven highly efficient on stack gases containing submicron particles, further research was undertaken to develop fiber mist eliminators which would be most economical for the collection of particles which are predominantly 1 to 20 microns in diameter. The installation of fiber mist eliminators within various processes to purify gases was started after several difficult air pollution problems had been solved. The widespread application of fiber units to chlorine plants was reported in detail, but the applications to many other processes has not been reported previously. It should be noted that mists are present in many chemical processes at pressures ranging up to 5,500 lb./sq. in. gauge. The temperatures at whcih mists are present are usually moderate since many mists vaporize at higher temperatures.

00800

E.P. Stastny

ELECTROSTATIC PRECIPITATION. Chem. b8eng. Prog, 62, (4) 47-50, Apr. 1966.

The electrostatic precipitator has proven to be the answer to an important consideration in the production of oleum in the sulfuric acid industry. Through its utilization, in addition to its air pollution abatement role, important production gains have been made possible. Look not only at what it can do for your present operation conditions, but establish its design criteria for ultimate plant capacity so as to insure full satisfaction at maximum outputs under future air pollution codes.

01125

D. Zanon and D. Sordelli

PRACTICAL SOLUTIONS OF AIR POLLUTION PROBLEMS FROM CHEMICAL PROCESSES . (Realizzazioni nel Campo delia Prevenzione dell' inquinamento Atmosferico di Origine Industriale.) Translated from Italian. Chim. Ind. (Milan), 48(2):251-261, March 1966.

A strict control of pollutant to be dispersed in the atmosphere offers technical and economic problems, both in the design and the operation of chemical processing units. Three examples of processes for which pollution control has been established are described: SO2 derived from contact sulfuric acid and from hydroxylamine sulfate plants, nitrous gas from low and high-pressure nitric acid plants, and fluorine-containing effluents from hydrogen fluoride production. The general approach, kind of abatement process adopted, materials and construction costs are discussed.

02355

S.T. Cuffe C.M. Dean

ATMOSPHERIC EMISSIONS FROM SULFURIC ACID MANUFACTURING PROCESS; A COMPREHENSIVE ABSTRACT. Preprint. (Presented at the 58th Annual Meeting, Air Pollution Control Association, Toronto, Ontario, Canada, June 1965.)

This paper includes basic descriptions of both the chamber and contact processes. Variations in process conditions that may appreciably change the magnitude of emissions, e.g., the manufacture of oleum or the use of different sulfur bearing feed materials, are noted. Concentrations of both nitrogen oxides and sulfur dioxide emissions from chamber plants were found to range from about 0.1 to 0.2 volume percent. The concentration of combined acid mist and spray from chamber plants varied from about5 to 30 milligrams per cubic foot. For contact plants, the range of sulfur dioxide concentrations in the absorber exit stack ranged from 0.13-0.54 volume percent; while acid mist concentrations varied from 1.1 to 4.8 milligrams per cubic foot. The test data show that it is possible to recover 99 percent of all of the acid mist and spray emissions by adding commercially available mist elimination. (Author abstract)

02985

K. Stopperka

ELECTROPRECIPITATION OF SULFURIC ACID MISTS FROM THE WASTE GAS OF A SULFURIC ACID PRODUCTION PLANT. Staub (English Transl.) 25, (11) 70-4, NOV. 1965. CFSTI TT66-51040/11

Optimum conditions for electroprecipitation of sulfuric acid mist from waste gas in sulphuric acid production have been investigated in a pilot plant. The specific effect of the shape of the discharge electrode has been tested in addition to the influence of collecting electrode dimensions and different moisture contents on separation efficiency. The tests which have been carried out with a 'Korobon' filter pipe (electrode graphite) indicate that the corrosion problem has been solved permanently. (Author summary)

03129

Avy., A. P.

METHODS OF REDUCING POLLUTION CAUSED BY SPECIFIC INDUSTRIES. (CHAPTER VI. CHEMICAL INDUSTRY). European Conf. of Air Pollution, Strasburg, 1964. p. 337-356.

The pollutants discharged by the chemical industry may be subdivided into several classes. The first and most important class is that of harmful products emitted in large quantities by the 'heavy' chemical industry and, in particular, organic chemical works: Sulphur dioxide, sulphuric acid, chlorine, whether manufactured or in the form of impurities in the basic

material: fluorine in the case of fertilizers and fluorine again in aluminum electroechemistry. The chemical industry has a wide range of special problems which is in a constant state of flux owing to the wide and ever-increasing variety of new synthetic products (intermediate and finished) in the organic chemical industry. From the technical point of view, the prevention of pollution by such products depends on their presentation and manner of application. A problem directly connected with chemical manufacture is that of smell: mercaptans, hydrogen phosphide, methylamines, etc., although, of course, it does not arise in the chemical industry alone. Technical methods used to reduce pollution are highly devellped for dusts and smoke and there is a wide choice of apparatus. The chemical industry, like all others, is subject to laws and regulations governing industrial air pollution. A fairly sharp distinction, however, should be drawn between laws, which lay down in general terms the objects to be attained and the obligations to be fulfilled, and the regulations which embody detailes of the limits imposed and the degree of reduction demanded. In this last report, caution is necessary and impossible or unnecessary standards should not be set. It is clear that international liaison or even international collaboration is not only desirable, but necessary.

03945

F. T. Meinhold

THREE-WAY PAYOUT FOR H2SO4 GAS CLEANER. Chem. Progress 29, (3) 63-4, Mar. 1966.

A compact and efficient acid gas cleaner was installed in the top of each absorber and was adapted to the acid absorbers. Another potential air pollution source was quenched in the plant which involved the acid drying towers. Elimination of the course mist not only prevents corrosion in the connecting duct, but also reduces the over-all vol. of mist leaving the absorbers. Each of the 900-tpd. acid plants was completed on a turn-key basis in 8 months. The exhaust stacks cleared in only 50 min. and now, after regular scheduled shut-downs, the stacks are usually cleared in 5 to 30 minutes, depending on the length of shut-down.

04067

E. O. Kossovskii

SANITIZATION OF IRON PYRITES GRINDING AT THE M.B. FRUNZE SULFURIC ACID PLANT. Gigiena i Sanit. 28, (1) 77-9, Jan. 1963. Russ. (Tr.) (Translated by B. S. Levine in U.S.S.R. Literature on Air Pollution and Related Occupational Diseases, Vol. 12.)

The iron pyrite grinding department at the M. F. Frunze sulfuric acid plant was an intense source of fine air-suspended dust which was coming from the transportation, unloading, grinding, and loading of the groundbore onto the small transfer cars. The entire pyrite grinding process was accomplished in an inclosed brick building. Fine dust was intensely liberated into the surrounding air at each step of the procedure. The density of the air-suspended pyrite dust was inversely proportional to the moisture content of raw ore, but the temperature of the air generally reduced the initial moisture of the raw pyrite by 65-70%, and under the prevailing ore grinding conditions it was not possible to raise the moisture content of the material artificially. Attempts to sanitize the working conditions had to be limited to encasing points of dust generation and to establish a suitable system of leak-proof ventilation. Before the sanitary improvements in the process of iron pyrites grinding were instituted the density of the generated and air suspended pyrite dust was great and constituted a serious sanitary problem. The density of the iron pyrite dust in the air surrounding the process was to a degree inversely proportional to the moisture content in the raw ore. The sanitary improvements consisted basically in leak-proof encasing of strategic dust generating production points and in instituting an arterial ventilation system.

05079

N. Morash, M. Krouse, and W. P. Vosseller

REMOVING SOLID AND MIST PARTICLES. Chem. Eng. Progr. 63, (3) 70-4, Mar. 1967.

The laboratory and pilot plant development work for a technique which successfully removes submicron size dust and acid mist particles from exhaust gases is described. The result obtained when an irrigated, thin, felted fiber filter is used to remove a mixture of fine titanium dioxide and sulfuric acid mist particles from the exhaust gases of pigment calciners is discussed.

05514

R. L. Cotham

ELECTROSTATIC PRECIPITATION OF SULPHURIC ACID MISTS. Proc. Clean Air Conf., Univ. New South Wales, 1962, Paper 20, Vol. 2, 16 p.

The most important feature of electrostatic precipitators is their ability to remove very small concentrations of finely divided particulate matter, at high efficiency, from extremely large gas flows, in a plant of moderate size with a low pressure drop across the equipment. Although little is known in regard to the phenomena encountered, the process of electrostatic precipitation has gained world-wide acceptance as one of the most efficient collection systems known, and for many years has been successfully applied to the problem of sulphuric acid mist removal. In this application, single-stage Cottrell precipitators with a wire and tube electrode arrangement are usual. Industrial precipitators are normally operated with their discharge electrodes at as high a negative potential as possible without sparking in order to obtain maximum particle migration velocities. For the treatment of gaseous effluent from contact sulphuric acid plants, efficiency tests have indicated average migration velocities in the range of 0.40 to 0.60 ft/sec with attendant fficiencies in the order of 99.7%. The Deutsch Equation, relating efficiency with migration velocity and specific collecting area, is a satisfactory basis for equipment design and comparisons provided that the value of migration velocity used in the equation is an empirical or average value determined from plant wxperience or pilot plant studies on a similar application. (Author abstract)

05567

L. Silverman

HIGH TEMPERATURE GAS AND AEROSOL REMOVAL WITH FIBROUS FILTERS. Proc. Air Water Pollution Abatement Conf., 1957. pp. 10-23m.

The use of a slag wool fiber filter as an inexpensive cleaner of high temperature gases and fumes produced in open hearth steel furnaces was described and evaluated. These fibers are small (4 microns mean diameter) and are refractory, thus able to withstand temperatures of 1100 F. ;or high efficiency separation of fine aerosols, fine targets in large number are necessary which packed slag fiber layers can provide. Theoretical, laboratory and field studies show that slag wool filters show efficiencies ranging from 90 to 99%, depending upon fiber layer compositions, density, and thickness. The chief separating mechanisms appear to be diffusion and impaction. Results are presented of the air flow resistance charac-

teristics of a rotary screw agglomerator, used to provide dynamic gas treatment to increase particle size of the efficiency of the screw as an inertial collector for iron oxide fume. The collection efficiency and resistance characteristics of slag wool fiber filters was extended to other aerosols and gases such as fly ash, sulfur dioxide, hydrofluoric acid and sulfuric acid mist. The filter (one inch thickness, five pounds per cubic foot density) at velocities used for collecting iron fume (50 to 150 feet per minute) showed efficiencies for SO2 of approximately 30% when moist and zero when dry. For hydrogen fluoride (dry and wet), efficiencies range from 70 to 90%. For fly ash resuspended from Cottrell ash, efficiencies ranged from 60 to 90%, whereas when feeshly formed fly ash was created by burning powdered fuel, efficiencies ranged from 93 to 99%. A revised pilot model slag wool filter was constructed for 750 to 1000 cfm gas flow based on results of the first field unit.

06247

SULFURIC ACID MIST IS CLEANED FROM AIR BY FOG FILTER SYSTEM. ((Air Eng.)) 9(3):24-25, Mar. 1967.

In the making of TNT, contaminants such as sulfuric acid mist are emitted to the air. A relatively new method of cleaning air, the fog filtration system is essentially a high pressure scrubbing operation in which vaporized water cleans the polluted air is silo- shaped chambers spaced about 50 ft. apart. The air-cleaning system is actually a three-stage operation. Its functioning is described: (1) Polluted air is drawn through one of seven Cottrell electrostatic precipitators, where entrained moisture receives electric charges from electrodes, (2) The now partially clean air is drawn into one of the three fog filters, where it is washed under high pressure, pulled downward in a swirling pattern, is then drawn up through a pipe and expelled, with virtually all impurities removed, and (3) The effluent (dirty) water flows from the bottom of the filter to a collecting basin several hundred feet away, where it is treated and discharged. These three powerful fans draw the contaminated air from the electrostatic precipitators are big units: 21 ft. high, 20 ft. wide, and 10 ft. deep. Once the acid-polluted air is drawn into them, the suspended matter in the air acquires a charge and is precipitated at the ground surface. Droplets so precipitated unite to form a liquid which drains down the sides of the tubes and is collected below. The next step is the suction of the still acidic polluted fumes through the fog filters. Then the air is given a thorough scrubbing with fog particles. The wetting nature of the high pressure fog permits fine particles to be 'centrifuged' out of the air by a simulated cyclone action in the wetted gases. Fog particles from high pressure nozzles provide an excellent induced draft air pump, because all air entrained must necessarily move with substantially the same velocity as that of the fog particle. The system is virtually maintenance-free, even though the filters are operating on a 24 hour a days basis to keep the air clean. Beyond a routine schedule of cleaning the filter chambers, there is no requirement for maintenance manpower.

06282

A. S. Arkhipov, A. N. Boytsov

TOXIC AIR POLLUTION FROM SULFURIC ACID PRODUCTION. Gigiena i Sanit., Vol. 31, p. 12-17, Sept. 1962. 5 refs. Engl. transl. by JPRS-R-8824-D, p. 1-7, Nov. 11, 1967.

In order to analyze working conditions in the production of sulfuric acid against a background of technical progress and modernization of the progress, data on air pollution were collected in furnace sections of sulfuric acid shops at 12 chemical plants. Technical progress, the introduction of new calcining methods for pyrite, the mechanization of many manual operations, the introduction of automation features, better ventilation and other means have improved working conditions in kiln shops of sulfuric acid plants. The concentrations of SO2 in a number of plants producing sulfuric acid have dropped to permissible levels. The reduction in SO2 concentration to permissible levels and the marked reduction in clinker dust have been achieved even during increased technical progress, greater charges of raw materials and gas per cubic meter of furnace and cubic meter of building volume and the greater production of sulfuric acid plants.

07535

W. Leithe

CLEAN AIR MAINTENANCE - AN IMPORTANT TASK FOR CHEMISTRY AND ECONOMY. (Reinhaltung der Luft ein dringendes Anliegen fur Chemie und Wirtschaft.) Text in German. Allgem. Prakt. Chem. (Vienna), 18(8):239-241, Sept. 10-17, 1967. 4 refs.

This article is a summary of two lectures given at meetings of chemical societies. The problem of air pollution and some control methods are outlined. Typical examples of well-known air pollution problems are mentioned: London's smog chiefly caused by domestic heating, the smog of Los Angeles due to automobiles, the sun, and temperature inversions, and the industrial air pollution of the Ruhr Valley. Some characteristic data for all three examples are quoted. The techniques for the control of dust emissions are farthest advanced. This is verified by the fact that in Germany, emission of cement dusts decreased to one third while the production of cement tripled in the last 17 years. Far less satisfactory is the control of SO2 emissions. About twice as much sulfur is blown into the air than is used for the production of sulfuric acid. Some wet and dry processes for the elimination of SO2 from smoke are mentioned, but no method is known today which is both effective and economical. The chemical industry tackled its problems mostly by reducing the emission of air polluting substances by increasing the efficiencies of the relevant chemical processes. Examples are the production of sulfuric acid and nitric acid. Organic compounds can be recovered by either absorption on activated charcoal or oxidation by catalytic afterburners.

07552

Billings, Charles E., Charles Kurker, Jr., and Leslie Silverman

SIMULTANEOUS REMOVAL OF ACID GASES, MISTS, AND FUMES WITH MINERAL WOOL FILTERS. J. Air Pollution Control Assoc., 8(3):195-202, Nov. 1958. 20 refs. (Presented at the 51st Annual Meeting, Air Pollution Control Assoc., Philadelphia, Pa., May 26-29, 1958.)

Investigations have indicated that two in. thick filters at four lb/cu. ft. packing density will remove up to 80% of acid mist and up to 99% of acid gases and fumes. Total filter life depends upon concentration of contaminant in the entering air. A summary of filter performance is given. Estimated operating life based upon one use of the filter material can be obtained from the data given. With particulates such as iron oxide and fly ash, it has been found possible to wash and reuse filters about ten times. When iron oxide was collected simultaneously with SO2, filters were reused about eight times. Acid gas collection is significantly improved by the presence of moisture on slag wool filters. Mineral wool filters have several features such as, low cost (about 1 cents/lg.), small fiber diameter (4 micron and ability to withstand high temperatures (1000 deg F.). Slag wool will simultaneously remove sub-micron particulate materials with 90 to 99% efficiency. Resistance to flow through two in. slag wool filters (with an HF efficiency of

95%) is on the order of one or two in. of water, or if continuously moistened, at most 6 in. of water.

07925

Beighton, J.

THE SPECIAL INDUSTRIAL PROCESSES. Roy. Soc. Health J. (London). 87(4):215-218, July-Aug. 1967. 2 refs. (London)

The air pollution problems of a group of industries which produce: sulfuric acid, nitric acid, petroleum and petrochemicals, iron and steel, copper, aluminum, gas, ceramics and electric power are reviewed. The basic technical approach is to avoid the formation of the emission by design of the process, then to require the treatment of any unavoidable emission, and finally to require adequate dispersal of any residual amount which has to be discharged. The legislation is designed to compromise between safeguarding of public health and amenities and providing for a realistic acceptance with adequate control of special processes. Although the loss of gases in the manufacture of sulfuric acid is limited to 2% of the sulfur burned, the loss from a contact acid plant with a 500-ton-per-day capacity may be considerable so that chimney heights as high as 450 ft may be required. Acid mist from contact plants burning sulfur is a special problem as it is difficult to control and its occurrence is unpredictable. There are two nitric acid plants in Britain equipped with catalytic tail-gas reduction units which should solve the problem of brown nitrous fume emission to the air. The use of special flares is required to control H2S and mercaptans emitted by oil refineries. In the steel industry the development of the Fuel-Oxygen-Scrap process is regarded as an alternative to the electric arc furnace. It is claimed that melting and refining can be carried out without exceeding a fume level of 0.05 grains per cu ft.

08181

Varlamov, M. L., G. A. Manakin, and Y. I. Starosel'skii

PURIFICATION OF EXHAUST GASES OF A SULFURIC ACID TOWER PLANT BY A FLOWMETER PIPE TYPE OF APPARATUS. Zh. Prikl. Khim., 31(2):178-186, 1958. 19 refs. Translated from Russian by Bture on Air Pollution and Related Occupational Diseases, Vol 4, p. 68-77, Aug. 1960. CFSTI: TT 60-21913

A venturi apparatus for the recovery of spray, sulfuric acid aerosol, and nitrogen oxides from the exhaust gases of a sulfuric acid tower plant is described. The experimental arrangement consisted of two units: a small assembly, producing up to 50 cu m/hour, and a larger one producing up to 500 cu m/hour. In one apparatus, the fluid entered the main channel at an angle; in a second apparatus, the fluid entered tangentially and became distributed evenly over the perimeter of the diffuser. A third apparatus had a radial fluid feed in relation to its main axis. The separator walls of the small unit were arranged concentrically which forced the passing gas to impinge upon the surface of the liquid twice in succession. Another type of tube was tested in connection with the large unit. This tube had two radial fluid feeds set at 90 deg, and a separator of the type of abbreviated cyclone TsKTI. The power consumed in the operation of the flowmeter tube type of apparatus in the purification of exhaust gases emitted by the tower nitrose system ranged between 5 6 kilowatt-hours per ton of H2SO4, or 10 to 12% of the total power used in the production of one ton of sulfuric acid by the nitrose method.

09126

Moeller, W. and K. Winkler

THE DOUBLE CONTACT PROCESS FOR SULFURIC ACID PRODUCTION. J. Air Pollution Control Assoc., 18(5):324-325, May 1968. 1 ref. (Presented at the 60th Annual Meeting, Air Pollution Control Assoc., Cleveland, Ohio, June 11-16, 1967, Paper No. 67-115.)

In the Bayer double contact process the reaction is interrupted after approx. 90% SO2 has been converted to SO3. The SO3 is removed in a first absorption stage the so-called intermediate absorption and the remaining SO2-air mixture is once more reacted at the contacts. By removing the SO3 during the intermediate absorption, the distance of the remaining gas mixture from the state of equilibrium is increased and this permits further reaction, which means higher degrees of conversion. Theoretically, the double contact process allows the conversion degree to be increased from approx. 98% for the normal contact process to approx. 99.8%, and thus a reduction of SO2 emitted by a factor of ten. After the intermediate absorption, the temperature at which the catalyst begins to respond is about 50 degrees C lower than usual. This greatly helps to control air pollution, since the more favourable state of equilibrium further cuts down the quantity of emitted SO2 by at least 50% at a temperature which is 50 degrees C lower. The SO2 concentration emitted by the double contact plant, based on elemental sulfur, does not exceed 240 ppm at 20% overload and is as low as 100 120 ppm SO2 at normal load. Plants which have now been operating for 3 years on the basis of pyrites still give the same degree of conversion of 99.7%.

09559

Hensinger, C. E., R. E. Wakefield, and K. E. Claus

TURNING POLLUTION GASES INTO PROFITS. Eng. Mining J., 169(2): 131-135, Feb. 1968.

Fluid Column zinc roasters have been developed to process pelletized zinc concentrates with the resulting sulphur dioxide in the roaster gas used to produce sulphuric acid in a contact plant. These installations reflect the modern trend toward more efficient roasting processes and sulphuric acid plants of larger tonnage. In Fluid Column roasting several contiguous fluidized beds of pelletized zinc concentrates of varying degrees of fluidization are superimposed one on top of the other without intervening mechanical grates. Air is the primary fluidizing agent, however, provision is made for the introduction of other gases to produce different conditions in each bed, e.g. the lowest may be oxidizing while the upper bed may be reducing. The roasting process and the sulfuric acid plant are described in some detail.

09913

Guyot, G. L. and J. P. Zwilling

SNPA'S PROCESS FOR H2SO4 PRODUCTION DEVELOPED WITH EYE ON AIR POLLUTION. Oil Gas J., 64(47):198-200, Nov. 21, 1966.

A new process provides for reducing the sulfur content of residual gases to a very low level and converting the removed sulfur into high concentration (92 to 94%) H2SO4. The new process purifies exhaust gases containing up to 30 vol % steam and 0.8 to 3.0 vol % sulfur derivatives. The gases, after transformation of sulfur compounds into SO2 go through a multibed catalytic converter to transform SO2 into SO3. The conversion rate varies from 90 to 95%, depending on initial SO2 concentration. The SO3 is condensed, in the form of sulfuric acid of 92 to 94% concentration. The SO3-rich gases are cooled to a temperature slightly higher than their dew point.

Then they are sent to an absorption tower for countercurrent washing and cooling by the acid already produced. No filters or electrostatic precipitators are needed. An acid of 92 to 94 wt% concentration can be made from a gas with less than 1% SO2 and up to 30% water.

11058

W. Teske

IMPROVEMENTS IN THE PROCESSES AND OPERATION OF PLANTS IN THE CHEMICAL INDUSTRY LEADING TO REDUCED EMISSION. Staub (English translation), 28(3):25-33, March 1968. CFSTI: TT 68-50448/3

The emissions from chemical plants can be reduced, in special cases, by changing the production process or, in general, by using a gas cleaning method. Change in the production process may be achieved by a basic alteration of the process itself, by changing the mode of operation, by modifying the equipment and by using a different raw material. For this purpose, the doublecontact method for sulphuric acid production, the pressure method for nitric acid recovery and the introduction of a covered carbide furnace are mentioned as examples. The superphosphate process, viscose process, production of betanaphthol, production of thermal phosphoric acid and production of calcium chloride are given as examples for waste gas cleaning. (Author's summary)

11146

Anon.

SULPHUR. A HIDDEN ASSET IN SMELTER GASES. PART 4. Eng. Mining 169(8):59-66, Aug. 1968.

Smelter and converter gases and their contained sulfur are a specialized problem which may be turned into an asset for profit. The worldwide application of technology to this problem is reviewed Process description and applications are discussed.

11235

J. A. Brink, Jr., W. F. Burggrabe, and L. E. Greenwell

FIBER MIST ELIMINATORS FOR SULFURIC ACID PLANTS. Preprint, Monsanto Co., St. Louis, Mo., ((31))p., 1968. 10 refs. (Presented at the Symposium on Sulfur, Sulfuric Acid and the Future, Part II, 61st Annual Meeting, American Institute of Chemical Engineers, Los Angeles, Calif., Dec. 1-5, 1968, Paper 6-F.)

Fiber mist eliminators not only utilize the mechanisms of impaction and interception on the large and intermediate size particles, respectively, but also are the only type of equipment which can be designed to utilize the Brownian movement of particles to effect extremely high collection efficiencies in the low and sub-micron ranges. Collection efficiences on particles greater than 3 microns are essentially 100% while efficiencies as high as 99.98% on all remaining particles 3 microns and less in size can be achieved depending on design and economics. High efficiency fiber mist eliminator elements for sulfuric acid plants plants consist of fibers packed between two concentric screens. Mist particles collected on the surface of the fibers, become a part of the liquid film which wets the fibers. The liquid film is moved horizontally through the fiber bed by the drag of the gases and is moved downward by gravity. The liquid drains down the inner screen to the bottom of the element and then to a liquid seal pot. The liquid overflows the seal pot continuously back to the process.

11238

R. R. Dukes, and M. D. Farkas

SULFUR SHORTAGE VS PLANT DESIGN. Preprint, Leonard Construction Co., Chicago, Ill., 25p., 1968. 5 refs. (Presented at the 61st Annual Meeting, American Institute of Chemical Engineers, Symposium on Sulfur, Sulfuric Acid and the Future, Part I, Los Angeles, Calif., Dec. 1-5, 1968, Paper 5-C.)

Sulfuric acid plants can be built using SO2 bearing gases from various sources. The most important characteristic from the viewpoint of economics is the SO2 concentrations. Catalyst poisons such as fluorides should be avoided, and the SO3 and particulate contents should be as low as possible. If the SO2 content is low, the operating costs will be high because of increased utility requirements as fuel to keep the plant in thermal balance, and a power to supply refrigerated water. The amortization costs will be high because of the increased capital requirements. (Authors' summary)

11250

C. F. Scheidel

SULPHUR DIOXIDE REMOVAL FROM TAIL GAS BY THE SULFACID PROCESS. Preprint, Lurgi Apparatebau Gesellschaft mbh, Frankfurt (Germany), ((25))p., 1968. (Presented ath the 61st Annual Meeting, Symposium on Sulfur, Sulfuric Acid and the Future, Part II, Los Angeles, Calif., Dec. 1-5, 1968, Paper 6 E.)

A sulfur dioxide removal process is described. Gases containing SO2 are passed through an activated carbon reactor and optimum removal of SO2 is reached if the gas is saturated with water at a temperature of approximately 160 degree F. The bed of activated carbon is sprayed with water. The following process steps are required for wet catalytic conversion to sulfuric acid: 1) adsorption of SO2 milecules 2) oxidation of SO2 3) removal of SO3 by flushing with water 4) increase of solubility of SO2 with lower sulfuric acid concentration in liquid film 5) the rate of H2SO4 adsorption increases with H2SO4 concentration which slows down SO2 diffusion in adsorbent. A description of the chemical plant and equipment used in this process is given along with operating costs.

11629

Zwilling, J. P. and G. Guyot

RECOVERY OF THE WASTE GASES FROM CLAUS UNITS FOR THE PRODUCTION OF SULFURIC ACID. Erdoel Kohle (Hamburg), 21(5):290-292, May 1968. (Presented at the 19th Annual Meeting of the German Society for Petrology and Coal Chemistry, Hamburg, Oct. 6, 1967.) Translated from German. 8p.

At a natural gas purification plant, separated acid gas is processed to sulfur in a Claus unit. Since five percent of the sulfur was removed as sulfur dioxide with the waste gases, a continuous catalytic oxidation process was developed to convert sulfur compounds to sulfur trioxide and to recover concentrated sulfuric acid. The oxidation of the sulfur compounds is preceded by the combustion of residual gases at 540 C to oxidize hydrogen sulfide to sulfur dioxide and by the subsequent cooling of the combustion gases at 410 C. The sulfur-containing gases are then contacted with a vanadium catalyst in an adiabatic converter; oxidation takes place with the release of heat. Gases leaving the converter are cooled to 275 C and then passed to a concentration tower where they are contacted with 90-94% sulfuric acid in a counterflow precedure. Gases from the concentration tower flow to an absorption tower where the sulfuric acid vapors are scrubbed with 80-85% sulfuric acid. The gases impart their heat to the

acid; since the absorption by the sulfuric acid also generates heat, the circulation absorption-sulfuric acid is cooled in graphite exchangers. Any acid remaining in the gases is removed by a Teflon filter; no electrostatic filters are required. Production of sulfuric acid is 65,000 to 140,000 ton/yr. The concentration of the acid is 91-94%.

11906

Hilder, Wolfgang

A NEW SULPHURIC ACID INSTALLATION REDUCES SULPHER DIOXIDE EMISSION. ((Neue Schwefelsaureanlage verringert Schwefeldioxidemission.)) Text in German. Stadtehygiene, 19(6):125-127, June 1968.

An increased (24%) consumption of sulfuric acid (H2SO4) (used in the manufacture of fertilizers, vitamin pigments, artificial fibers, etc.) in the German Federated Republic over the last 5 years, a 78% H2S04 made in the Chamber and Tower Process which did not fulfill all purity requirements, and a shortage of elemental sulfur caused interest in the Pyrite-roasting Process of H2SO4 production. Copper, zinc, and a purple ore which is a valuable raw material in the iron industry, are also by-products of this process. With a daily production of 650 tons, the new pyrite-burning, H2SO4 installation of the Hoechst Dye Works is one of the largest plants of its kind. This non-urban, modern factory, which utilizes a closed combustion and exhaust system and a highly effective noise-isolation system, performs 4 operations: heat utilization, gas cleaning, contact, and absorption. The dust-containing mixture of SO2 and air is freed of floating particles and moisture in hot,roasting ovens used also in the manufacture of steam and electricity. The dust from the ovens and from the gas cleaning is collected for further utilization. The cleaned gases, emitting only 1/5 the amount of SO2 as the earlier process, escape after final absorption through a stack 135 m in height. The improved contact operation, which oxidizes SO2 to SO3, produces most of the H2SO4 in the Federal Republic (90%) and U.S.A. (95%). Since only 2% of the SO2 emissions are contributed by all H2SO4 manufacturers in West Germany, it is a fallacy to believe that the new installation will reduce atmospheric SO2 pollution substantially. The overwhelming portion of SO2 pollution is emitted from heat or electricity-producing fossil fuel installations.

13206

Bulicka, Milan, Jaroslav Podmolik, and Josef Hajek

ECONOMY OF ABSORPTION UNIT INSERTED FOR LOWERING OF EXHALATIONS FROM SULPHURIC ACID PRODUCTION PLANT. (Ekonomie vyroby kyseliny sirove s vlozenou absorpci). Text in Czech. Chem. Prumysl (Prague), 19(3):140-142, 1969. 5 refs.

When the daily production of sulfuric acid ranged to 100 t/day, with 95 to 97% conversion and with an average absorption of 99%, even with relatively low chimney heights, the immediate vicinity of factory was free from emissions. When production exceeded 300 t/day, higher chimneys did not sufficiently reduce the local concentrations. In most plants using the heterogeneous oxidation manufacturing method, SO2 emissions are 0.2 to 0.4%, SO3 emissions are 0.02 to 0.1%, and H2SO4 emissions are 0.075%. For the work in Prerov, which produces 100,000 t/year, a two stage exothermic process of catalytic oxidation of SO2 was adopted. Output is higher than 103,000 t/year, and 10 kg of sulfur are recovered for 1 t of the manufactured sulfuric acid. The process uses a closed circuit of cooling water which requires 20% more water than with traditional methods, and 3.5 kWh/t more sulfuric acid, and which produces 10 kg less of steam per ton of sulfuric acid. The cost of the absorption equipment is offset by the value of the sulfur recovered. The greatest advantage of the unit is its reduction of harmful emissions.

13337

Emicke, Klaus

A METHOD OF REMOVING SULPHUR DIOXIDE FROM GAS CONTAINING SULPHUR DIOXIDE. (Nor Deutsche Affinerie, Hamburg, Germany), British Pat. 1,107,626. 5p., March 27, 1968. (Appl. June 11, 1965, 12 claims).

A method of removing SO2 from exhaust gases is described. The gas is brought into contact with an aqueous solution of selenious acid in reaction vessels through which the solution is passed in countercurrent to the gas which contains SO2. The removal of the SO2 is performed in two stages. The selenium which is formed in the first stage is removed from the circulating liquor, and the SO2 is completely removed from the gas in the second stage. It is possible to perform this method economically and to remove the SO2 completely because the selenium formed is precipitated in solid form and does not dissolve in the H2SO4 which is formed simultaneously.

13667

Lehle, W. W.

PROCESSING OF WASTE GASES FROM SULFURIC ACID PLANTS. In: The Manufacture of Sulfuric Acid, Werner W. Duecker and James R. West (eds.), Am. Chem. Soc. Monograph Series, New York, Reinhold Publishing Corp., 1959, Chapt. 20, p. 346-358. 25 refs.

Tail gases from contact sulfuric acid plants consist mainly of nitrogen, oxygen, carbon dioxide, and a small amount of sulfur dioxide. Though present normally in small concentrations, sulfur dioxide, sulfur trioxide, and sulfuric acid can exceed permissible limits during start-ups and plant upset conditions. Sulfur trioxide and sulfuric acid vapor both form sulfuric acid mists which produce visible plumes from acid plant stacks. Processes for treating tail gases of sulfuric acid plants include scrubbing sulfur dioxide from waste with water, soda ash solutions, lime slurries, salt solutions, and ammonia solutions; the exorption process developed by the Consolidated Mining and Smelting Company; and the Katasulf modified autoclave process. As illustrated by the Cominco sulfur dioxide recovery system, an automated two-stage scrubber method using ammonia solutions has a number of advantages. It will reduce sulfur dioxide concentrations in tail gases to 0.03, handle gas concentrations as high as 0.9% sulfur dioxide, produce a scrubber liquid which has commercial value, and, by eliminating pollution, allow a plant to operate at an overload capacity on the order of 20%. Pease-Anthony Venturi scrubbers and Calder-Fox scrubbers are not efficient for sulfuric acid mists less than 10 microns. Of the equipment available for mist removal, wire-mesh eliminators and ceramic filters are more effective than cyclone separators, baffles, Vane-type separators, and packed-bed separators. The costs of wire-mesh removals is modest, though the possibilities of corrosion must be considered in selecting the mesh-wire material. The ceramic filter tube requires considerably more filtering area.

13672

KENNECOTT STARTS UP HUGE H2SO4 PLANT. Chem. Eng. News., 45(13):59-61, 1967.

Kennecott Copper's sulfuric acid plant near Salt Lake City is autothermal and designed to run on smelter gas containing 2-6% SO2. Gas from copper converters first goes through a glass cleaning section comprising a Cottrell precipitator, a large

Peabody scrubber, and Cottrell mist eliminators. The cleaned gas passes through a drying tower, two 2000 hp blowers, and into a series of five gas-to-gas heat exchangers before entering a three-pass converter where SO2 is converted to SO3. From the converter, the gas goes to the absorbing tower where the SO3 is absorbed by 98% sulfuric acid. The efficiency of the absorption towers is considered to be doubled by the use of 3 in. interlocked saddles, which allow a higher throughput of gas, and by an increased number of distribution ports for the acid that contacts the gas. The mist eliminator installed at the top of the absorption tower is a two-stage device with a Teflon mesh.

13728

Guyot, G.

PRODUCTION OF CONCENTRATED SULFURIC ACID FROM SULPHUROUS GASES WITH HIGH WATER VAPOUR CONTENT. (Fabrication d'acide sulfurique concentre a partir de gaz sulfureux a forte teneur en vapeur d'eau). Text in French. Chim. Ind. (Paris), 101(6):813-816, March 1969.

Although the contact process is applicable to both dry and wet gases, the sulfuric acid produced from wet gases by this method has a relatively low concentration (80%). A process is described for producing commercial concentrations (94%) of the acid from sulfurous gases with a high content of water vapor, even when the sulfur dioxide content is lower than 1%. The unit operating at Lacq is given as an example of the economics and applications of the process. (Author abstract modified)

13806

SULFURIC ACID PROCESS REDUCES POLLUTION. Chem. Eng. News, 42(40):42-43, Dec. 21, 1964.

The Bayer process for H2SO4 production is based on a double pass of SO2-bearing gases through the converter. The first contact is accomplished in three stages of varying depths of vanadium pentoxide. The second contact is accomplished in the fourth stage. The gases increase in temperature from 450 to 600 C in the first stage and must be cooled before entering the second stage. Cooling is accomplished by adding a side stream of cold SO2-containing gas to the reactor just below the first stage. A series of heat exchangers remove the heat of reaction in the remaining three stages. The SO3-rich gas is removed from the converter and the SO3 is absorbed in H2SO4 after the first three stages. The unreacted SO2 is recycled back through heat exchangers to the fourth stage. Up to 99.7% of the original SO2 has been removed after the fourth stage. The gas has an analysis of about 0.7% SO3, 0.03% SO2, 5% O3, and the remainder nitrogen. The SO3 is absorbed in a packed tower. Sulfur dioxide sent to the stack is one-seventh to one-tenth the concentration found in conventional processes.

13880

Siedlewski, J.

THE MECHANISM OF CATALYTIC OXIDATION ON ACTIVATED CARBON. THE ROLE OF FREE CARBON RADICALS IN THE OXIDATION OF SO2 TO SO3. Intern. Chem. Eng., 5(4):608-612, Oct. 1965. 14 refs. (Also: Roczniki Chem., 39(2):263-271, 1965.)

Free carbon radicals have been shown to have no influence on the maximum quantity of physically adsorbed SO2; rather, they constitute the active centers of the carbon surface in the chemisorption of SO2. The quantity of chemisorbed SO2 increases with a rise in concentration of free radicals on the carbon surface. If SO2 and O2 are introduced on the catalyst simultaneously, the increase in the mass of the catalyst as a result of the adsorption and oxidation processes which occur is found to be proportional to the size of the catalyst surface. However, the quantity of SO3 formed does not depend on the total amount of adsorbed reactants, but on the number of chemisorbed molecules. Samples of carbon characterized by the strongest signal in resonance spectrum have been found to have the maximum catalytic activity.

14030

Guyot, G.

S.N.P.A. PROCESS FOR THE TREATMENT OF RESIDUAL GASES WITH LOW CONCENTRATION IN SO2. (Procede developpe par la Societe Nationale des Petroles d'Aquitaine pour traiter des gaz residuaires charges de faibles teneurs de SO2). Text in French. Chim. Ind. (Paris), 101(1):31-34, Jan. 1969.

The sulfuric acid plant of the Societe Nationale des Petroles d'Aquitaine at Lacq is able to produce a sulfuric acid with a concentration of 94% from gases containing only 1.5% by volume of SO2 and H2S, and 30% water vapor. The process involves the oxidation of H2S to SO2, followed by the oxidation of SO2 to SO3 on a vanadium catalyst in an adiabatic reactor, gas-liquid contact in a bed of Raschig rings, and, finally, the absorption of SO3 by diluted acid circulated and cooled in graphite exhangers. After leaving the absorption unit, the gas is passed through a Teflon filter which retains any drops of acid that are carried along with the gas. To avoid the condensation of acid in the chimney, gases are lightly heated before being exhausted into the atmosphere. Gases emitted from the plant contain 75 mg/cu m SO3 at the most.

14386

Smyslov, N. I.

MEANS OF ELIMINATING HARMFUL WASTES FROM SULFURIC ACID TOWERS. (Puti likvidatsii vrednykh vybrosov bashennykh sernokislotnykh sistem). Text in Russian. Ochistka Ispol'z. Stochn. Vod Prom. Vybrosov, Kiev, Sb., 1964:88-93.

Various causes of instability in tower operation, and hence increases in the amount of harmful wastes above permissible levels together with a decrease in productivity, are discussed in general terms. Measures adopted in 1954 to normalize operating conditions and limit each plant to operation with a single raw material type were only partially implemented but did yield positive results; by 1962, the average consumption of nitrogen oxides per ton of products for all plants had been reduced from 28 kg (1954) to 20 kg; leading plants reduced HNO3 consumption to as low as 10 kg. The so-called cross-reflux scheme has recently been proven effective and is recommended for adoption. Conversion to a combined contact-tower system at the Odessa plant has been completed; it can be applied to plants operating with pure sulfur or pyrite. It is concluded that sufficient means are available for improving sulfuric acid systems and for eliminating harmful wastes; accelerated implementation is urged.

14533

A METHOD FOR THE RECOVERY OF NITROGEN OXIDES. (Werkwijze voor het winnen van stikstofoxyden). Text in Dutch. (Universal Oil Products Co., Des Plaines, Ill.) Dutch Pat. 6,607,036. 13p., Nov. 25, 1966. (Appl. May 23, 1966, 8 claims).

The system is particularly suited to handling tail gases from a nitric acid factory and from the lead chamber process of a sulfuric acid factory. This method also gives a distinct improvement in the output of a nitric acid plant. The waste gas is passed over a bed of adsorbing coal particles followed by a hot fluid desorption medium to remove the adsorbed nitrogen oxides from the particles. The desorption medium consists of steam at about 10 atm at a temperature greater than 157 C and preferably more than 177 C. The nitrogen oxide-containing steam is cooled and the mixture obtained is returned to the adsorption zone of the nitric acid plant. The desorption medium can also be hot air. The depth of the bed should not exceed 0.3m to prevent a large pressure drop. The stream waste gas through the adsorption bed is diverted upon saturation with nitrogen oxides to another bed of adsorbing coal. The coal in the first bed is then desorbed until the second bed is saturated and the cycle is repeated. Waste gas from sulfuric acid plants is treated the same way. The advantages of this method are better removal of nitrogen oxides with cost reduction, since no extra fuel is required. Due to integration of the units for preparation of acid and for recovery, higher output is obtained; output of a nitric acid plant can be increased by 5% by more complete use of NO2.

14568

Safiullin, N. Sh. and M. I. Olevinskiy

RENDERING HARMLESS THE WASTE GASES FROM SULFURIC ACID TOWER SYSTEMS. (Obezvrezhivaniye otkhodyashchikh gazov bashennykh sernokislotnykh sistem). Text in Russian. Khim. Prom. (Moscow), no. 3:132-136, 1955.

It is reported that a complex consisting of a precipitation section irrigated with strong acid and a moist electrofilter will assure reliable purification of waste gases from tower systems. Such a system reduces the aerosol and vapor sulfuric acid content to 0.04-0.10 g/cu m, a 20-fold reduction. Complete absorption of an equimolar mixture of nitrogen oxides results in a reduction in specific consumption rate of nitric acid by 6-8 kg/ton. Absorption of nitrogen oxides and reduction of nitric acid discharge rate may be increased significantly by supplying the equipment with nitrogen oxides with a degree of oxidation of 45-50%. In order to assure normal operation of the equipment, the amount of original sulfuric acid circulating in it must be not less than 88%. Joint operation of both the irrigating system and the electrofilter is imperative for proper purification of waste gases.

14660

Herzog, G.

DESULFURIZATION OF FLUE GASES - PROBLEMS AND SOLUTIONS. (Die Entschwefelung von Rauchgasen Probleme und Losungswege). Text in German. Energietechnik, 17(12):539-542, Dec. 1967. 9 refs.

The state of the art of desulfurization methods in East Germany is reviewed. The main emission sources for SO2 in East Germany are the power production plants and the sulfuric acid industry. In 1965, the power plants emitted a total of 685,000 tons of SO2. The sulfuric acid plants emitted about 17,500 tons of SO2 in 1966. No economic desulfurization method yet exists to cope with these enormous emission quantities. The wet processes based on absorption of SO2 by aqueous or alkaline suspensions or solutions have three specific disadvantages. The gases must be cooled prior to the desulfurization process, which leads to corrosion problems in the heat exchanger; there is a waste water problem; and the cold, wet gases have no thermal buoyancy. Due to such problems, industry has turned to dry methods in recent years. The Reinluft process for oxidation of SO2 to sulfuric acid over an activated carbon catalyst has been of prime interest, although it is not economical. A brief outline of the essential principles of this method is given. Oxidation of SO2 to SO3 and subsequent removal of the latter by condensation with water to form H2SO4 or by adsorption on activated coal is mentioned. Studies are presently underway in East Germany on the binding of SO2 to alkaline substances such as ash.

15739

Popovici, N., P. Potop, L. Brindue, and P. Anghel

PROPOSED EQUIPMENT FOR RETAINING SO2-CONTAINING RESIDUAL GASES DERIVED FROM THE MANUFACTURE OF SULFURIC ACID, IN THE CONTEXT OF A FERTILIZER MANUFACTURING PLANT AND UNDER FAVORABLE ECONOMIC CONDITIONS. (Proiectarea unei instalatii de retinere a gazelor reziduale cu SO2 de la fabricarea acidului sulfuric in cadrul unei uzine de ingrasaminte complexe, in conditii economice avantajoase). Text in Romanian. Rev Chim. (Bucharest), 18(1):40-44, 1967. 17 refs.

Economic development of Rumania calls for increasing the production of chemical fertilizers, including ammonium phosphate, to 340,000 tons in 1965 and 1,300,000 tons in 1970. The need for industrial sulfuric acid is also increasing. Ammonia can be used to remove SO2 from exhaust gases and phosphoric acid to decompose the ammonium sulfite-bisulfite solution. Optimum values, when working with an SO2 concentration of 0.2-0.3%, are a liquid-gas relationship of about 3.5 per thousand; a SO2/NH3 ratio of 0.7; a maximum and 50 C maximum concentration of ammonium sulfite bisulfite in solution of 700 grams per liter; absorption temperature. Phosphoric acid is used as decomposing agent of the bisulfite solution, preferably with a gas flow of 75 meters per second. Optimum values to be achieved include: a 50% P205 concentration in the phosphoric acid; an H3P04/NH3 ratio of 2.2 minimum; an operating temperature of 95 C; and a liquid-gas ratio of .0043. Under these conditions a 90% recovery of SO2 is possible. A device designed to achieve these conditions can process about 44,000 Nm3 per hour of residual gases containing 0.2-0.3% SO2 at a minimum operating cost. This cost (for water, steam, and electrical energy) is offset by the amount of extra sulfuric acid obtained: about 3,500 tons per year.

15846

Koto, K.

REMOVAL OF SULFUR DIOXIDE FROM EXHAUST GAS. (Haigasu chu no aryusan gasu shori-ho). Text in Japanese. (Toa Gosei Chemical Industry Co., Japan) Japanese Pat. 174,880. 2p., June 6, 1948. (Appl. Dec. 28, 1943, claims not given).

The coal dust and inorganic compounds (SiO2, Fe2O3, Al2O3, CaO) resulting from coal gas production are used to remove sulfur dioxide gas from factories engaged in sulfuric acid manufacture. This coal dust is activated by the high temperature, oxygen, and steam, and shows a tremendous adsorptive power for SO2. In addition, the inorganic compounds included in large amounts with the coal dust (40.23 to 57.96%), neutralize the SO2 present in the water. Thus, 600 l of coal dust is homogenized with 1.7 l of water and is scattered inside a cylinder in which SO2 (0.7% of the total exhaust gas) passes at the rate of 135 cu m/min. The washed exhaust gas includes only 0.04% of SO2 at a temperature of 12 C. The coal dust can be used in this procedure for 48 hrs.

15879

IMPROVEMENTS IN OR RELATING TO A PROCESS FOR RECOVERING SULPHUR DIOXIDE FROM A GAS MIXTURE CONTAINING THE SAME. (American Smelting and Refining Co., New York) British Pat. 564, 734. 5p., Oct. 11, 1944. (Appl. June 29, 1942, 16 claims).

In a cyclic process for recovering sulfur dioxide from smelter smoke, flue gases, etc., sulfur dioxide-containing gas is first absorbed in an aromatic amine reagent of the aniline class and its homologues and derivatives preferably dimethylaniline. The exit gases are then scrubbed with sodium carbonate and sulfuric acid solutions to remove the reagent, following which the resulting solutions are combined and heated by steam to release the sulfur dioxide and the regenerated amine esters. The released reagent is returned to absorb additional sulfur dioxide. While various types of scrubbers may be employed in the process, best results are obtained with bubble towers. Compared to other processes, the operation greatly reduces reagent losses and regenerative costs.

15991

Fleming, Edward P. and T. Cleon Fitt

RECOVERY OF SULPHUR DIOXIDE FROM GAS MIXTURES. (American Smelting and Refining Co., New York) U. S. Pat. 2,295,587. 3p., Sept. 15, 1942. (Appl. Nov. 25, 1939, 7 claims).

A cyclic process for recovering sulfur dioxide from smelter smoke, flue gases, and the like uses an aromatic amine as the reagent absorbant. Compared to other methods, the process, which preferably takes place in a bubble tower, greatly reduces reagent losses and regenerative costs. Sulfur dioxide-bearing gases, after cleaning to remove nongaseous contaminants, are passed to the bottom of an absorber where they flow upward in countercurrent to the absorbent, preferably dimethylaniline. Within the absorber, the sulfur dioxide is transferred from the gas mixture to the dimethylaniline, with the efficiency of the transfer enhanced by controlled cooling of the absorber. The sulfur dioxide-depleted gases are passed through sodium carbonate and sulfuric acid solutions and steam is added to free the gases from the regeant. The aromatic amine and sulfur dioxide mixture is passed through a heat exchanger on its way to the stripping tower. The excess steam and reagent vapors are brought into contact with the aromatic amine and sulfur dioxide mixture to expel the latter and yield a warm stripped reagent. The stripped reagent is further cooled and separated into two components, mainly water and reagent. The anhydrous reagent is returned for treating additional volumes of sulfur dioxide-bearing gases.

16289

Yeselev, I. M., I. P. Mukhlenov, and D. G. Traber

CERTAIN QUESTIONS ABOUT THE OPERATING REGIME OF A COMBINED CONTACT-TOWER SYSTEM. (Nekotoryye voprosy rezhima raboty kombinirovannoy kontaktno-bashennoy sistemy). Text in Russian. Zh. Prikl. Khim., vol. 37:1204-1210, May-Aug., 1964. 13 refs.

Analysis of data from the literatures showed that optimum temperatures in the preliminary catalytic oxidizing arrangement with a fluidized catalyst bed are subject to the same dependences as in arrangements with a stationary bed. Formulated calculations indicate that a system producing 315,000 tons of sulfuric acid per year is economically feasible with a preliminary oxidation arrangement using an iron oxide catalyst with a particle size ranging from 0.80 to 1.30 mm.

16290

Yeseleve, I. M., I. P. Mukhlenov, and D. G. Traber

USE OF IRON CATALYST IN THE CONTACT-TOWER PROCESS. II. (K voprosu ispol'zovaniya zheleznogo katalizatora v kontaktno-bashennom protsesse). Text in Russian. Zh. Prikl. Khim., vol. 37:972-979, May-Aug., 1964. 14 refs.

The rate of sulfur dioxide oxidation in a reactor with a fluidized iron oxide catalyst bed is reduced as compared with a reactor with a stationary layer. The degree of reduction in rate is characterized by the ratio of contact time required to achieve a given degree of conversion in a fluidized catalyst bed to the analogous contact time for a stationary layer, all other conditions being equal. Empirical formulas derived for determining this ratio are shown to describe the kinetics of SO2 oxidation in an arrangement with a fluidized catalyst bed with sufficient accuracy. Verification on a pilot installation has demonstrated complete suitability of these equations for designing industrial reactors.

16291

Lastochkin, Yu. V., I. P. Mukhlenov, I. G. Lesokhin, Ye. S. Rumyantseva, and T. P. Bondarchuk

OXIDATION OF SULFUR DIOXIDE IN AN ARRANGEMENT WITH A PSEUDO FLUIDIZED BED OF IRON OXIDE CATALYST UNDER CONDITIONS OF CONTACT-TOWER PRODUCTION OF SULFURIC ACID. (Okisleniye sernistogo gaza v apparate s psevdoozhizhennym sloyem okisnozheleznogo katalizatora v usloviyakh kontaktno-bashennogo proizvodstva sernoy kisloty). Text in Russian. Khim. Prom. (Moscow), 42(6):45-48, 1966. 4 refs.

Optimum conditions for sulfuric acid production in a pseudo fluidized bed of an iron oxide catalyst were studied on both a laboratory and industrial scale. Data indicated that, with a sulfur dioxide content of 12% at an optimum temperature of 680-700 C, there is a sharp rise in catalyst productivity with an increase in volumetric gas flow rate. With a constant linear gas flow rate, there is a resultant decrease in hydraulic resistance of the system and an increase in the volumetric flow rate, at the same time, a minimum required degree of preliminary oxidation is assured. Increasing the volumetric flow rate also reduces catalyst consumption to five times below existing systems using vanadium catalysts.

16447

Tamm, O. M. and E. M. Vasil'eva

MEASURES FOR REDUCING ATMOSPHERIC POLLUTION IN CITIES OF THE ESTONIAN SSR. (Meropriyatiya po snizheniyu zagryazneniya atsmofernogo vosdukha v gorodakh Estonskoy SSR). Text in Russian. In: Sanitation Measures Against Air and Water Pollution in the Planning of Cities. (Ozdorovleniye vozdushnogo i vodnogo basseynov gorodov). Government Committee on Civil Building and Architecture (ed.), Lecture series no.2, Kiev, Budivel 'nik, 1968, p.39-40.

Air pollution problems in Estonia center around the cities of Tallinn and Kohtla-Jarve. A paper and pulp plant, a sulfuric acid plant, a mineral-enriching installation, and a shale processing combine are cited as major air pollution sources in the Kohtla-Jarve area and some of the measures taken to control these sources are mentioned. Control measures widely instituted in the country include: conversion to gas and liquid fuels, the use of central heating plants, removal from the cities of large pollution sources such as asphalt-concrete plants, and the closing of installations which do not lend themselves to air pollution control (e.g., the stone crushing facility at the Tallinn concrete plant, and the asphalt-concrete plant at Toyl).

16480

Boreskov, G. K., L. G. Rimmer, and E. I. Volkova

IGNITION TEMPERATURE OF VANADIUM SULFURIC ACID CATALYSTS. (Temperatura zazhiganiya vanadievykh sernokislotnykh katalizatorov) Text in Russian. Zh. Prikl. Khim., 13(3):250-260, 1949. 7 refs.

A thermographic method of determining the ignition temperature of the catalytic mass was developed and verified. The ignition temperature of sulfuric acid-vanadium catalysts was experimentally determined for gas mixtures containing from 7-95% sulfur dioxide and 5-75% oxygen at initial degrees of catalysis of 0 to 50%. It was shown that a change in the ignition temperature of vanadium catalysts in relation to the composition of the gas was dependent on the shift of the temperature of the phase transformation of the catalytically active polyvanadates into vanadyl sulfates and with a change in the reaction rate. Equations are proposed and a diagram constructed for determining of the ignition temperature of gas mixtures of varying composition. At a constant concentration of oxygen, the ignition temperature was practically independent of the sulfur dioxide concentration. With an increase in oxygen concentration, the ignition temperature decreased. For gas obtained by roasting pyrites and containing 7% sulfur dioxide and 11% oxygen, the ignition temperature was 423 C. For a stoichiometric mixture (66.7% sulfur dioxide, 33.3% oxygen), the ignition temperature equalled 394 C. An increase in the degree of catalysis to 50% increased the ignition temperature 20-30 deg. A decrease in the activity of the vanadium catalysts as a result of terminal treatment or lengthy processing increased the ignition temperature which was directly proportional to the logarithm of the ratio of thyinitial and final values of the reaction rate constant. The temperature of extinction was determined for gas mixtures containing 7% sulfur dioxide; 11% oxygen and 50% sulfur dioxide; and 50% oxygen. At a hypothetical linear gas flow rate equal to 0.15 m/sec, the temperature of extinction in the first case was 7 deg and in the second, 85 deg below the temperature of ignition. The difference in the temperatures of ignition and extinction corresponded well with the difference in surface temperature of the grains in the first layer of catalyst and gas, calculated according to the rate of heat loss. This indicates that catalytic oxidation of sulfur dioxide is carried out entirely at the surface of the catalyst.

16718

Remirez, Raul

DOUBLE-ABSORPTION GETS U.S. FOOTHOLD. Chem. Eng., 76(2):80-82, Jan. 27, 1969.

The first sulfuric acid plant in the Western Hemisphere to use a double-absorption process will soon be constructed. The process has been popular in Europe not only for its antipollution properties but also because the higher conversion (99.5%) results in attractive raw-material savings. However, installation and operating costs still appear to be substantially higher than for single absorption units. When sulfur emission control laws are enacted it is probable that single absorption plants now in existence will find it desirable to either convert to the double absorption process or improve the efficiency of the present installation. Some of the possible avenues open to improve the single absorption units are discussed.

17053

Connor, John M.

NEW METHOD REDUCE AIR POLLUTION IN OLDER SULFURIC ACID PLANTS. Water Sewage Works, 117(1):IW/16-IW/19, Jan.-Feb. 1970.

There are a large number of plants in operation and in good shape, producing large quantities of acid, which were not designed according to current conversion standards and which cannot, without modification, meet the proposed new air pollution standards. Many of the smaller plants will probably be shut down, but the larger plants in good condition can be modified. Two schemes are offered for removing the sulfur dioxide from sulfuric acid plant stacks. Flow charts are given. A modified version of the first scheme could be designed to suit roaster gas plants in some cases, but the problem in connection with these plants is much more complex and each plant would have to be considered individually. The second scheme is simpler to install in an existing plant, and can potentially increase the total output of the plant by 10 to 20% and improve conversion at the same time. By taking advantage of the fact that the double absorption process is usually operated with 10% SO2 in the converter feed, compared to 8% in the standard plant, scheme 2 could be used to increase production by as much as 35%.

17810

Srbek, Josef, Rostislav Klimecek, and Lubomir Jager

PROCESS OF RECOVERING SULFUR DIOXIDE FROM EXHAUST GASES. (Zpusob zachycovani kyslicniku siriciteho z odpadnich plynu). Text in Czech. (Assignee not given.) Czech. Pat. 108093. 3p., Aug. 15, 1963. (Appl. Nov. 15, 1958, 2 claims).

A process of recovering sulfur dioxide during the last stages of sulfuric acid manufacture is presented. The exhaust gas is channelled to the absorption device, where a solid compound of zinc is in water suspension. The process is characterized by using only that amount of the water suspension of zinc oxide or hydroxide which corresponds to the amount of the absorbed SO2 from the exhaust gases. To prevent solidifying the suspension, a very diluted suspension below 3% of the total amount of zinc should be used.

17887

Garbato, Carlo

PROCEDURE FOR CATALYTIC OXIDATION OF SULFUROUS GASES, NO MATTER HOW PRODUCED, AS A MEANS OF MANUFACTURING SULFURIC ACID AND OLEUM, USING CATALYSTS DISPERSED AS A FINE DUST IN THE REAGENT GAS AND CIRCULATING WITH IT: MEANS AND DEVICES FOR ITS APPLICATION. (Procedimento per l'ossidazione catalitica di gas solforosi, comunque prodotti, per la fabbricazione di acido solforico ed oleum a mezzo di catalizzatori dispersi in povere fine nella massa gassosa reagente, e con essa fluenti mezzi e apparecchiatura per realizzarlo). Text in Italian. (Assignee not given.) Italian Pat. 435,452. 3p., May 18, 1948. (Appl. April 11, 1946, 6 claims). In the process of making sulfuric acid from sulfurous gases, the principle of a 'flowing' rather than a 'static' catalyst is preferred, wherein the catalyst is pulverized to a suitable particle size and is circulated directly with the gas itself throughout the apparatus. This avoids the problem, encountered with the stationary catalyst, of the accumulation of heat in the catalyst, which if not dissipated in some way or other causes the reaction temperature to rise, disturbing the relationship of SO3 to SO2, thereby reducing the yield of sulfuric acid. The preferred catalyst is an iron oxide produced by roasting powdered iron pyrite. The pyrite roasting and the SO2 oxidation take place in the same apparatus, the iron oxide produced being used immediately as catalyst for the oxidation of SO2. Catalysis takes place in a special apparatus consisting of a metal chamber, which is cooled by the circulation of some type of fluid which

absorbs excess heat produced by the reaction. The apparatus is constructed so as to resist pressures above atmospheric pressure. A partial catalysis may also be performed with a circulating catalyst wherein the process is completed with the conventional 'static' process.

17889

Roesner, Gerhard

UTILIZATION OF INDUSTRIAL AND RESIDUAL GASES BY THE METHODS OF THE LURGI ENTERPRISES. (L'Utilisation de Gaz Industriels et Residuels par les Procedes des Societes Lurgi). Text in French. Metallges. Periodic Rev., no. 13:22-31, 1938. 8 refs.

The modern trend in the chemical industry is to utilize processes in which the chemical reactions take place in the gas phase. This raises the problems of cleaning gases prior to their reaction, as well as of processing the residual gases of that reaction. The Lurgi enterprises address themselves to the task of providing engineering solutions to these kinds of problems, including processes of purification of reacting gases of substances which 'poison the catalyst' used to accelerate or to make possible the desired reaction and processes of removel of dust and other particulate solids, of condensable vapors, and of gaseous constituents from the residual gases, with the objective of their recovery or of prevention of their discharge into the atmosphere. Various devices and existing industrial installations are reviewed, such as 'Multiklon' centrifugal dust separators, electrostatic filters for removal not only dry dusts but also condensable mists, scrubbing towers for selective absorption of gases or mists by liquid absorbents and the 'Benzobon' process of absorption by solid charcoal of benzene from city gas or coking-plant gas. A large section of the paper is devoted to the removal of sulfur dioxide and hydrogen sulfide from waste gases, the production of ammonium sulfate and particularly the production of sulfuric acid.

19033

Roll, Kempton H.

CONTROLLING CORROSIVE AIR POLLUTANTS. J. Air Pollution Control Assoc., 1(6):6-10, May 1952.

Control of an aerosol, such as sulfuric acid mist, is a problem of collection, but an entirely different technique must be utilized in the case of a gas such as sulfur dioxide. Conversion of SO2 to H2SO4 is a possibility, as is absorption of the gas in chemicals from which it can be recovered as pure SO2. Hydrogen sulfide is now being treated in a number of oil refineries by burning it in air to convert it to sulfur dioxide and water vapor or by burning it in the presence of sulfur dioxide to convert it to elemental sulfur and water vapor. It is common practice to add an electrostatic precipitator at the end of the processing circuit through which all gases bearing sulfuric acid mist must pass. As the gases pass through the precipitator, they receive electrical charges which cause them to coalesce, whereas the sonic collector operates on the principle that high intensity sound will cause particulate matter to agglomerate and descend to the bottom for removal. One of the newest and most successful methods of converting sulfur dioxide to liquid involves dissolving the impure gas in cool dimethylaniline and extracting it as pure SO2 by heating the pregnant dimethylaniline solution.

19228

Drechsel, Herbert, Karl-Heinz Doerr, and Hugo Grimm

METHOD FOR THE CATALYTIC OXIDATION OF SO2 TO SO3 IN SO2 LADEN GASES AND PRODUCTION OF SULFURIC ACID. (Verfahren zur katalytischen Oxydation von SO2 in SO2-haltigen Gasen zu SO3 und Herstellung von Schwefelsaeure). Text in German. (Metallgesellschaft A. G., Frankfurt (W. Germany)) Swiss Pat. 478,712. 4p., Sept. 30, 1969. (Appl. Oct. 25, 1963, 5 claims).

A method for the catalytic oxidation of sulfur dioxide in SO2-laden gases to SO3 with the aid of oxygen containing gases and production of sulfuric acid by absorption of the formed SO3 is described. The SO2-laden gases are heated by heat exchange with the formed SO3 containing gases. The SO2 content in the gases is increased prior to catalytic oxidation by mixing with gases from the combustion of sulfur. The invention pertains to the use of primary gases with an SO2 content at 9% or less by volume. The hot gases from the combustion of sulfur are mixed at least with part of the heated flow of primary gas after it has left the heat exchanger and prior to the entrance into the catalytic oxidation chamber. The sulfur and oxygen quantities must be selected so that the sum of the heat developing at the combustion of sulfur to SO2 plus the heat developing at the oxidation of SO2 to SO3 suffices to compensate for the heat loss suffered at the intermediate absorption of SO3. The sulfur dioxide content of the mixture of primary gas/sulfur combustion gas may not exceed 9% by volume. A branch of non-heated SO2 containing primary gas is added to this gas mixture to obtain a temperature of 440 C (maximum). If the primary gas contains less than 9% SO2, 3 to 4 kg, preferably 3.5 kg, sulfur per 1000 cu m primary gas are burned for each missing percentage and added to the gas.

19370

Ganz, S. N., I. E. Kuznetsov, V. A. Shlifer, and L. I. Leikin

REMOVAL OF NITROGEN OXIDES, SULFUR DIOXIDE, MIST, AND SULFURIC ACID SPRAY FROM EXHAUST GAS BY PEAT-ALKALI SORBENTS UNDER PRODUCTION CONDITIONS. J. Appl. Chem. USSR (English translation from Russian of: Zh. Prikl. Khim.), 41(4):700-704, April 1968. 1 ref.

Optimal conditions were determined for the absorption of nitrogen oxides, sulfur dioxide, mist, and sulfuric acid spray from sulfuric acid tower systems by means of peat-alkali absorbents. Shredded peat with a moisture content up to 50% was used for absorption; solid ash, apatite concentrate, aqueous ammonia, and ammonia gas were used as additives to the peat. The moisture content of the peat in the absorber must not be below 25-30%, as at lower moisture contents the peat begins to form dust and the absorption process deteriorates considerably. Ammonia introduced directly to the fluidized beds was the most effective additive, removing 90% of the acidic components of the waste gas in 90 min. For 80% purification of the gas in one hr, it is sufficient to have one or two beds with a total sorbent height of about 500 mm. A sulfuric acid plant with a gas output of up to 60,000 cu m/hr will require 0.294 tons ammonia, 1.5 tons of dry peat, and 3 tons of peat (with a moisture content of 50%) per hr for gas decontamination. Sorption of the gases by the peat-ammonia sorbent yields an effective organomineral fertilizer.

19383

SO2 ABSORBER: TWO SCRUBS BETTER THAN ONE. Chem. Eng., 62(2):132-134, Feb. 1965.

Sulfur dioxide in concentrations as high as 0.9% is effectively removed from sulfuric acid plant fumes in a double scrubbing tower that comprises two separate scrubbers built one above the other. The scrubbing system utilizes ammonium sulfite-bisulfite solutions. Inlet gases pass countercurrent to the first scrubbing solution in the lower scrubber, where most of the sulfur dioxide is recovered. Gas then moves through a chim-

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ney to the upper section, where a weaker solution removes the remaining sulfur dioxide. Tail gases discharged to the atmosphere contain less than 0.3% sulfur dioxide. Ammonium sulfate is recovered as a by-product by passing the solution from the lower scrubber to a stripping tower and reacting it with sulfuric acid from the acid unit. The ammonium sulfate is pumped to an adjacent fertilizer plant.

19469

Woollam, J. P. V. and A. Jackson

THE REMOVAL OF OXIDES OF SULPHUR FROM EXIT GASES. Trans. Inst. Chem. Engrs. (London), vol. 23:43-51, 1945. 33 refs. (Presented at the Institution of Chemical Engineers North Western Branch Meeting, Manchester, England, March 17, 1945.)

A process is described for removing sulfur dioxide and trioxide from the exit gases of contact acid plants, boiler installations, and smelting processes. It consists of scrubbing the gases with a solution of ammonium sulfite, bisulfite, and sulfate mixture, keeping the pH value at a predetermined figure by the addition of aqueous ammonia, and bleeding off the make of solution to an autoclave where it is heated with steam to form ammonium sulfate solution and sulfur. On the basis of encouraging preliminary tests, a large-scale process facility was built at a contact acid plant. Testing and results are given in detail, and permit definition of the limits for optimum conditions. The SO2 and SO3 present in the exit gases can be reduced to less than 5% of their original value, and the price of the ammonia feed can be reduced to 60% of that for the pure 25% ammonia by the use of 18-20% concentrated gas works liquor. Two applications of the process are briefly discussed: acid plant exit gas treatment, and 'devil gas' treatment with reference to a 15% hydrogen sulfide gas mixture.

19486

Hara, Haruichi

RESEARCHES ON CONTACT REACTION RATE FOR SO2-OXIDATION. Ann. Genie Chim., 1967:187-196, 1967. 6 refs.

The velocities of contact reaction rates for sulfur dioxide oxidation over vanadium pentoxide-industrial catalyst were measured for both forward and reverse reactions using a differential reactor. For gas phase reactions, an approximate rate formula of catalytic reaction was derived theoretically in case of the reactions being in stationary state and having no side and no consecutive reactions. Results of applying the derived formula to the experimental data and to many reactor designs for sulfuric acid factories in Japan were satisfactory. (Author abstract modified)

19592

Takeuchi, Tsugio and Tamotsu Tanaka

DRY REMOVAL PROCESS OF SULFUR COMPOUNDS IN EXHAUST STACKS. Translated from Japanese. Franklin Inst. Research Labs., Philadelphia, Pa., Science Info. Services, 3p., Oct. 29, 1969.

The ability of activated charcoal to remove sulfur dioxide from exhaust gas in the form of sulfuric acid was tested by passing the treated gas through a hydrogen peroxide solution and titrating by alkali the H2SO4 that was produced in the solution. The amount of sulfur dioxide entrained by the charcoal varied greatly with the linear velocity of the gas and with space velocity. In addition, activated charcoal wetted with ammonium sulfate captured about three times as much sulfur dioxide as the original activated charcoal. Presumably, the sulfuric acid produced on the charcoal reacts with ammonium sulfate to yield ammonium hydrosulfate and to free sulfuric acid not produced on the charcoal. The experiments demonstrate that ammonium sulfate can be used to regenerate the activated carbon and that crystallized ammonium sulfate can be easily recovered as a by-product.

19593

Chemical Construction Corp., New York, N. Y., Consulting Div.

A BIBLIOGRAPHY OF REMOVAL OF NITROGEN OXIDES FROM WASTE GASES, EXCEPT METHODS BASED ON REDUCTION AT HIGH TEMPERATURE AND CATALYTIC DE-COMPOSITION, 1907-1968, WITH ABSTRACTS. (PART 4). In: Engineering Analysis of Emissions Control Technology for Sulfuric Acid Manufacturing Processes. Volume 2. Literature Search. Contract CPA 22-69-81, 52p., March 1970. 158 refs. CFSTI: PB190471

References and abstract from U. S. and foreign sources, including patents, are arranged and indexed by a variety of individual adsorption and absorption control methods, within one of two major subdivisions. Part One pertains to the removal of nitrogen oxides from chamber and Mills-Packard sulfuric acid plant tail gases, while Part Two is concerned with the removal of low concentrations of nitrogen oxides from waste gases.

19594

Chemical Construction Corp., New York, N. Y., Consulting Div.

A BIBLIOGRAPHY OF SULFUR TRIOXIDE AND SULFURIC ACID MIST EMISSIONS AND THEIR CONTROL, 1907-1968, WITH ABSTRACTS. (PART 3). In: Engineering Analysis of Emissions Control Technology for Sulfuric Acid Manufacturing Processes. Volume 2. Literature Search. Contract CPA 22-69-81, 32p., March 1970. 105 refs. CFSTI: PB 190471

References and abstracts from U. S. and foreign sources, including patents, are arranged and indexed by subject into seven major categories. These are: sulfuric acid mist formation; physical behavior of H2SO4 mists; sulfuric acid mist emissions and their control; mist removal in general; sulfuric acid mist removal; sulfur trioxide removal; and analytical methods.

19595

Chemical Construction Corp., New York, N. Y., Consulting Div.

A BIBLIOGRAPHY OF SULFUR DIOXIDE REMOVAL AND RECOVERY FROM WASTE GASES AND SULFURIC ACID PLANT TAIL GASES, EXCLUDING THE LIMESTONE AND DOLOMITE INJECTION PROCESSES, 1953-1968, WITH ABSTRACTS. (PART II). In: Engineering Analysis of Emissions Control Technology for Sulfuric Acid Manufacturing Processes. Volume 2. Literature Search. Contract CPA 22-69-81. 58p., March 1970. 223 refs. CFSTI: PB 190471

References and abstracts from U. S. and foreign sources, including patents, are arranged and indexed by subject within 13 major categories. These are: data on SO2 emissions; toxicity and tolerance of SO2 in the atmosphere; absorption of SO2 in water; absorption of SO2 in inorganic aqueous salt solutions; aqueous slurries; sorption by solid materials; molten salts; aqueous solutions of organic compounds; oxidation of SO2 to SO3; removal of SO2 by reduction; chromatographic separation; general reviews and economic aspects; and bibliographies. Several tables of data on SO2 air pollution are also included.

19606

Burgess, Wilfred Duncan

TREATMENT OF FLUE GASES. (Consolidated Mining and Smelting Co. of Canada, Ltd., Montreal (Quebec)) U. S. Pat. 2,862,789. 8p., Dec. 2, 1958. 8 refs. (Appl. May 17, 1954, 4 claims).

A method of economically recovering sulfur from flue gases which contain very small amounts of sulfur oxides is presented. The process employs ammonium sulfate as an absorbing agent, and involves a series of cooling and concentrating steps and treatment with sulfuric acid. Previously, in applying this absorption process to the treatment of gases from combustion furnaces, a number of difficulties were encountered, such as: high cost of cooling gases to the desired temperature, problems with fly ash acting as condensation nuclei, and evaporation of large quantities of water in order to avoid a very dilute concentration of ammonium sulfate. These difficulties are successfully overcome by the process described.

19644

Tsudo, Kozaburo

OPERATION OF SO2 GAS ABSORBING PLANT. Nippon Kokan Giho (Tokyo), 19(1):1-6, 1966. Translated from Japanese Belov and Associates, Denver, Colo., 19p., April 21, 1970.

A method for controlling sulfur emissions from a sulfuric acid plant is described. This method is a limestone-gypsum injection where the sulfurous acid gas and sulfur dioxide are neutralized, and the gypsum is recovered. Lime milk is sprayed into an elimination tower where the SO2 and acid are absorbed. The solution containing SO2 is sent to a pH tower where it is regulated to a suitable pH by an acidification reaction. Calcium sulfite, formed in the elimination tower, is sent to an acid tower. Here it is acidified to calcium sulfate to form gypsum by minute mist. The gypsum is transported to a gypsum thickener where it is separated, washed, and deliquidated. The operation and production data of this system are also included.

19682

Amelin, A. G.

CONDENSATION OF SULPHURIC ACID. Ann. Genie Chim., 1967: 52-61, 1967. 12 refs.

The process of sulfuric acid condensation is complicated by several concurrent processes which are specific for the production of sulfuric acid. Therefore, proper corrections should be introduced into average calculation formulae. Moreover, sulfuric acid vapor is easily condensed in volume, forming a stable mist which causes great difficulties in production processes. When a vapor-gas mixture contacts a colder surface, two independent processes occur simultaneously cooling of the gas and condensation of the vapor. The rates of these processes are in such a relation that at the beginning, vapor oversaturation increases, reaches the maximum value, and then goes down. When oversaturation reaches the critical value, the vapor condenses in volume forming nuclei which later increase because of condensation growth. While considering the process of vapor condensation on the surface, it is necessary to differentiate strictly between conditions before and after mist formation. In the first case, the process of condensation can be calculated according to well-known formulae, in the second case a stage-by-stage method of calculation is used. The results of investigations show that the necessary data are available for establishing such condensations under which the formation of mist can be eliminated. However, this is usually connected with the decrease of condensation process rate. Therefore it often appears very profitable to conduct the process at high rates with the formation of larger drops of mist and then to remove that mist in filters. Minimum material expenses for the realization of the process are determined by vapor condensation on the surface and by the conditions of mist evolution in filters. (Author abstract modified)

19856

Postnikov, V. F. and T. I. Kunin

ON THE RECOVERY OF SO2 FROM WASTE GASES FROM CONTACT SULFURIC-ACID PLANTS. (K voprosu Izvlecheniya SO2 iz otkhodyashchikh gazov kontaktnykh Sernokislotnykh zavodov). Text in Russian. In: Tr. Ivanovsk. Khim. Tekhnol. Inst., no. 2, p. 56-70, 1939.

The use of a quinoline-water mixture as a sulfur dioxide absorber was studied experimentally, and a 1:1 ratio was found to be optimum. Absorption was significant, but neither the degree of SO2 accumulation, nor the frequency of regeneration, were determined. Studies were made at 20-100 C with gas mixtures containing 0.7% SO2 and 0.2-0.3% SO3, and with gas flow rates ranging 0.09-0.24 m/sec.

19886

Bacon, Raymond F. and Isaac Bencowitz

RECOVERY OF SULPHUR. (Raymond F. Bacon) U. S. Pat. 1,917,234. 5p., July 11, 1933. (Appl. July 29, 1930, 11 claims).

In various processes suggested for recovering elemental sulfur from roaster gases, the sulfur dioxide gases are usually treated at some point removed from their source. This results in loss of the sensible heat of the gases, and the necessity of supplying supplemental heat to replace the lost heat. A process is described for recovering elemental sulfur from SO2 gases in which the high sensible heat of the gases is retained, and additional heat is derived from the furnace itself. The hot gases are first sent to a collector to remove any fine dust entrained in the SO2. The cleaned gases are passed into the reaction chamber where they are contacted with a reducing gas, such as natural gas, water gas, or producer gas. The temperature of the reducing gas is raised when it is mixed with the hot SO2 gases, and by absorption of heat from the burner. The reaction between the SO2 and the reducing gas is rapid and exothermic. As the gases leave the chamber they are cooled in a waste heat boiler, and treated with an electrostatic precipitator or by absorption to remove the sulfur. The residual gases may be catalytically oxidized to remove hydrogen sulfide and recover additional sulfur.

19943

Grodzovskiy, M. K.

MECHANISM OF CATALYTIC OXIDATION OF SO2 IN A SOLUTION OF MANGANESE SALTS. II. THE EFFECT OF OZONE ON MANGANESE SALT SOLUTIONS. (Mekhanizm kataliticheskogo okisleniya SO2 v rastvore solei margantsa. II. Deystviye ozona na rastvor zakisnoy soli marganitsa). Text in Russian. Zh. Fiz. Khim., vol. 6:496-510, 1935.

Studies of sulfur dioxide oxidation in manganese salt solutions have led to the following conclusions: SO2 concentrations of 0.3-0.4% do not provide sufficient conversion of Mn-2 to Mn-3 when used as the catalyst in amounts of about 5%; low O2 partial pressure (5-10%) in the flue gases also hampers this conversion, or renders it nonexistent with poor absorption equipment; as acidity increases, alpha O2 decreases to 30-40% sulfuric acid, and the rate of induced oxidation diminishes to zero due to inhibition of complex formation, oxidation, and to a drop in regenerative capability of the catalyst resulting from

formation of stable Mn2(SO4)3; increasing catalyst concentration above 0.025% has no further effect, especially when the oxygen partial pressure is low; increasing the solution volume in itself yields no improvement; negative catalysts poison the manganese; the action of ozone is necessary to counteract the above factors so as to maintain manganese activity; gradually increasing the ozone concentration maintains oxidation and regeneration up to a practical H2SO4 level of 50% (60-65% maximum) even with low SO2 and O2 concentrations; ozone should lead both to accelerated oxidation of MNSO2 and to direct oxidation of Mn-2; these and other effects of ozone form a basis for evaluating the use of ozone to produce concentrated sulfuric acid from flue gases; since SO2 oxidation proceeds by means of Mn oxidation, perhaps more economical means are possible, such as electro-oxidation.

20024

Yeselev, I. M., I. P. Mukhlenov, and D. G. Traber

USE OF IRON CATALYST IN THE CONTACT-TOWER PROCESS. (K voprosu ispol'zovaniya zheleznogo katalizatora v kontaktno-bashennom protsesse). Text in Russian. Zh. Prikl. Khim., vol. 37:722-727, Jan.-April 1964. 22 refs.

Equations were verified for calculating the contact time of gas on an iron catalyst that were sufficient to yield a given degree of conversion. Sulfur dioxide was oxidized over a stationary iron catalyst layer with a grain size of 0.75 mm. The gas flow rate was 0.975 m/sec and rate constants were determined over the range 610-730 C. Estimations of the energy of activation were about 126 kJ/mole for temperatures above 640 C, and 280 kJ/mole below 640 C. The discountinuity at 640 C is explained by the conversion of active ferric oxide to the inert sulfate. The literature is reviewed with respect to the reaction kinetics for SO2 absorption on an iron catalyst with both stationary and fluidized beds.

20248

Public Health Service, Cincinnati, Ohio, National Air Pollution Control Administration

A STATUS REPORT: PROCESS CONTROL ENGINEERING; R & D FOR AIR POLLUTION CONTROL. 37p., Nov. 1969.

The various phases of the work of the Process Control Engineering Division of the National Air Pollution Control Administration are described as of late 1969. These include sulfur oxides control (dry and wet limestone processes, coal cleaning, and new processes such as those employing molten alkali carbonates), industrial process control (nonferrous smelting, iron and steel, sulfuric acid, papermaking, graphic arts, iron foundries, aluminum smelting, etc.), combustion emissions control (e.g., fluidized-bed combustion, nitrogen oxides), applied equipment research (wet scrubbers, fabric filters, electrostatic precipitators, incinerator control), supporting measurements (detection, spectroscopy, dust and gas-sampling analysis, holographic determinations, continuous monitors, etc.), and advisory and supporting services. A special report is also given on the alkalized alumina process for control of SO2. A list of 110 specific research projects and 11 services is given. More than eleven million dollars was budgeted for the Process Control Engineering programs in 1969. The 1970 budget is expected to be more limited, necessitating an emphasis on sustaining rather than new programs.

20416

(Inventor not given.)

PROCEDURE FOR PRODUCTION OF SULFURIC ACID. (Procede de production d'acide sulfurique). Text in French. (Mitsubishi shipbuilding and Engineering Co., Ltd., Japan) French Pat. 1,348,923. 7p., Dec. 2, 1963. (Appl. Feb. 28, 1963, 5 claims.)

Two procedures are presented for producing sulfuric acid from a gas containing sulfur oxides and from a suspension. In the first case, the gas is brought into contact with an aqueous suspension of a manganese oxide, of a concentration at which it remains fluid, to form MnSO4. If the latter reacts with HCl, H2SO4 and a crystalline precipitate of MnCl2 are formed. In the presence of O2 and H2O vapor at an elevated temperature, MnCl2 decomposes into HCl gas and a Mn oxide, which are returned to the operations of H2SO4 formation and MnCl2 precipitation and of preparation of an aqueous suspension of a Mn oxide. In the second case, from an aqueous suspension of crystalline MnSO4, a gas containing hydrochloric acid is introduced into the aqueous suspension at a temperature not exceeding 50 C and, preferably, at ambient temperature to produce H2SO4 and crystalline MnCl2. After separating the latter from H2SO4, it is reacted with a gas containing O2 and H2O vapor at a temperature between 350 and 600 C in order to oxidize it to HCl and a Mn oxide. The resulting gas containing hydrochloric acid is re-used for production of MnCl2 from MnSO4. In addition, a hot gas containing hydrochloric acid produced in the oxidation of MnCl2 is used to eliminate HCl remaining in H2SO4 after its separation from MnCl2. This gas is cooled in an indirect heat exchanger by transferring its heat to H2SO4, yet to undergo the HCl elimination treatment. Air is brought into contact with the HCl-bearing H2O condensate of that heat exchanger to obtain air containing HCl and H2O vapor to be used for MnCl2 oxidation.

20670

Furkert, Herbert

METHOD OF RECOVERY OF SULPHURIC ACID. (Chemiebau Dr. A. Zieren G.m.b.H. and Co. K. G., Cologne-Braunsfeld (West Germany)) U. S. Pat. 3,490,868. 5p., Jan. 20, 1970. 4 refs. (Appl. March 4, 1968, 6 claims).

Sulfuric acid is produced from sulfur dioxide-containing gases by a multi-stage catalytic oxidation process and a two-stage sulfur trioxide absorption. The first absorption stage is arranged before the last oxidation stage and the second absorption stage is arranged after the last oxidation stage. Sulfur trioxide-free exhaust gas leaving the first absorption stage is reheated to the starting temperature for the last oxidation stage with superheated steam. The steam is obtained from an exothermic step of the overall sulfuric acid recovery process starting with a sulfur containing raw material. (Author abstract)

20777

Tamura, Zensuke and Yukio Hishinuma

A PROCESS AND APPARATUS FOR THE DESULFURIZATION OF INDUSTRIAL WASTE GASES. (Hitachi, Ltd., Tokyo (Japan)) U. S. Pat. 3,486,852. 6p., Dec. 30, 1969. 4 refs. (Appl. Sept. 21, 1967, 20 claims).

A process and apparatus for desulfurizing industrial waste gas and recovering sulfuric acid as a byproduct are described. A portion of the waste gases are introduced into an adsorption tank to remove the sulfur oxides by contacting them with active carbon, while the remaining portion is sent to a region for drying the active carbon which has been wet in a preceeding rinse-desorption step. From the drying tank the gases are led to the adsorption tank. Waste gases free of sulfur oxides are released to the atmosphere from the adsorption stage. Sulfur oxides are removed from the active carbon by rinsing with

water, and the washings are removed and sent to a concentration tank where they are heated and sulfuric acid is recovered. The functions of the respective regions is the adsorption-desorption apparatus are shifted one after another at a certain time interval, so that a cycle of operation consisting of adsorption, rinsing-desportion and drying, is carried out concurrently repeatedly.

21309

Argenbright, L. P. and Bennett Preble

SO2 FROM SMELTERS: THREE PROCESSES FORM AN OVERVIEW OF RECOVERY COSTS. Environ. Sci. Technol., 4(7):554-561, July 1970.

About 2.2 million long tons per year of sulfur is contained in the sulfur oxide gases generated in the operation of copper, zinc, and lead smelters in the western United States. Nearly 23% of this is recovered, mostly as sulfuric acid. A study was made to identify and evaluate the technological and economic problems associated with controlling the sulfur oxide emissions of these smelting operations. Three processes for control and by-product recovery were considered: the contact sulfuric acid process, the Cominco absorption process, and the ASARCO reduction process. All three are adversely affected by the low percentage of sulfur in the exhaust gases. Similarly, all are limited in optimum size, since the capital investment for larger operations off-sets the reduction in operating cost. Of the three processes considered, the contact sulfuric acid process is the least costly, both in terms of initial cost and operating cost.

21203

Romovacek, Jiri and Jaroslav Fohl

APPARATUS FOR THE PREPARATION OF GASEOUS MIXTURES WITH LOW SO2 CONCENTRATION. (Apparatur zur Herstellung von Gasgemischen mit kleiner SO2-Konzentration). Text in German. Erdoel Kohle (Hamburg), 23(5):294-296, May 1970. 13 refs.

A gaseous mixture with sulfur dioxide concentrations of 0 to 1 mg/cu m is obtained by continuously adding dichlorsulfitomercurate-(II) to sulfuric acid and by diluting the liberated SO2 with a regulated flow of carrier gas. The solution of dichlorsulfitomercurate-(II) is pumped peristaltically into a spiral-shaped glass column simultaneously with the H2SO4. The spiral column has an inner diameter of 8 mm and a length of 800 mm. The carrier gas nitrogen is taken from a pressurized gas bomb, and is cleaned with solid NaOH. The speed of the carrier gas is controlled by a manometer. A constant SO2 concentration was produced in long-term experiments.

21824

Chemical Construction Corp., New York, N. Y., Consulting Div.

ENGINEERING ANALYSIS OF EMISSIONS CONTROL TECHNOLOGY FOR SULFURIC ACID MANUFACTURING PROCESSES. Contract CPA 22-69-81, 276p., March 1970. CFSTI: PB 19093

The capabilities and state of development of the available processes and devices to effect control for both existing and new plants were evaluated to determine the cost of control by various methods, and to outline programs for further development of systems which appear to have the greatest overall potential for reducing undesirable emissions from sulfuric acid plants in the United States at the lowest cost. Existing plants can reduce their emissions somewhat by modifying their operating conditions with little capital expenditure, but this control is limited to about 2000 ppm of sulfur dioxide. Present technology can achieve a control effectiveness of 500 ppm of SO2 via the dual absorption route, and excellent acid mist control in the order of 0.1 mg/SCF. No fully developed acid plant control systems are commercially operated in the U. S. which achieve an effectiveness of 100 ppm of SO2, but there are promising ones in various stages of development. It is doubtful that there is any contact plant in the U. S. to which some type of control system could not be applied to reduce emissions to less than 500 ppm SO2, but to do so economically may be a different story. Cost of emission control varies widely with plant capacity, type of control system and other factors. Cost of less than 500 ppm SO2 control for a 250 T/D contact plant varies from about $.75 to over $3 per ton of acid. Mist control costs vary from $.02 to $.35/tons of acid. These costs are predicated on an asssumption that promising processes will work as expected. Control cost is lower for large plants. Recommended areas for study include development of resin and molecular sieve adsorbents, oxidation inhibitor development for tail gas recovery processes, study of stack dispersion and factors affecting it, plus development work on several processes, both for treatment of tail gas and improved in-plant conversion.

22055

Snowball, A. F.

A CYCLIC PROCESS OF SULPHURIC ACID MANUFACTURE AT TRAIL, B. C. Can. Chem. Process, vol. 31:1110-1114, Dec. 1947. 2 refs. (Presented at the C.I.C. Meeting, Banff, Ontario, June 8-11, 1947.)

In a cyclic process of sulfuric acid production, pure sulfur dioxide and oxygen are fed to a circulating gas stream that is moved by centrifugal blowers through heat exchangers to cylindrical steel converters packed with vanadium catalyst. The converted gas containing sulfur trioxide at high temperature is first cooled in the heat exchangers, then in air-cooled pipes before entering absorber towers where the sulfur trioxide is removed in contact with 98.4% sulfuric acid. The cycle is complete when the gas passes through spray catchers and coke filters back to the blowers. Measured quantities of oxygen and 100% sulfur dioxide gas are added during and after absorption, replacing sulfur trioxide and bringing the gas concentration back to the ideal operating percentages of 25% sulfur dioxide, 30% oxygen, and 54% nitrogen. Control of catalyst temperature in the converter is reviewed, as are the steps taken to prevent metal corrosion. Efficiency of the plant, which is operated by one attendant through centralized control, is 99.5%.

22182

(Inventor Not Given.)

METHOD OF REGENERATING ADSORBING COKES CHARGED WITH SULFURIC ACID. (Procede de regeneration de cokes adsorbants charges d'acide sulfurique). Text in French. (Bergwerksverband G.m.b.H., Essen, W. Germany) Belg. Pat. 707,739. 9p., June 10, 1968. (Appl. Dec. 8, 1967. 4 claims).

A method is described for the regeneration of adsorbing cokes charged with sulfuric acid after having served to fix sulfur dioxide obtained from gas containing SO2 in the presence of oxygen and water vapor. The adsorbing coke charged with H2SO4 is first washed in the known manner by means of hot water or of aqueous solutions. Between 1 and 5% (by weight) sodium or potassium hydroxide is added to the wet coke and the coke is heated in an inert atmosphere at a nominal 600-1000 C (400 C minimum) for 1/2 4 hours. The thermal treatment includes simultaneous rinsing by means of an inert gas.

22943

Hammond, Rolt

ELIMINATING DUST IN CHEMICAL PLANT. Chem. Age, (New York), vol. 77:431-433, March 9, 1957.

Among new equipment for eliminating dust from chemical plant flue gases is a multi-wash collector that removes submicron particles with maximum efficiency. The collector comprises a cylindrical stainless steel tower with six and one-half vaned impingement stages. An entrainment separator placed above the units forms a seventh tier. Air enters the tower just below its conical base, which acts as a wet cyclone to collect the heavier particles upon entry. A water curtain descending from the top of the tower combines with spray and impingement to envelop the particles rising with the air, carrying them down into the cone and out of the collector. When most of the dust is above the submicron range, collectors with fewer stages are employed. These collectors are equally effective on both soluble and insoluble dusts and on soluble gases. For the removal of gaseous contaminants such as hydrogen sulfide, sulfur dioxide, hydrochloric or hydrofluoric acid vapors, alkaline solutions are added to the recirculated liquid. For the 0.1 to 5 micron particles found in pharmaceutical and bacteriological work, an esparto grass-based paper filter with asbestos fibers has an efficiency of 99.95%. This filter can be accommodated in a very small place. A reverse-jet type filter has proved very efficient for vaporized silica of 0.6 micron and less. Electrostatic precipitators are used to remove dust and fumes from pyrite roasters, sulfuric acid mist from wet catalyst sulfuric acid plants, and sulfuric acid mist from coal roaster gases. Static rectifiers for the precipitators are available that dispense with the high-tension connections formerly required. Alternating current is rectified and used without high-frequency effect on the wave-form, as in the case of mechanical rectifiers.

23048

TIME TO RETHINK SULFURIC SOURCES. Chem. Week, 102(19):55-56, May 11, 1968.

Slightly more than a year ago, engineers agreed that while chemical process technology is readily available to make sulfuric acid from pyrite concentrate or gypsum, the methods could not compete economically with sulfuric from elemental sulfur. However, the handicaps associated with pyrites and gypsum are beginning to disappear, now that the price of sulfur is $42 per long ton. Total plant investment costs are compared on the basis of 400,000 short tons of acid per year produced from brimstone, pyrite, and gypsum. For each method, the total plant investment is equal to 125% of the battery-limit costs. Total indirect costs are 16.6% of the entire plant investment. The economics of the gypsum process are expected to become more attractive with the development of a fluid-bed process for recovering sulfur from calcium sulfate in the form of waste gypsum. There are two steps to the process: first, dry gypsum is preheated in a fluid bed and the two mols of combined water are driven off at a temperature high enough to support combustion of residual hydrocarbons; secondly, the calcium sulfate is reduced in a second chamber to calcium sulfide at approximately 1560 F. The latter is recovered as a suspension in water, where it is carbonated with carbon dioxide gas to yield calcium carbonate and also sulfur in the form of hydrogen sulfide gas. The gas is burned with air to form the sulfur dioxide gas feeding the sulfuric acid plant.

23070

Averbukh, T. D., I. A. Apakhov, O. V. Maydurova, N. P. Bakina, N. P. Blinova, A. A. Burba, and I. V. Avdeyeva

REMOVAL OF SULFUR FROM COPPER-SULFUR PLANT WASTE GASES BY THE AFTERBURNING METHOD. (Ochistka otkhodyashchykh gazov mednosernyk zavodov ot sery metodom dozhiganiya). Text in Russian. Khim. Prom. (Moscow), no. 4:51-58, 1962. 7 refs.

Catalytic afterburning of waste gases containing about 3 vol. % carbon disulfide, carbon sulfide, hydrogen sulfide, and sulfur dioxide (50 g/cu m of sulfur) to produce sulfuric acid was studied experimentally at temperatures of 200-600 C using 16 different catalysts. Data are given for the following catalysts: various types of bauxite, barium-aluminum-vanadium (BAV), and chamotte treated with nickel and aluminum nitrates. Pilot studies made at flow rates of 800-1200 cu m/h using bauxite and BAV catalysts are reported, and a proposed production installation is described.

23264

Adachi, Noriyoshi, Makoto Kimura, and Seiko Hashimoto

ELECTRIC FILTRATION OF SO2. Taiki Osen Kenkyu (J. Japan Soc. Air Pollution), 2(1):98-100, 1967. Translated from Japanese. 8p.

To develop equipment for the removal of sulfur dioxide in flue gas, a wet-type electric precipitator was constructed and a basic study of electric filtration of SO2 was performed. Liquid was dropped along the inside wall of a glass cylinder of 35 mm inner diameter. The corona electrode was placed at the center of the cylinder and voltage was applied between the corona electrode and the liquid surface. A known concentration of SO2 gas was introduced from the bottom of the cylinder, passed through the corona discharge, and was taken out from the top of the cylinder. Sampling of SO2 was in accordance with Japan Industrial Standard JIS-KO103-1963; titration was employed for the analysis of SO2. As SO2 is an electronegative gas on which electrons are easily attached, its collection efficiency was increased at a corona starting voltage of 5 kV and the efficiency was constant with voltages larger than a certain value. The collection efficiency was always higher with a negative corona electrode voltage than with a positive one. With positive voltage above a certain level, collection was not achieved steadily. A flow rate of about 100 ml/min. was most adequate. Gas collection efficiency was greater than 95% with an applied voltage of 9 kV and SO2 concentration below 0.45%. In the preceding results, water was employed as the collection medium. Further experiments were conducted using a 5% aqueous solution of Na2CO3 and a 10% aqueous solution of sulfuric acid. The collection efficiency was reduced with the increase of SO2 concentration; this tendency was more pronounced with the sulfuric acid solution. With a voltage of 7 kV, the efficiency with the Na2CO3 solution was almost 100%, whereas with the sulfuric acid solution it was only 35%.

23556

Clauss, N. W.

THE REDUCTION OF ATMOSPHERIC POLLUTION FROM SULFURIC ACID RECOVERY PROCESSES. Manufacturing Chemists Association, Washington, D. C. Air Pollution Abatement Committee and Manufacturing Chemists Association, Washington, D. C., Water Pollution Abatement Committee Proc. Mfg. Chem. Ass. 1952-53 Pollution Abatement Conf., 9p.

Effluent gases from air-blown sulfuric acid concentrators contain sulfuric acid mist and sulfur dioxide resulting from the decomposition of sulfuric acid by carbonaceous materials

present in the spent acid. A pilot plant was designed to study the removal of the mist by low-pressure water sprays, high-pressure water sprays, bag filters, and decomposition by heat. When the data obtained suggested that the high-pressure water spray system was most effective, a plant-scale acid mist removal unit was put into service. The sulfuric acid mist removal of the plant-scale unit appears to be higher than the efficiency obtained in the pilot spray unit, probably due to the elimination of wall effects. It is concluded that when the full capacity of the system is made available, the system can be operated, at a net operating cost (1953) of $5000 year, at maximum production rates with no pollution of the atmosphere by sulfuric acid mist.

23939

Nagibin, V. D.

SMELTING CONCENTRATES IN CONVERTERS AND PRODUCTION OF SULFUR DIOXIDE FOR SULFURIC ACID MANUFACTURE. Soviet J. Non-Ferrous Metals (English translation from Russian of: Tsvetn. Metal.), vol. 9(10):39-42, Oct. 1968.

Industrial tests were performed on the converter smelting of copper matte in an air blast enriched with up to 24-27% oxygen. The output capacity of converters increased proportionally to the percentage of oxygen in a blast. The temperature of the molten charge in converters increased sharply as a result of the heat of exothermic reactions; this permitted the processing of cold additions in the form of ore, concentrate, and other copper containing materials. Concentrations of sulfur dioxide in the waste gases of the converter increased by 1.5-2.5% (in absolute value), varying during the second blowing period by 5-10%. The operating regime of the converters decreased markedly when enriched blasts were used during the first and second blowing stages. On the basis of these findings, programs were developed for the smelting of pelletized copper concentrates and for the production of sulfuric acid from converter waste gases alone. The latter process is based on a starting concentration of about 4% SO2 in converter waste gases fed to a contact-reaction vessel and on special conditions for matte blowing. At least two converters are continually on blast, the blast consumption of each varying between 30,000 to 45,000 cu m/hr. Before being passed to the sulfuric acid production plant, the exhaust gases are pressure fed by a blower to electrostatic dust separators. An automatic switching system for changing the direction of the gases from the sulfuric acid units to stack exhaust makes it possible to stabilize the content of sulfur dioxide being shipped to the former.

24103

Browder, Timothy J., Jr.

METHOD OF SULFURIC ACID MANUFACTURE. (Parsons (Ralph M.) Co., Los Angeles, Calif.) U. S. Pat. 3,525,587. 4p., Aug. 25, 1970. 3 refs. (Appl. July 19, 1968, 12 claims).

A process is described for the production of sulfuric acid by the catalytic oxidation of sulfur dioxide containing gas and the multiple stage absorption of sulfur trioxide produced by such catalytic oxidation. Sulfur dioxide containing gas can be produced by a variety of reactions, such as by the oxidation of hydrogen sulfide or hydrocarbon mercaptans, or by metallurgical smelting. Conventional multiple oxidation stage processes which utilize intermediate absorption between stages are deficient in that they fail to allow the desired flexibility of initiation of optimum inlet or exit temperatures for each of the oxidation stages. The present method utilizes a portion of the exothermic reaction heat of gas exiting from the first of at least three successive oxidation stages, having an intermediate absorption stage between the second and third stages for preheating gas passing into the third oxidation stage. Exit gas from the first oxidation stage is preferably split into two streams; one stream is fed to a heat exchanger for pre-heating gas to be fed into the first oxidation stage, and the other stream is utilized to pre-heat gas passing from the intermediate absorption stage to the third oxidation stage.

24110

Berly, Edward M., Melvin W. First, and Leslie Silverman

RECOVERY OF SOLUBLE GAS AND AEROSOLS FROM AIR STREAMS. Ind. Eng. Chem., 46(9):1769-1777, Sept. 1954. 18 refs.

High efficiency absorpiton of soluble or reactive gases was obtained with wetted fiber beds. Wetted fibers were five to 10 times more efficient than Raschig rings or Berl saddles, compared on the basis of equal volumes. When compared on the basis of weight of packing, 1 pound of 78-micron-diameter saran fibers was 75 times more effective for the absorption of hydrogen fluoride gas than 1 pound of 1/2 inch Berl saddles. In addition to hydrogen fluoride gas, cleaning efficiency for sulfuric acid and ammonium bifluoride mists, ammonium bifluoride and aluminum chloride fumes, and silica, tale, and atmospheric dusts was investigated. High efficiency collection (greather than 99.9%) generally required the addition of a droplet eliminator composed of a 1 to 2-inch depth of dry fibers less than 5 microns in diameter. Although absorption of the gas was complete, a significant quantity of fluorides passed the scrubber in the form of fine (less than 10 micron) mist droplets formed from condensation of hydrogen fluoride gas in the humid atmosphere of the scrubber or from fine droplets formed by the sprays. When gas streams containing inert particles were treated, the absorbing stages were protected from fouling and plugging by the use of an impingment device such as a Neva-Clog screen as a prefilter. Over-all resistance of the scrubber was proportional to the flow rate. For gas flows of 200 cu ft/min, sq ft of scrubber face area, high efficiency scrubbing of gas and submicron particulate matter was obtained with resistances not exceeding 6 inches of water gauge For atmospheric pollution control of stack gas, emissions resistances less than half this may be adequate. (Author summary)

24246

Farrar, G. L.

LACQ LEADS IN SULFUR-RECOVERY OPERATIONS. Oil Gas J., 68(42):72- 75, Oct. 19, 1970. 2 refs.

Already the largest single producer of chemically derived sulfur in the world, and with one of the largest gas throughputs anywhere, the Lacq gas processing plant in southern France is now the leading pioneer in recovering sulfur from plant exhaust gases. The air-pollution-prevention attack is three pronged. The sulfur plants are automated to insure that sulfur-content of effluent gases from Claus sulfur units is at an absolute minimum. A sulfuric acid plant, operating on a part of the sulfur-plant offgas, makes a salable product and reduces the sulfur content in the effluent gas to the hundreds of ppm range. A new sulfur recovery process, operating on another part of Claus offgas, utilizes a special catalyst, which is active at reactive conditions and low operating temperatures to drastically cut the concentration of sulfurous gases in the effluent. In the new (Sulfreen) process, the feed gas is first cleaned by contacting it with liquid sulfur, then passed to a battery of six reactors where Claus reactions are carried out at temperatures lower than those utilized in the sulfur plant.

These temperatures insure that product sulfur deposits are deposited on the catalyst as a liquid. A stream of nitrogen sweeps the catalyst clean while the liquid sulfur product is drained off to liquid storage. The feasibility of installing other Sulfreen units is being studied.

24256

Yashke, Ye. V., A. G. Amelin, V. A. Petrovskiy, and V. A. Osmul'kevich

GLASS-FIBER FILTERS FOR TRAPPING SULFURIC ACID MIST. (Steklovoloknistyye fil'ty dlya ulavlivaniya tumana sernoy kisloty). Text in Russian. Khim. Prom. (Moscow), no. 3:196-200, March 1965. 16 refs.

The use of alkali glass fibers as filter material for the collection of sulfuric acid mist was studied experimentally for sulfuric acid concentrations of 75-98%, with mist droplets 0.2-0.5 micron in diameter. Procedures for estimating degree of deposition as a function of droplet size, mist density, gas flow rate, gas viscosity, fiber diameter, and filter packing density are discussed. Data on the operation of such a filter in an industrial installation in combination with an electrofilter are presented. This filter handles 10,000-15,000 cu m of mist per hour, effecting 99.7% removal.

24451

Petersson, Stig

CONCENTRATING SULFUR-CONTAINING GASES FROM SMELTING PLANTS. (Koncentrering av svaveldioxidhaltiga smaeltverksgaser). Text in Swedish. Kem. Tidsskr., 82(1):34-38, Jan. 1970.

Copper, lead, and zinc are usually present in nature in sulfide ores. When these ores are processed by industrial operations, gases containing sulfur dioxide are liberated. The SO2 concentration varies depending upon the process. A primary control method for SO2 involves absorption of the gas by water or an organic solution, followed by heating and condensing to liquid SO2 for sulfuric acid manufacturing. A Swedish plant is described which produces liquid SO2 from smelter plant gases. The plant capacity is 50,000 cu m/hr at 4.5% SO2. The liquid SO2 is partly sold and partly used to raise the gaseous SO2 content at a sulfuric acid plant. The absorption tower is designed for an efficiency of 98% calculated at maximum load and at a water temperature of 11 C. The plant raises the use of SO2 in the gases from the smelting plant from 75% to 95%. The plant was motivated by both production efficiency and environmental concern.

24594

Rosendahl, Fritz

RECENT PROCESSES FOR THE REMOVAL OF SULFUR COMPOUNDS FROM GASES, AS SEEN IN GERMAN PATENTS FOR THE YEAR 1964. (Neuere Verfahren zur Entfernung von Schwefelverbindungen aus Gasen--dargestellt an Hand deutscher Patent von 1964). Text in German. Gas Wasserfach (Munich), 106(31):857-859, Aug. 6, 1965. 19 refs.

German patent literature is reviewed, summarizing achievements in the field of dry gas removal, wet ammonia processes and other wet processes, reactions between hydrogen sulfide and sulfur dioxide, and the removal of organic sulfur compounds. An iron oxide is obtained from the roasting of pyrite, the fine granular form of which can absorb 93.3% S. One ammonia process, making use of waste water from a coke plant, gives a 70-80% sulfuric acid yield. Wet processes use not only water but also various organic solvents such as methanol, pyrrolidone, or piperidone. The advantage of the two last-mentioned solvents is their relatively high boiling point. Acetone, methanol, or ethanol can also be added to the water used in scrubbers (5-20 vol. %), reducing the viscosity and making possible a lower operating temperature. Hydrogen sulfide and carbon monoxide can be removed from waste gases under pressure by using various esters and ester mixtures. The removal of organic sulfur compounds can be achieved with an efficiency of at least 90%. The removal of hydrogen sulfide from gases by the use of activated charcoal requires a pore diameter of more than 60 A, while the removal of organic sulfur compounds requires a diameter on the order of 20-40 A.

24628

Drechsel, Herbert, Karl-Heinz Doerr, and Hugo Grim

PRODUCTION OF SULFUR TRIOXIDE AND SULFURIC ACID. (Metallgesellschaft A. G., Frankfurt (W. Germany)) U. S. Pat. 3,525,586. 7p., Aug. 25, 1970. (Appl. Oct. 12, 1966, 4 claims).

A catalytic oxidation process is described which utilizes sulfur dioxide-containing gases to produce sulfur trioxide and sulfuric acid. The SO2 content of the gas must be at least 9% in order for this process to work. The process involves a series of heat exchange and oxidation steps and a hot single stage intermediate absorption step. It is self-sufficient as to sensible heat requirements, actually producing recoverable excess heat to be utilized for other purposes. The advantages of this process over previous ones are that the initial concentration of SO2 in the starting gas can vary over a specified range, and that this process produces excess heat while other processes require heat inputs to function properly. This process results in a high degree of conversion, making it economically desirable.

24673

Asano, Toyoshi

DISPOSAL OF WASTE GAS CONTAINING DELUTE SULFUR OXIDE. (Kihaku sanka iou ganyu gasu no kaishu). Text in Japanese. Kogyo Kagaku Zasshi (J. Chem. Soc. Japan), 73(7):1731-1732, July 5, 1970. 3 refs.

Disposal of sulfur dioxide in pyrites roasting, petrochemical industry, or power plant waste gas is discussed. In a conventional wet disposal method, SO2 is merely neutralized by an agent like lime or ammonia, but a very large quantity of the neutralization agent is needed. Another disadvantage of the conventional method is that its sulfur oxide absorption efficiency drops with substances formed as a result of the neutralization process. When SO2 gas was made to flow countercurrent to manganese ore suspension in a tower, SO2 was reduced to sulfuric acid of a densit about the same as that obtained in a lead chamber method, and practically no SO2 was contained in the gas discharged from the tower. A 10% manganese-ore suspension was used in an experimental device in which the suspension was heated to the desired temperatures and, when vaporized by the heating, automatically reduced from gas to liquid. Ore composed of Mn(27.96%), SiO2(37.32%), Fe(8.16%) and P(0.03%) was pulverized to 80-mesh grains and mixed with water at a 10:90 ratio to make the suspension used as the absorbing agent. From the results of this test, it was determined that the higher temperature of the suspension, the higher its SO2 absorption efficiency; the amount of SO2 absorbed decreased with increasing sulfuric acid density in the suspension; at 50 C, the quantity of sulfuric acid contained in the suspension reached 74.3 g/100 ml. The contact time of SO2 gas with the suspension was 5.7 sec and the gas injection speed 8 cm/min. The device maintained about 100% SO2 absorption efficiency for 20 hrs, indicating that the manganese oxide suspension can be effectively used as an SO2 absorbing agent.

24695

Fairs, G. Lowrie

HIGH-EFFICIENCY FIBRE FILTERS FOR THE TREATMENT OF FINE MISTS. Trans. Inst. Chem. Engrs. (London), vol. 36:476-485, 1958. 3 refs.

The treatment of contact process sulfuric acid plant tail gases to remove completely a sulfuric acid mist with particles of less than two micron was studied. If a filter of fine glass-wool is treated with a silicone to provide a water repellent surface, the acidity of the gases leaving the filter is reduced to 0.2% of the inlet acidity as compared with 2.5% for untreated wool under similar operating conditions. This twelve-fold improvement of scrubbing efficiency is important, since the gases scrubbed with the silicone-treated fiber were invisible when vented to the atmosphere, while a visible plume persisted after scrubbing with the untreated fiber. A scrubbing efficiency of 99.6% was obtained with a garnetted Terylene polyester fiber, which is in itself water repellent. Comparative performance data for the two filters are summarized. (Author abstract modified)

24833

York, Otto H. and E. W. Poppele

TWO-STAGE MIST ELIMINATORS FOR SULFURIC ACID PLANTS. Chem. Eng. Progr., 66(11):67-72, Nov. 1970. 5 refs.

Sulfuric acid plants, and plants producing oleum in addition to sulfuric acid, are a major source of concern to air pollution authorities because of the dense and highly corrosive acid mist discharged with the absorption tower tail gas. Modern air pollution codes require that mist emissions from existing plants be reduced to below 2 mg/std cu ft. Compliance with these regulations is achieved at minimum cost by means of a two-stage scrubber, one stage designed for the removal of the coarse fraction of the mist and the other for removal of very fine mist particles. Fluorocarbon fibers are used for the contact stages as they combine complete corrosion resistance with high separation efficiency at moderate pressure drop. Efficiency of the scrubbers, unlike that of two-stage wire mesh mist eliminators, is essentially 100% for particles down to about one micron. Reduction of particles down to 0.3 micron is also substantial.

25133

Donovan, J. R. and P. J. Stuber

AIR POLLUTION SLASHED AT SULFURIC-ACID PLANT. Chem. Eng., 77(25): 47-49, Nov. 30, 1970.

Among processss for controlling emissions from sulfuric acid production, attention is now being given to interabsorption, or double-catalysis. This system markedly lowers sulfur dioxide emissions and gives higher conversion to acid at generally modest cost penalties. While in a conventional contact-acid plant, SO2 is converted into sulfur trioxide in one operation, interabsorption instead interrupts the reaction to remove some of the SO2 product. This has a favorable effect on both the kinetics and the equilibriu of further conversion. Equipment required for an interabsorption plant is similar to that of conventional facilities with the addition of heat exchangers and an interpass absorption tower. Conversion of 99.5% can be guaranteed by the process as compared to 98% for a conventional plant. Capital and operating costs, together with indirect charges, are itemized for the first facility in the Western Hemisphere to use this German-based process

25275

Nilsson, Folke and Bengt Rudling

AIR POLLUTION CONTROL AT THE BOLIDEN COPPER AND LEAD SMELTING PLANT, ROENNSKAERSVERKEN, SWEDEN. Preprint, International Union of Air Pollution Prevention Associations, 36p., 1970. (Presented at the International Clean Air Congress, 2nd, Washington, D. C., Dec. 6-11, 1970, Paper SU-24D.)

Factors considered when the Boliden Company's copper and lead smelter was erected in Sweden in 1928-1930 are reviewed. Built for smelting copper-arsenopyrite ore from the Boliden mine, the smelter was placed on a peninsula at the Bothnian Gulf. To utilize excess sulfur in the ore as pyrite and thereby reduce the sulfur dioxide emission by about 50%, the ore was concentrated. After World War II a sulfuric acid plant took care of the roaster gases and ten years later the production was increased three-fold by further SO2-utilization. Hereafter no effect can be seen on forest, crop, or garden. The concentration of SO2 in ambient air around the the smelter is far beneath the official limit. The production of liquid SO2 for the paper and pulp industry will now make it possible to utilize over 90% of the SO2. The SO2-recovery is made by absorption in water. This process is economical when a good supply of cold water for cooling and inexpensive surplus steam is available. Along with diversified and increased production, dust cleaning has been extended and modernized. The results of these activities have been followed up by medical studies of the population. (Author abstract modified)

25370

Quitter, Volker

ELECTROSTATIC SEPARATION OF SO3 MISTS. Staub (English translation from German of: Staub, Reinhaltung Luft), 30(4):8-10, April 1970. 2 refs.

Electrostatic precipitators with special electrodes have been used successfully for precipitating sulfur trioxide mists. Production of sulfuric acid and oleum on an anhydrite base entails the generation of waste gases with high sulfur dioxide and SO3 contents which cause heavy damage to agriculture and forestry. Tail gas precipitators were manufactured and investigated under a variety of operational conditions. Lead and 'korobon' plates were used as collecting electrodes, while the discharge electrodes consisted of barbed lead wire. SO2 and SO3 contents, temperature, and gas humidity were measured upstream and downstream of the precipitator. While rising SO3 content causes the current consumption to fall, collection efficiency on the other hand will rise. The flashover limit is associated with the gas velocity and with the composition of the tail gas.

25468

Glowiak, Bohdan and Adam Gostomczyk

SULFUR DIOXIDE SORPTION ON ANION EXCHANGERS. Preprint, International Union of Air Pollution Prevention Associations, 19p., 1970. 10 refs. (Presented at the International Clean Air Congress, 2nd, Washington, D. C., Dec. 6-11, 1970, Paper EN-23E.)

The experiment of using anion-renewable exchangers in sulfur dioxid sorption from gases was conducted in three stages. An artificially created mixture of sulfur dioxide and air was passed through a column 50 mm in diameter in the first stage. The column was filled with an anion layer 300 mm high. Next, a laboratory device was use for obtaining SO2 from the exhaust gases which were emitted by a boiler-house. The gases had to be dedusted and cooled before passing through the

column with anion. At the third stage, a pilot apparatus was installed in a sulfuric acid works, and the characteristic features of an installation working at this stage are described. The method which was utilized consisted of forcing gases with countercurrents through a layer of anion exchanger resin which was sprayed with hydroxide solution. This method can be used for purification of gases which have a temperature lower than 60 C and which do not contain dust. Efficiency increases slightly, simultaneous with the increasing concentration of spraying solution and with that of SO2 in the purified gas. (Author abstract modified)

25491

Franz, Milan and Rostislav Klimecek

PROCESSING OF SULFUR DIOXIDE FROM COMBUSTION GASES. (Zpusob zpracovani kyslicniku siriciteho ze spalin). Text in Czech. (Czechoslovak Republic) Czech. Pat. 110,995. 3p., Dec. 15, 1963. (Appl. July 22, 1961, 1 claim).

Sulfur dioxide from combustion gases (from the manufacture of contact gas in the production of sulfuric acid) is absorbed by a solution of sodium hydroxide with the formation of sodium hydrogen sulfite. A surplus of sulfuric acid is then added to the absorption solution to obtain a pH of approximately 1, yielding concentrated SO2 which escapes and sodium sulfate which remains in solution. The sodium hydroxide needed for the absorption and the sulfuric acid needed for the decomposition are recovered from the sodium sulfate solution electrolytically. Electrolysis generates oxygen in a quantity equivalent to the quantity of the sodium hydroxide recovered and thus also equal to the quantity of absorbed SO2; the oxygen oxidizes SO2 to SO3. Sulfur trioxide from the combustion gases causes a disequilibrium between sodium and sulfate ions in the solution with a resulting accumulation of free sulfuric acid. This excess must be neutralized before electrolysis and part of the solution of sodium sulfate equivalent to the SO3 content in the combustion gas is removed and the sulfate is recovered by crystallization. The method works at normal temperatures.

25643

Sykes, W. and F. Broomhead

PROBLEMS OF ELECTRICAL PRECIPITATION REVIEWED. Gas World, 134(3494):98-104, Aug. 4, 1951. 5 refs.

Aspects of the design, construction, and operation of the electrical precipitator are discussed. The great advantage of this device is its ability to remove with high efficiency dust of particle size much smaller than that removable by mechanical or cyclone separators. Back pressure, and power needs to produce the corona discharge, a very small; however initial costs are much higher. Problems considered at length include removal efficiency and its relation to time contact of the gases in the field, design of the precipitation chamber, insulator breakdown, gas distribution across the precipitator, removal of deposits from electrodes, and electrical equipment requirements. Five essential design factors are given: correct time contact, good gas distribution throughout the fields, design and arrangement of the electrodes, maintenance of clean electrodes, and maintenance of correct voltage. Examples of the following typical application are described and the principal design features are indicated in each case to point up the great variety of constructions required by specific and differing operating conditions: detarring of producer gas from coal and coke, chamber and contact process sulfuric acid manufacture, aluminum and cement production, boiler flyash precipitation, gypsum dust removal, sodium sulfate recovery in the Kraft pulp industry, cleaning of blast furnace gas, air conditioning, and spray painting.

25717

Brink, Joseph A., Jr.

LIQUID MIST COLLECTION. (Monsanto Enviro-Chem Systems, Inc., Chicago, Ill.) U. S. Pat. 3,540,190. 7p., Nov. 17, 1970. 5 refs. (Appl. May 16, 1963, 5 claims).

A finely divided mist is separated and collected from a gas in which the mist is disposed by passing the gas through a bed of inorganic fibers (preferably glass fibers), composed almost entirely from fibers having diameters within the range of about 5 to 30 micron and compressed to a density of about 5-20 pounds per cubic foot. The mist is collected upon the surfaces of the fibers, then drained from the fiber bed by gravity flow in a continuous liquid phase. The apparatus is particularly useful with respect to the removal and recovery of acid mists, such as sulfuric or phosphoric acids.

25742

Nakazono, T.

REMOVAL OF SO2 GAS. (Aryusan gasu kaishu hoho). Text in Japanese. (Koga Mine Industrial Co. (Japan)) Japan. Pat. 172,814. 6p., May 31, 1946. (Appl. Oct. 28, 1940, claims not given).

Sodium formate and/or calcium formate were used as the absorbents for the removal of sulfur dioxide gas of low concentration under low temperature. The amount of SO2 gas absorbed was remarkably increased with an increase in the amount of absorbents. With an increased amount of SO2 gas, using the same concentration of formate, the amount of SO2 absorbed increased until SO2 concentration reached 4%; it increased the least amount thereafter. The SO2 gas obtained by heating (55 to 100 degree) the formate solution which had absorbed SO2 gas was utilized for producing sulfuric acid in industry. The formic acid, produced by the sulfuric acid which was an intermediate product during this procedure was neutralized with alkaline salt(s) to regenerate the sodium or calcium formate. This method is economical and can be utilized for the long-term removal of SO2 gas.

25768

Skrivanek, Jaroslav and Vladimir Cada

ABSORPTION OF SULFUR DIOXIDE IN A VENTURI TUBE. (Absorpce kyslicniku siriciteho ve Venturiho trubici). Text in Czech. Chem. Prumysl (Prague), 7(32):340-343, 1957. 6 refs.

Gas containing 0.2% SO2 emanating from the manufacture of H2SO4 was absorbed in a venturi tube by a soda ash solution dispersed by the gas stream in the constricted neck of the tube. The degree of absorption and loss of pressure were studied with the view of testing the industrial feasibility of this method of recovery of sulfur. The venturi tube can be used only where the pipeline gas pressure exceeds 50 cm H2O and for comparatively low concentrations of gas to be absorbed. The theoretical relationship between gas absorption, gas flow volume and velocity was analyzed, an equation for the dependence of the absorption constant on gas flow volume, on liquid flow volume and on the intitial soda ash concentration derived. The experimental arrangement and the method of determining the residual concentration of SO2 in the gas following absorption is described. The absorption constant increases with increasing gas flow velocity and decreases with increasing absorption liquid volume. The absorption constant rise with rising gas flow velocity is greater than linear. The effectiveness of the venturi tube increases with increasing gas flow velocity, even though the contact between the phases is shortened, because of the positive effect of flow velocity on the absorption constant.

26095

Brink, J. A., Jr., W. F. Burggrabe, and J. A. Rauscher

FIBER MIST ELIMINATORS FOR HIGHER VELOCITIES. Chem. Eng. Progr., 60(11):68-73, Nov. 1964. 8 refs.

Fiber mist eliminators are now installed in various chemical processes for air pollution control and gas purification. The design superficial velocity of the gas through the fibers in most of the eliminators has been 5 to 30 ft/min. Now, as a result of extensive testing, eliminators are available with superficial velocities of 30 to 90 ft/min, or even higher. These new units are smaller and less expensive than previous designs. Performance data is presented for high-velocity units on sulfuric acid and phosphoric acid mist. At a large-scale sulfuric acid plant, collection efficiencies as high as 96% are obtained for particles three microns and smaller, and pressure drop is constant at 7.5 to 8.0 in. of water. The efficiency of the unit does decrease on smal submicron particles when oleum is produced.

26254

Perrine, Richard L. and Limin Hsueh

MISCELLANEOUS INDUSTRIAL EMISSIONS. In: Project Clean Air. California, Univ., Berkeley, Task Force 5, Vol. 1, Section 14, 5p., Sept. 1, 1970. 3 refs.

Five broad categories of industrial polluters are briefly considered, as well as their kinds of emissions and control problems. The inorganic chemical industry has problems with hydrochloric acid, hydrofluoric acid, nitric acid, sulfuric acid, calcium oxide, chlorine, soaps and detergents. Steel production is a major industry, but the open hearth furnaces are gradually being replaced by the basic oxygen furnace. Although this also produces fumes, the new plants can be constructed with proper control equipment. Foundries may change the work they do from day to day so that control problems are at their worst, but methods to trap particles and fumes are available. The handling of large volumes of minerals normally involves problems with dust, while the special biological effects of asbestos must be noted. Glass fibers can also be a problem, as well as fluoride-containing ores. Copper lead, and zinc mining and milling operations involve dust problems, while sulfur oxides may be released during smelting. Hydrogen sulfide, mercaptans, sulfide and polysulfides which have very bad odors, and other noxious gases are emitted during wood pulp processing. Typical gaseous emissions from Kraft pulping are presented tabularly. Coffee roasting plants, slaughterhouses, and pickel plants emit strong odors. An areas of concern is new processes to break down waste and return it to a state useful in natural processes without problems of storage. A particularly important point which needs to be considered is site location.

C. MEASUREMENT METHODS

00040

ATMOSPHERIC EMISSIONS FROM SULFURIC ACID MANUFACTURING PROCESSES. Public Health Service, Cincinnati, Ohio, Division of Air pollution and Manufacturing Chemists' Association, Washington, D.C. (999-AP-13.) 1965. 127 pp.

Emissions to the atmosphere from the manufacture of sulfuric acid were investigated jointly by the Manufacturing Chemists' Association, Inc. and the U. S. Public Health Service; the study was the first in a cooperative program for evaluation of emissions from selected chemical manufacturing processes. The report describes the growth and potential of the sulfuric acid industry, types of raw materials used, design of plants, process variables, emissions from plants under normal operating conditions, and the methods and devices used to limit and control emissions. The sampling and analytical techniques by which emissions were assessed are presented in detail. (Authors' abstract)

00381

W. L. Crider

HYDROGEN FLAME EMISSION SPECTROPHOTOMETRY IN MONITORING AIR FOR SO2 AND SULFURIC ACID AEROSOL. Anal. Chem. 37, 1770-3, Dec. 1965.

The principle of hydrogen flame emission spectrophotometry is demonstrated to be of practical use in monitoring the atmosphere of animal exposure chambers for SO2 in concentrations from 0.1 ppm (v./v.) to 100 ppm and for airborne droplets of H2SO4 in the concentration range from 0.17 to 5.2 mg per cu meter. Some parameters influencing emission intensity are explored. (Author)

00482

F. P. Scaringelli, R. E. Boone, and G. A. Jutze

DYNAMIC CALIBRATION OF AN ACID AEROSOL ANALYZER. J. Air Pollution Control Assoc. 16(6):310-313, June 1966.

A method is described for dynamic calibration of an acid aerosol analyzer based on a commercial modification of the Thomas Autometer. This automated instrument removes acid aerosol from an air stream by sonic impaction, and the sulfuric acid collected is determined conductometrically. An all-glass aerosol generator based on the reaction of water vapor with sulfur trioxide vapor released from fuming sulfuric acid was built for the calibration. Air samples were withdrawn for instrument calibration before and after the concentration of the acid aerosol was determined by titration. The apparent particle size as determined by an Andersen sampler ranged from 2.0 microns to less than 0.68 micron and exhibited a sharp peak with mass median diameter at 1.3 microns in the distribution curve. The size of the aerosol, within certain limits, could be controlled by humidity. Data indicated a linear response with an aerosol collection efficiency of 80% in the important respirable size range. (Author abstract)

01387

J.V. Kerrigan K. Snajberk

STUDIES ON SULFURIC ACID MIST DOWNWIND FROM A SULFURIC ACID MANUFACTURING PLANT. J. Air Pollution Control Assoc., 15(7):316-39, July 1965.

Air pollution downstream from a sulfuric acid manufacturing plant is comprised of two aspects, the amount of acid mist fallout and the concentratuon in the atmosphere. This investigation shows that it is desirable to determine each of these by an independent method of collection. Pans of distilled water were used to collect and determine the sulfuric acid mist concentration in the atmosphere. The use of Stokes' Law to convert the results obtained by one method to those obtained by the other requires a knowledge of the particle size of the sulfuric acid mist droplets. Data presented show that the use of an average particle size can yield a picture of pollution which is in error by many orders of magnitude. The study shows that areas adjacent to a plant may be subjected to fallout of rather large particle size when there are not adequate methods for removal from the emission or byproduct gases. (Author abstract)

01819

R.E. Boone R.M. Brice

CONTINUOUS MEASUREMENT OF ACID AEROSOL IN THE ATMOSPHERE. Preprint. (Presented at the 58th Annual Meeting, Air Pollution Control Association, Toronto, Canada, June 20-24, 19659)

Experience in operating a combination acid aerosol and sulfur dioxide automatic analyzer in ambient air at an urban site is reported. Data for a 1-month period showed an average concentration of 9.2 micrograms/cu m of acid aerosol as sulfuric acid and 550 micrograms/cu m of sulfur dioxide. Limitations of the instrumentation have been determined and indicate appreciable variation in acid aerosol due to losses from incomplete impaction and from measurement of nonacid electrolytes as acid aerosol in the conductivity cell. The overall factors for converting instrument reading to actual acid aerosol concentration averaged from 0.52 to 0.70 when determined by 3 methods. The appreciable variations in instrument response to total acid aerosol in the air sampled, the range of variations in impaction efficiencies for acid aerosol, and significant variations in instrument response to nonacid electrolytes suggest that much more study is necessary before the practicability of the present instrumentation for monitoring acid aerosol can be determined. (Author abstract)

03035

M. Hayashi, S. Koshi, and H. Sakabe

DETERMINATION OF MIST SIZE BY METAL COATED GLASS SLIDE. Bull. Nat. Inst. Indust. Health (Kawasaki, Japan) 6, 35-42, 1961

A new method for the determination of mist size and numbers of mist particles is described, which is useful in air pollution research as well as in industrial hygiene. A glass slide was coated with a very thin layer of metal film; iron was the best

of three metals tried. The slides were placed in an Owens type dust counter or a cascade impactor for the collection of mist particles. Both acid and alkaline mists were tested. As the corrosive particles hit the slide, metal was dissolved and the transparent holes which were formed could be detected under an optical microscope. Methods for calculating true particle size from the holes in the metal-coated slide are given.

03852

E. S. Kohen

INDICATOR TUBE FOR THE INSTANTANEOUS DETERMINATION OF THE SO2 CONTENT OF THE AIR. Indikatorrohrchen zur Soforthestimmung des So2 - Gehaltes der Luft. Chem. Tech. (Berlin) 18, (11) 688, Nov. 1966. Text in Ger.

The tube was developed to facilitate the rapid determination of SO2 required for worker protection in the rapidly expanding sulfuric acid and sulfide ore industry. The operation of the tube is based on standard reaction tests for S2 and SO32- using sodium nitroprusside in an alkaline medium. The adsorbent is Fajan's powder. The preparation of the adsorbent and the complete indicator powder is described in detail. A calibration table (ranging from a length of coloring of 2mm for an SO2 concentration of 0.01 mg per liter to 60 mm for 0.64 mg per liter) is given. The sensitivity of the tube is about 0.01 mg per liter. Tubes tested in sulfuric acid plants gave accurately reproducible results. H2S does not affect the results unless present in very high concentrations. The tubes are found to be superior to those of the firm 'drager' (adsorbent, silical gel; reagent, potassium iodide and starch) with respect to cost, ease of manufacture, accuracy, and sensitivity. The tubes last about 10 months.

09033

Scaringelli, F. P. and K. A. Rehme

DETERMINATION OF ATMOSPHERIC CONCENTRATIONS OF SULFURIC ACID AEROSOL. Preprint, Public Health Service, Cincinnati, Ohio, National Center for Air Pollution Control, ((10))p., 1968. 32 refs. (Presented at the Division of Water, Air, and Waste Chemistry, American Chemical Society, San Francisco, Calif., April 3, 1968.)

A new sensitive, relatively specific method has been developed for sulfuric acid aerosol. It is based on the collection of the aerosol by sonic impaction on a copper disc, or by filtration on glass fiber filters. The free sulfuric acid or the prepared metal salt is thermally decomposed under a stream of nitrogen to sulfur trioxide. The sulfur trioxide is converted to sulfur dioxide by a catalytic bed of hot copper. The resulting sulfur dioxide is determined spectrophotometrically or by titration in a microcoulometer. Most salts of sulfuric acid do not interfere. Ammonium sulfate responds quantitatively, but this fact is not considered objectionable. This salt, in all likelihood, results from the reaction of sulfuric acid and ammonia in the atmosphere. The method is reproducible and is suitable for the determination of sulfuric acid in the parts per billion range.

09295

N. N. Basargin, N. K. Oleinikova

DETERMINATION OF SULFURIC ACID MIST IN THE GASES FROM SULFURIC ACID CONTACT PLANTS. Ind. Lab. (USSR)(English Transl.), 32(8):1118-1119, Aug. 1966. 4 refs.

In order to meet the need for a method for the rapid and precise determination of H2SO4 mist in gases containing acid components and arsenic, a direct volumetric method was developed for titrating sulfate ion with a barium salt in the presence of a new indicator for barium, namely nitrochromazo. Special features in the structure of nitrochromazo enable it to react with barium in an acid medium. The titration can be carried out at pH 2.0, which completely eliminates the effect of arsenates. The basis of the method was the direct titration of absorbed sulfuric acid, in a 50 percent aqueous acetone or aqueous alcohol medium, with a solution of barium chloride in the presence of nitrochromazo. The equivalent point was shown by a sharp change in the color of the indicator from violet to blue (complex with barium). The gas was drawn through the system by a vacuum pump. The sampling rate was 1 liter/min. The H2SO4 mist content of the sample should be 20 to 40 mg. The filter with absorbed sulfuric acid was washed through with distilled water by means of a water pump. The wash water was collected in a 100 ml graduated flask. The sampling tube was washed out into the same flask, and the volume was made up to the mark with water. An aliquot portion (10 to 20 ml) of this solution was transferred to a 100 ml conical flask, the pH was adjusted to 2.0 as judged by universal indicator paper, and the liquid was acidified with a few drops of N HCL. An equal volume of acetone or alcohol was added, and the solution was treated with 1 to 2 drops of 0.2 percent nitrochromazo solution in water and titrated, with shaking, with 0.02 N BaCl2 solution until the color changed. The strength of the BaCl2 solution was determined by titration of 0.02 N H2SO4 solution under the same conditions, in the presence of nitrochromazo. A blank titration was carried out to check the purity of the water and acetone or alcohol. The titration with nitrochromazo as indicator was checked with pure acid solutions. The proposed method was tested under laboratory conditions and at two sulfuric acid plants. Results for the determination of H2SO4 mist in production gases by the alkalimetric and nitrochromazo titration methods are compared; the former method gave high results in most cases.

09369

Wilson, H. N. and G. M. Duff

INDUSTRIAL GAS ANALYSIS: A LITERATURE REVIEW. Analyst, 92(1101):723-758, Dec. 1967. 712 refs.

Analytical methods are reviewed for: permanent and inorganic gases; analysis of liquefied or pure gases; fuel gases; flue gases; motor exhaust gases; analysis of micro samples; and atmospheric pollutants. The years from 1958 to about mid-1966 were covered. In no branch of analysis is the swing towards physical methods more marked than in gas analysis. There have been no important developments of the conventional methods during the last ten years; the chief advances have been the application of galvanic methods to 'trace' of certain gases, and gas chromatography. The rapid spread of the electrogalvanic methods for the 'on-stream' determination of traces is also most significant. The other most noticeable feature is the vast and increasing attention being paid to atmospheric pollutants of all kinds, particularly sulphur dioxide, sulphuric acid and hydrocarbons.

09633

Green, W. D.

SENSITIZED FILMS FOR THE DETECTION AND ANALYSIS OF CHEMICAL AEROSOLS. Preprint, Meteorology Research, Inc., Altadena, Calif., 12p., 1968. 4 refs. (Presented at the 9th Conference on Methods in Air Pollution and Industrial Hygiene Studies, Pasadena, Calif., Feb. 7-9, 1968.)

The chemical species to be detected in the aerosol undergoes a specific reaction with the indicator in the film following impactin and absorption of the particle. At the present time, films

for the detection of sulfate, halide, iodine, iodide, oxidants, nonspecific acids and bases, and sulfuric acid have been developed. Semi quantitative analysis of the ion concentration in single particles particles is possible by precalibration of the films with droplets aerosolized from solutions of known concentration. These films have been used on various air pollution oriented programs to trace sulfates, halides, and acid aerosols in the Los Angeles Basin and near San Juan, Puerto Rico, and to detect halides and acid aerosols in automobile exhaust. (Author's abstract, modified)

09983

Ubl, Z.

UNIFIED METHODS FOR THE ANALYSIS OF POLLUTANTS IN THE FREE ATMOS- PHERE. Acta Hygienica, No. 1, Suppl, 1966. 84p. 24 refs.

Methods for the analysis of pollutants in the air are presented with precise and complete notes dealing with procedure, apparatus, reagents, and possible problems. Procedures are given for determining the following compounds in the air: SO2, CO, NO2, NOx, sulfuric acid aerosols, Cl2, H2S, Pb compounds, CS2, phenol, As, F2, NH3, soot, Mn compounds, SiO2, and formaldehyde. Also discussed are methods of air sampling, calibration methods, calculations, sensitivity and error in the determinations interferences from other compounds, and the principle involved in the method.

11089

Scaringelli, F. P. and K. A. Rehme

DETERMINATION OF ATMOSPHERIC CONCENTRATIONS OF SULFURIC ACID AEROSOL BY SPECTROPHOTOMETRY, COULOMETRY, AND FLAME PHOTOMETRY. Preprint, Public Health Service, Cincinnati, Ohio, National Air Pollution Control Administrstion, 27p., 1968. 34 refs. (Presented before the American Chemical Society, Div. of Water, Air and Waste Chemistry, San Francisco, Calif., April 3, 1968.)

A sensitive, relatively specific method for sulfuric acid aerosol has been developed. The method is based on the collection of the aerosol by sonic impaction on a copper disc, or by filtration on glass fiber filters. The free sulfuric acid or the prepared metal salt is thermally decomposed under a stream of nitrogen to sulfur trioxide. The sulfur trioxide is converted to sulfur dioxide by a catalytic bed of hot copper. The resulting sulfur dioxide is determined spectrophotometrically or by titration in a microcoulometer. Most salts of sulfuric acid do not interfere. Ammonium sulfate responds quantitatively, but this fact is not considered objectionable. This salt, in all likelihood, results from the reaction of sulfuric acid and ammonia in the atmosphere. The method is reproducible and is suitable for the determination of sulfuric acid in the parts per billion range. (Authors' abstract, modified)

11140

Cares, Janet Walkley

THE DETERMINATION OF OXIDES OF SULFUR BY X-RAY EMISSION SPECTROMETRY. Am. Ind. Hyg. Assoc. J., 29(4):386-389, July -Aug. 1968.

Determination of sulfur dioxide, sulfur trioxide, or sulfuric acid mist becomes difficult in the presence of other acid gases or where collected samples are highly colored or turbid. A method is described by which all oxides of sulfur are oxidized and precipitated as barium sulfate. The barium in the precipitate is determined by measuring the intensity of the L-alpha emission produced by x-ray excitation. The method is useful for about 0.05 to 10 micromoles of oxides of sulfur in the aliquot analyzed. (Author's abstract)

12596

O'Keeffe, Andrew E.

AIR POLLUTION INSTRUMENTATION. STATE OF THE ART. Preprint, National Air Pollution Control Administration, Washington, D. C., Methods Development Section, 23p., 1968 (?). (Presented at the American Council of Independent Laboratories, Inc., Annual Meeting, Washington, D. C., Oct. 20, 1968.)

Brief descriptions of a number of new air pollution monitoring instruments being developed are presented. A key feature of these devices is their ability to sense and measure pollutants without use of reagents in solution. A flame photometric sulfur detector is being modified to read sulfur dioxide by gas chromatography. Fuel cells can be made for burning carbon monoxide, methane, SO2, or other compounds of interest. Semiconductors, such as zinc oxide change resistance when exposed to certain compounds. Microwave plasma detectors, in conjunction with spectrophotometers, can analyze certain gases. A chemiluminescent ozone monitor can measur ozone due to a release of light energy in direct proportion to the partial pressure of ozone. The permeation tube primary standard emits a constant supply of a desired gas, a feature which makes it desirable as a standard. Variations of gas chromatography and mass spectrometry are discussed. A system for the analysis of sulfur trioxide (sulfuric acid mist) is described. Not all of these methods will necessarily be commercial successes, but a number of them will certainly prove to be of great value in the detection of air pollutants.

14486

Uhi, K.

THE DETERMINATION OF ACIDIC GASES IN WORKING ENVIRONMENTS BY ALKALI FILTER PAPER. (Alkali roshi ho ni yoru sagyo kankyo chu sansei gas no sokutei). Text in Japanese. Nippon Eiseigaku Zasshi (Japan J. Hyg.), 24(1):49, April 1969.

The alkali filter paper method for determining acid gases in working environments entails soaking filter paper in a 30% potassium carbonate solution, drying the paper in air, and putting it in a vinyl holder having an exposure area of 64 sq cm. Absorbed gases are extracted with distilled water and determined qualitatively and quantitatively. The required exposure time is determined by the type of acid being measured, the production process, and the sensitivity of the determination method. Generally, 1 to 8 hrs are appropriate for acidic gases like SO2, HCl, and NO2, and 8 to 24 hrs for acid mists of sulfuric, phosphoric, and chromic acids. One hour is usually required for SO2 measurements by the para-rosaniline formaline method; the CL-Ba method requires 8 to 24 hrs. When the relationship between the amount of SO2 adsorbed on the filter paper and the average gas concentration in the working environment is plotted, a curve is obtained. Thus, on a per day basis, the coefficient of conversion depends on the amount adsorbed. However, the graph for an hour of exposure time is linear, suggesting that shorter exposure times would be convenient for the calculation.

14735

Steinke, Irmhild

CONTRIBUTION TO THE DETERMINATION OF SO2 AND SO3 IN WASTE GASES. (Beitrag zur potentiometrischen Bestimmung von SO2 und SO3 in Abgasen). Text in German. Z. Anal. Chem., 244(4):253-254, 1969. 3 refs.

In the determination of sulfur trioxide and sulfuric acid aerosols in the presence of sulfur dioxide, the latter substance is oxidized to SO3 and both oxides are determined jointly. After additional determination of the SO2 content, the SO3 content is obtained from the difference. In experiments to test this method, both oxides were absorbed in NaOH/H2O2 solution. Woulf's absorbing flask was used for this purpose. Gas components which are not immediately absorbed will be absorbed after shaking. In this alkaline solution, the SO3 (composed of SO3 and the oxidized SO2) is present in form of sulfate ions, which are best determined by the method of Baudisch, Beilstein, and Neuenhausen to an accuracy of plus or minus 0.16 mg. The SO2 concentration was separately determined by absorption in Na2(HgCl4) solution (West and Gaeke method). By this approach, the SO2 and SO3 concentrations in waste gases from sulfuric acid plants can be determined to a minimum concentration of 1 g/cu m plus or minus 0.07 g/cu m.

15745

Dubois, L., R. S. Thomas, T. Teichman, and J. L. Monkman

A GENERAL METHOD OF ANALYSIS FOR HIGH VOLUME AIR SAMPLES. I. SULFATE AND SULFURIC ACID. Microchim. Acta, vol. 6:1268-1275, Nov. 1969. 11 refs.

A method for analyzing high volume samples, particularly with respect to sulfates and sulfuric acid, was described which makes use of microdiffusion at 200 C to separate the volatile sulfate fraction from an aliquot portion of an air sample on a glass fiber. This separation ensures that only fixed sulfate is left in the aliquot disc after heating, and that the sulfuric acid, if originally present, will be removed. At the same time, any sulfuric acid evolved is trapped in a sodium hydroxide absorbent, which can be analyzed for fixed soluble sulfate using a method specifically for sulfates. The measurement of the separated volatile sulfate may then be carried out by microtitration or by square wave polarography. The polarographic method is more rapid and agrees with values found by microtitration; it is readily adapted to large scale analyses, and analytical speed can be improved. The proposed method is free from inaccuracies and ambiquities associated with procedures which depend upon pH measurement or nonspecific acid-base titration.

19384

Taylor, H. D.

THE CONDENSATION OF SULPHURIC ACID ON COOLED SURFACES EXPOSED TO HOT GASES CONTAINING SULPHUR TRIOXIDE. Trans. Faraday Soc., vol. 47:1114-1120, 1951. 8 refs.

Laboratory apparatus and techniques are described for sampling and analyzing the sulfuric acid condensing from a hot gas mixture of known water vapor and sulfur trioxide contents. The essential feature of the technique is the vaporization of sulfuric acid into an air stream of known composition and its condensation upon a surface held at a known temperature in such a manner that the condensate could be sampled and analyzed. Over the range of gas composition studied (from 60 to 600 ppm of SO3), the concentration of the condensate is not affected by the proportion of sulfur trioxide present. It is a function only of the surface temperature and the water vapor content of the gases and, independent of the latter, there is a peak in the rate of condensation at a surface temperature approximately 45-50 C below the dewpoint. The magnitude of this peak increases with increasing dewpoint. (Author abstract modified)

20595

Wyszynska, Halina, Konrad Kosinksi, Stefan Maziarka, Z. Misiakiewicz, and Artur Strusinsky

METHODS FOR THE SANITARY INVESTIGATION OF ATMOSPHERIC AIR DEVELOPED BY THE SECTION OF SANITATION LABORATORIES FOR THE PROTECTION OF ATMOSPHERIC AIR. (Metody sanitarnego badania powietrza atmosferycznego opracowanie zespolu Pracowni Sanitarnej Ochrony Powietrza Atmosferycznego). Wydawnictwa Metodyczne Panstwowego Zakladu Higieny (Methodologic Study Govt. Dept. Hyg.), no. 4(26); issue no. 10, 149p., 1968. 78 refs. Translated from Polish. Franklin Inst. Research Labs., Philadelphia, Pa., Science Info. Services, Oct. 14, 1969.

Methods are presented for determing atmospheric pollutants, with the exception of carbon monoxide and gasoline, the concentrations of which are defined by Polish law. In addition, methods are given for the determination of pollutants present in the atmosphere in quantities sufficient to create sanitation problems or to cause plant damage and corrosion to buildings. Some of the methods have been checked and tested extensively in the laboratory and in the field. Others have not yet been widely tested but are included for their potential usefulness in laboratory studies. The methods include the measurement of dust collected by the deposition method with respect to tars, sulfates, free silica, heavy metals, calcium, and fluorine. The other methods are the aspiration and contact methods for sulfur dioxide; the method employing thorium nitrate and eriochromecyanin R for sulfur trioxide-sulfuric acid; the para-aminodimethylaniline method for hydrogen sulfide; methylene blue and diethylamine and copper methods for carbon disulfide; the Saltzman method for nitrogen oxides; titration with thorium nitrate and colorimetric determination with eriochromecyanin and zirconium oxychloride for fluorine; o-tolidine for chlorine; titration for hydrogen chloride; buffered potassium iodide and the Heigal method for ozone; the Schryver method for formaldehyde; para-aminodimethylaniline and diazo-p-nitroaniline for phenol; nitration for benzene and chlorobenzene; and the indophenol method for aniline.

21056

Takahashi, Akira

ELECTROCONDUCTIVITY ANALYZER. (Taikichu no SO2 sokuteiho. 3. Yoeki dodenritsuho). Text in Japanese. Netsu Kanri (Tokyo) (Heat Eng.), 22(2):60-64, Feb. 28, 1970. 1 ref.

An electroconductivity analyzer was adopted to monitor sulfur oxides in a specified area in conformity with the requirements of the air pollution prevention law. The conductivity of an absorbent reaction solution is increased by sulfuric acid, which is formed by a reaction of hydrogen peroxide with the sample atmosphere. The density of the sulfur oxides is measured as an increase in conductivity. Measurement can be intermittent, automatic, or continuous. In one procedure the reagent used is a solution of 0.006% H202 and .00005 N sulfuric acid. The reagent will last for 20 days if 20 liters are used. A recorder can simultaneously measure the oxidized sulfur substance and floating gas. Sampling should be made to extract a representative sample of atmosphere at a specified district.

21415

Larrat, P. and J. Louise

CONTINUOUS DETERMINATION OF TRACE AMOUNTS OF SO2 IN THE ATMOSPHERE AND IN OTHER GAS MIXTURES. (Dosage continu de traces de SO2 dans l'atmosphere et autres melanges gazeux). Text in French. Chim. Anal. (Paris), 52(4):397-399, April 1970. 3 refs.

A method is proposed for making a wide range of sulfur dioxide content determinations: from concentrations on the order of 10 to the minus 6th power to those on the order of 10 to the minus 2 power. It offers the advantage that it does not require reference gas mixtures but only titred sulfuric acid solutions. The sulfur dioxide is first oxidized with hydrogen peroxide, after which the resulting sulfuric acid is determined by the conductimetric method. The method was tested with a gas rate of flow of 20 l/hr using 100 cu cm/hr of the liquid reagent. Absorption of SO2 was complete, and the relative accuracy of measurement was plus or minus 3 %.

22645

Barton, Sydney C. and Henry G. McAdie

PREPARATION OF GLASS FIBER FILTERS FOR SULFURIC ACID AEROSOL COLLECTION. Environ. Sci. Technol., 4(9):769-770, Sept. 1970. 5 refs.

When using glass fiber filters for sampling air containing microgram quantities of sulfuric acid, close attention must be given to blank effects since the residual alkali content of the filters can result in H2SO4 losses of 0.4 to 7.8 micrograms per sq cm of filter. In a new procedure, the sulfur contaminants responsible for the irreversible absorption of H2SO4 on the filter are deactivated by soaking the filter in 20% H2SO4 for two to three days, then rinsing it in distilled water, 80% isopropanal, and acetone. No H2SO4 losses have been observed in filters treated in this manner.

23771

Patton, W. F. and J. A. Brink, Jr.

NEW EQUIPMENT AND TECHNIQUES FOR SAMPLING CHEMICAL PROCESS GASES. J. Air Pollution Control Assoc., 13(4):162-166, April 1963. 7 refs (Presented at the Air Pollution Control Association, 55th Annual Meeting, Chicago, May 20-24, 1962.)

When the need for improved sampling equipment and techniques was recognized at Monsanto a number of years ago, a cascade impactor suitable for adiabatic measurements on process gases was developed. Simpler equipment, suitable for routine control of air pollution, can determine accurately the weight or chemical composition of the particles in a gas stream, as well as separately determine the loading of particles greater than three micron in diameter from particles smaller than this. The dust or mist sampling device is contained in a small case with a carrying handle and removable sides similar to an Orsat analyzer. Gases first enter the cyclone where the larger particles are collected, while the smaller particles are carried over and collected by the filter. Sampling preparations are discussed for large particles, fine particles, and isokinetic sampling. The procedures for sampling are outlined, as well as an example for sulfuric acid mist. Calculations of loadings from sampling data are also indicated. Eight sets of the sampling equipment have been utilized for sulfuric, phosphoric, and nitric acid mists, mercury mist, various phosphate salt dust, ammonium chloride fume, ammonium nitrate fume, and several organic mists.

24970

Heilingoetter, R.

ANALYTICAL METHODS USED TO DETERMINE DAMAGE BY ACIDS IN THE ATMOSPHERE. (Die chemische Untersuchungsmethoden des Luftsaeureschaedenexperten). Text in German. Chemiker-Zeitung, 51(45):429-433, June 8, 1927.

The three methods available for the assessment of damage caused by atmospheric acids are the so called leaf and needle ash analysis which directly measures damage caused to plants, atmospheric acid analysis by which the harmful content of acids can be measured on the spot and the qualitative determination of small quantities of acid in the atmosphere. The first method is based on the accumulation of acid in the exposed plants. In the ash of such exposed plant material (needles of conifers for example) water soluble sulfuric acid, chlorine, fluorine, and nitrogen are determined and the excess over normal levels is calculated. The second method, analyzing air acidity directly, uses a series of absorption bottles filled with different absorbent liquids designed to retain carbon dioxide, sulfur dioxide, sulfur trioxide, nitrogen oxides, ammonia, chlorides and hydrochloric acid which are then measured by appropriate analytical methods and the respective acidity is calculated. Toxicity limits are for SO2 3 mg/cu m, for N2O4 50 mg/cu m, for NH3 30 mg/cu m, for HCl 110 mg/cu m, for Cl2 64 mg/cu m and for HF 0.00033 vol %. The qualitative method uses cotton cloth dipped in a barium hydroxide solution and in lime water to determine the presence in the atmosphere of SO2 and of F respectively.

25445

Barton, S. C. and H. G. McAdie

A SPECIFIC METHOD FOR THE AUTOMATIC DETERMINATION OF AMBIENT H2SO4 AEROSOL. Preprint, International Union of Air Pollution Prevention Associations, 19p., 1970. 25 refs. (Presented at the International Clean Air Congress, 2nd, Washington, D. C., Dec. 6-11 1970, Paper CP-7D.)

Although the importance of sulfuric acid (H2SO4) aerosol as a toxic air pollutant is well established, the aerosol has received limited attention due to the lack of a satisfactory method for its determination. An instrument that employs new and improved versions of the established techniques of collection by filtration and colorimetric analysis provides a convenient method for the automatic determination of ambient H2SO4 aerosols under field conditions. The aerosol is collected, together with other particulates, on a Nuclepore polycarbonate membrane filter, then selectively eluted with 1-propanol for colorimetric analysis by the barium chloranilate method. Air is sampled at the rate of 20 l reciprocal min, and one-hour sampling intervals provide a full-scale sensitivity of 1 ppb, with a detection limit of approximately .05 ppb. The availability of this convenient and specific method should make it feasible for air quality authorities to undertake meaningful surveys to establish H2SO4 levels which at present are unknown or in serious doubt because of the limitations of existing methods.

25851

Nash, T.

LOW-VELOCITY GAS-LIQUID IMPINGER FOR THE CONTINUOUS ESTIMATION OF SULPHUR DIOXIDE AND OTHER ATMOSPHERIC POLLUTANTS. J. Sci. Instr. vol. 38:480-483, Dec. 1961. 3 refs.

An impinger is described, based on the observation that a low-velocity jet of air containing sulfur dioxide can transfer it very efficiently to the surface of dilute hydrogen peroxide, then by rapid micro-circulation to the underlying solution. Air is drawn into the cell compartment through a filter and glass jet, blowing vertically down onto 0.1 volume peroxide in the cell in which SO2 is scrubbed from the air and converted to sulfuric acid. The electrical conductivity of the solution in the cell is measured through electrodes connected to a simple oscillator, amplifier, and recorder. The vapor reaction, electrical circuit, stock solution, jet characteristics, and time constant are discussed. Calibration and performance are also described. The instrument records SO2 in the range 0.01 to 10 ppm where

rapid changes in concentration can be expected but the accuracy required is not more than 1 in 20. Its advantage is that gas absorption and measurement of conductivity are done in the same small cell, with the consequent gain in simplicity and speed of response. By using 0.1 mM alkali in the reservoir, and no peroxide, it is possible to record carbon dioxide concentration in the range normally encountered in air. One modification of the instrument measures light absorption instead of conductivity, permitting the use of colorimetric reagents.

D. AIR QUALITY MEASUREMENTS

05152

J. V. Kerrigan, and K. Snajberk

STUDIES ON SULFUR OXIDE POLLUTANTS IN THE ATMOSPHERE. California Univ., Berkeley, Sanitary Engineering Research Lab. May 10, 1960. 82 pp.

The location of the laboratory in an area zoned for heavy industry and having a local air pollution problem, together with the availability of an industrial sampling chamber as a source of sulfur oxide gases, made experimental work particularly feasible. The investigation was therefore designed to determine: (1) the comparative reliability of various instruments used to sample and detect sulfur oxide particles and gases; (2) the accuracy of various chemical methods of sulfate analysis at low sulfate ion concentrations; and (3) the concentration of certain sulfur oxide gases in the local atmosphere at the Richmond Field Station. Pans of distilled water were set up in the path of prevailing winds in such fashion that the winds would pass over an adjacent sulfuric acid manufacturing plant before entering the Field Station area. The pans were used to measure the fallout of sulfuric acid mist droplets, while an electro-static precipitator set adjacent to one of the pans measured the concentration of sulfuric acid mist in the air. The validity of the electro-static precipitator results was confirmed by comparison with a Greenburg-Smith impinger and with a sintered glass filter by sampling a gas chamber containing a mixture of sulfur dioxide and sulfuric acid mist under steady-state conditions. To approximate the concentrations of sulfuric acid mist under field conditions, samples fed to the instruments were diluted 10 to 50-fold with air. Both a Kruger autometer and a Thomas autometer were used to collect and analyze for sulfur dioxide. The turbidimetric, the Fritz titrimetric, the pH titration, and the acidimetric titration methods of chemical analysis for sulfate were compared in the course of the investigation.

11492

Polyak, V. E.

ATMOSPHERIC POLLUTION BY NITROGEN OXIDES IN THE MANUFACTURE OF SULFURIC ACID BY THE TOWER PROCESS. ((Zagryaznenie atmosfernogo vozdukha okislami azota pri bashennom proizvodstve sernoi kisloty.)) Hyg. Sanit. (English translation of: Gigiena i b8sanit.), 33(4-6):266-267, April-June 1968. CFSTI: TT 68-50449/2

An investigation of atmospheric pollution by nitrogen oxides (tail gases from the plant for the manufacture of sulfuric acid by the tower process) at various distances from the pollution source was made. The gases are discharged into the atmosphere by a chimney 40 m tall. The daily discharge into the atmosphere amounts to 4 tons of nitrogen oxides (expressed as nitric acid), with a gaseous volume of 817 cu m. There are no other discharges of nitrogen oxides on the factory premises or elsewhere in the district. Air was sampled at a level of 1-1.5 m from the ground, in the direct vicinity of the chimney, and at distances of 500, 1,000, 3,000 and 6,000 m, the total number of samples being 413. Measurements were made of the temperature, relative humidity and velocity of the air and of the barometric pressure, wind direction, cloudiness, and the color and movement of the visible 'tail' of the gas discharge. Nitrogen oxides were detected and determined at the laboratory in most samples (79-89.3%). In a considerable number of samples the concentration of nitrogen oxides exceeded the maximum permissible concentration, including some samples taken at large distances from the discharge site (3,000 and 6,000 m). All minimum concentrations were either equal to or lower than the maximum permissible concentration, but the maximum concentrations exceeded this level. The mean concentrations of nitrogen oxides likewise exceeded the maximum permissible concentration, being 2.45 mg/cu m at the distance of 6,000 m, i.e., eight times the maximum permissible concentration.

E. ATMOSPHERIC INTERACTION

10751

Hoegstroem, Ulf

A STATISTICAL APPROACH TO THE AIR POLLUTION PROBLEM OF CHIMNEY EMISSION. Atmos. Environ., 2(3):251-271, May 1968.

A method is described that not only gives one single concentration value but the expected concentration frequency distribution at an arbitrary point in the vicinity of the emitting chimney. The concentration frequency distribution obtained comprises the full range of meteorological conditions at a given place. In making the principal mathematical formulation of the method no assumptions whatsoever are needed about the mechanism of dispersion. In the practical application on the other hand, full use is made of the detailed knowledge of the dispersion process. First a 'basic case' is treated, the chief characteristics of which are: isolated stack, situated on a flat surface of uniform roughness; sampling time about an hour. The following information is found necessary for solving a concrete problem of this kind. (1) plant data, viz. rate of emission, gas volume and temperature, chimney height and exit diameter; (2) geographical site data, viz. roughness length; (3) meteorological data, viz. wind direction frequencies and statistics of 'dispersion categories' (stability and wind speed). Applicable formulae are discussed and also how statistics of 'dispersion categories' can be obtained by evaluating data from radiosonde stations. Certain deviations from the basic case are also treated in some detail; limited mixing height, the effect of large heat content on the dispersion parameters, the effects of buildings and topography, ground level release and sampling times other than an hour. A thorough test of the described method is presented. Nine months statistics of 2-hr SO2 concentration (2602 values) measured at a point situated 750 m from a sulphuric acid plant are compared with theoretically obtained statistics. The results strongly supports the method presented.

21791

Katz, Morris

PHOTOCHEMICAL REACTIONS OF ATMOSPHERIC POLLUTANTS. Can. J. Chem. Eng., vol. 48:3-11, Feb. 1970. 44 refs. (Presented at the Canadian Chemical Engineering Conference, 19th Edmonton, Alberta, Oct. 19-22, 1969.)

Photochemical reactions of atmospheric pollutants are described. The most important primary photochemical process is the dissociation of nitrogen dioxide into nitric and atomic oxygen. Activation energy for most atmospheric reactions may be supplied by absorption of ultraviolet and visible light by molecules and atoms that act as absorbers. The formation of free radicals from the photodissociation of aldehydes and other compounds which absorb solar radiation represents an important step in the series of reactions that lead to the production of eye irritation, plant damage, and photochemical smog. The meteorological and chemical circumstances which lead to photochemical smog are explained. Quantum yields from the photooxidation of sulfur dioxide are discussed, and an experimental method is described. The effect of humidity, nitrogen dioxide, light intensity, and unsaturated hydrocarbons are included. The roles of sulfuric acid aerosols, singlet oxygen, and ozone are analyzed.

F. BASIC SCIENCE AND TECHNOLOGY

00530

W. O. Negherbon

SULFUR DIOXIDE, SULFUR TRIOXIDE, SULFURIC ACID AND FLY ASH: THEIR NATURE AND THEIR ROLE IN AIR POLLUTION. Hazleton Labs., Inc., Falls Church, Va. June 1966. 1218 pp.

This monograph discusses the following: (1) Historical considerations; (2) Guidelines for the study of air pollution; (3) Physical and chemical properties of SO2, SO3, and H2SO4; (4) Meteorological considerations; (5) Anatomical and physiological considerations; (6) Deposition and retention of aerosol particles in the respiratory tract; (7) The effects of SO2 and H2SO4 on plants; (8) The effects of SO2, SO3, and H2SO4 mist on man and animals; (9) Fly ash origin, nature, and possible effects; and (10) Removal of pollutants from flue gases. The bibliography includes 2264 references.

04626

D. R. Coughanowr and F. E. Krause

THE REACTION OF S02 AND 02 IN AQUEOUS SOLUTIONS OF MNS04. Ind. Eng. Chem. Fundamentals 4, (1) 61-6, Feb. 1965.

An experimental investigation was made to determine the rate of reaction of sulfur dioxide and oxygen in aqueous solution containing manganous sulfate as a catalyst. The catalyst was varied from 0 to 15 p.p.m. of MnSO4 in a batch method, and from 100 to 10,000 p.p.m. in a flow method. The temperature was 25 C. The reaction is zero order with respect to both sulfur dioxide and oxygen. The concentration of manganous sulfate has a large effect on the rate of reaction; from 0 to 100 p.p.m. of manganous sulfate, the reaction rate constant, k, is proportional to the square of the catalyst concentration, but above 100 p.p.m., k increases less rapidly up to about 500 p.p.m., after which k increases very slowly with catalyst concentration. The reaction is easily inhibited by very small amounts of contaminant.

10907T

Lunge, G. and E. Berl

NITROGEN OXIDES AND THE LEAD CHAMBER PROCESS. II. BEHAVIOR OF A MIXTURE OF GASES, PRESUMABLY NO + NO2, IN CONCENTRATED SULFURIC ACID AND SODIUM HYDROXIDE 1/5 N. ((Untersuchungen ueber Stickstoffoxyde und ueber den Bleikammerprozess. II. Verhalten eines Gasgemisches von der ungefaehren Zusammensetzung NO + NO2 gegen konz. Schwefelsaeure und 1/5-n. Natronlauge.)) Translated from German. Z. Angew. Chem. (Weinheim), 19(19):857-869, May 1906.

The behavior of a gas mixture containing NO and NO2 in sulfuric acid and sodium hydroxide was investigated with the result that for analytical purposes sulfuric acid is the only absorption liquid for this gas mixture. Also the behavior of nitrogen oxide in the presence of oxygen and water was studied together with the kinetics of nitrogen oxide oxidation with oxygen or air. The kinetic curves indicated that the reaction 2NO+O2=N2O4 takes place at a constant rate which indicates that the oxidation takes place directly without formation of N2O3 as an intermediate.

13652

Ovchinnikova, Ye. N. and O. K. Davmyan

OXIDATION OF SULFUR DIOXIDE ON ACTIVATED CARBON BY THE LIQUID- CONTACT METHOD. (Ob okislenii sernistoge angidrida na aktivirovannom ugle zhidkostno-kontaktnym metodom). Text in Russian. Zh. Fiz. Khim., 30(8):1735-1738, 1956. 1 ref.

The oxidation of SO2 on the surface of activated carbon at room temperature with formation of a definite quantity of oxidation product which can be removed with water in the form of sulfuric acid was demonstrated. Above 220 C, the surface-oxidized product reverts to SO2. As the quantity of water sorbed by the carbon increases, the yield approaches a limit of 0.25 g H2SO4 per gram carbon. The rate of acid formation decreases as the acid concentration increases and is directly proportional to the square root of the product of the oxygen and sulfur dioxide partial pressures.

13802

Lewis, W. K. and E. D. Ries

INFLUENCE OF REACTION RATE ON OPERATING CONDITIONS IN CONTACT SULFURIC ACID MANUFACTURE. Ind. Eng. Chem., vol. 17:593-598, June 1925. 6 refs.

The data of Knietsch on the conversion of SO2 to SO3 by platinum at commercial operating temperatures demonstrates that the catalytic activity of platinum rises rapidly with the temperature to about 500 C, then goes through a maximum at about 525 C, beyond which it greatly decreases. The reason for this maximum is not clear and no experimental data are available to confirm it. Operating variables under the control of an engineer are the composition of the gas entering a converter, operating temperature, and the amount, character, and distribution of platinum used for a given amount of gas. Equations based on these conditions were derived to determine the capacity and efficiency of a converter and the optimum temperature at each stage of converter operation. They suggest that a decided increase in converter efficiency can be obtained by controlling the temperature of the gases. To achieve this, converters must be modified to absorb the heat of reaction and the sensible heat of the gases. Two types of converters employing this principle are suggested. In both, gases reach the bottom of the converter at about 400 C. The correct temperature gradient for one converter is maintained by by-pass valves. Gases are cooled by coils and contact masses. Gases passing through the second converter are cooled and diluted by auxiliary air valves. Adiabatic converters control the temperature. The temperature in the first converter after reaction can rise to 530 C without losing efficiency; the temperature in the second to 550 C.

13875

Pechkovskiy, V. V.

THERMOCHEMICAL DISSOCIATION OF MAGNESIUM SULFATE. (O termokhimicheskom razlozhenii sul 'fata magniya). Text in Russian. Zh. Prikl. Khim., 29(8):1137-1142, 1956. 5 refs.

The rate of thermochemical dissociation of magnesium sulfate as affected by termperature, time, oxygen content of the gas passing over the sulfate, and the presence of various metal oxides was studied experimentally to determine the usefulness of this material as a source for producing acid. Practical dissociation occurred at 950-1100 C. Of the additives tested (SiO_2, Fe_2O_3, CuO), ferric oxide and cupric oxide were found to have a very significant accelerating influence on the dissociation reaction, this influence being always greatest in the absence of oxygen (under nitrogen). The data presented will be helpful in determining additives to be selected for use with this process.

13940

Davtyan, O. K. and E. N. Ovchinnikova

INVESTIGATION OF THE MECHANISM OF OXIDATION, HYDROGENATION AND ELECTROCHEMICAL COMBUSTION ON SOLID CATALYSTS. I. OXIDATION OF SULFUR DIOXIDE ON ACTIVATED CARBON AT 20 C IN THE PRESENCE OF WATER VAPOR. (Issledovaniye mekhanizma okisleniya, gidrirovaniya i elektrokhimicheskogo goreniya na tverdykh katalizatorakh. i. Okisleniye sernistogo angidrida na poverkhnosti aktivirovannogo uglya pir 20 C v prisutstvii vodyanykh parov). Text in Russian. Zh. Fiz. Khim., 35(4): 713-718, 1961. 2 refs.

The low-temperature oxidation of sulfur dioxide on the surface of activated carbon at 20 C was studied, and a method was developed for determining the absorption and oxidation of SO_2 when the oxidation product remains adsorbed on the surface. It was found that in the presence of water vapor, the oxidation product is held on the surface in the form of sulfuric acid. As the amount of adsorbed water vapor increases, the quantity of sulfuric acid absorbed on the carbon reaches some maximum determined by the partial pressure of oxygen in the gaseous phase. Removal of the H_2SO_4 from the carbon completely restores its activity.

14249

Calderbank, P. H.

CONTACT-PROCESS CONVERTER DESIGN. Chem. Eng. Progr., 49(11): 585-590, Nov. 1953. 9 refs.

An equation was derived to express the rate of SO_2 oxidation with a vanadium oxide catalyst in a flow-type isothermal reactor. The expression is applicable up to 100% conversion for a variety of commercial vanadium catalysts and up to 59% conversion under near-isothermal conditions and can be used to calculate the weight of a catalyst required to produce a given amount of conversion. The units used for the expression can be converted into tons H_2SO_4 produced/tons catalyst/day, the loading in tons multiplied by fractional conversion giving the reaction rate in tons H_2SO_4 produced at the relevant temperature and mean partial pressure of SO_2, O_2, and SO_3. Reaction rate data from other sources are in broad agreement with the proposed equation, which was applied to an evaluation of adiabatic converters and converters with integral heat exchangers. Reaction rates, optimum temperature distribution, and the required amount of catalyst were determined. An adiabatic reactor producing 50 tons H_2SO_4 per day requires 14.7 tons of catalyst for 96% conversion of a feed. A reactor with a heat exchanger producing the same amount of H_2SO_4 requires 0.93 tons catalyst for 96% conversion. The calculated optimum temperature distribution does not differ greatly from that obtained in the converter with a heat exchanger.

14506

Hull, William Q., Frank Schon, and Hans Zirngibl

SULFURIC ACID FROM ANHYDRITE. Mod. Chem. Processes, vol. 5: 123-133, 1958. 12 refs. (Also: Ind. Eng. Chem., Aug. 1957.)

The chemistry of sulfate decomposition and differences in cement clinker production are discussed. The effect of decomposition speed, dependence on temperature and additives, particle size, and granular size with gypsum residues from the sulfate decomposition were investigated. In the industrial anhydrite sulfuric acid process, coke is used as a reducing agent and enough aluminum-containing materials are added so that portland cement is produced per ton of acid. Dissociation of the calcium sulfate consists of three stages; $CaSO_4$ plus 2 C yields CaS plus $2CO_2$; CaS plus $3CaSO_4$ yields 4CaO plus $4SO_2$ (the overall reduction process is $2CaSO_4$ plus C yields 2CaO plus CO_2 plus $2SO_2$); and 3CaS plus $CaSO_4$ yields 3CaO plus $2S_2$. The CaS and $CaSO_4$ have, at each temperature, a definite decomposition pressure. Additives of clay or similar materials raise the decomposition pressure and the temperature in order to maintain the same decomposition rate. Too much CaS and $CaSO_4$ also lowers the decomposition rate. As far as sulfur dioxide is concerned, this is the end of the process. The rest involves making the cement clinker. A further rise in temperature up to 1400 C completes the reaction between the components and lime, formed during decomposition, to produce a good clinker. Besides an exact adjustment of the proportions of the reduction coke to the anhydrite, the proportions of the added materials to the CaO and to each other must be carefully adjusted within determined limits so that a good clinker results. Even more important, kiln operation must be carried out under steady conditions. Heat consumption for clinker in the anhydrite sulfuric acid process as compared with that of normal portland cement clinker must also be considered. A typical plant and its contact process are described. Production is inexpensive, and cement is sold at market value. There was no difficulty in marketing surplus acid.

14526

Postnikov, V. F., T. I. Kunin, and A. A. Astasheva

THE CONTACT CAPABILITY OF CHROMIC OXIDE FOR THE OXIDATION OF SO2 TO SO3. (O kontaktiruyushchey sposobnosti okisi khroma dlya okislaniya SO2 v SO3). Text in Russian. Zh. Prikl. Khim., 9(8):1373-1377, 1936. 10 refs.

The catalytic activity of chromic oxide in the oxidation of sulfur dioxide depends on the starting materials and the method of preparation. Greatest activity was given by a chromic oxide gel precipitated with ammonia on heating; chromic oxide gels precipitated with sodium or potassium hydroxides had a much lower contact property. Water vapor increases the activity of pure chromic oxide, shifting the curve of contact in the direction of higher temperatures in comparison with operation in dry gas. Activation of the chromic oxide gel, precipitated by ammonia, by the acetates of calcium, zinc, aluminum, and nickel does not improve the contact properties of chromic oxide. The activity of chromic oxide precipitated with sodium hydroxide increases in the presence of activators but does not attain the level of activity of pure chromic oxide precipitated with ammonia.

14538

Boreskov, G. K. and V. P. Pligunov

KINETICS OF THE CONTACT OXIDATION OF SO2. (Kinetika kontaktnogo okisleniya SO2). Text in Russian. Zh. Prikl. Khim., 6(5):785- 796, 1933. 14 refs.

An isothermal method was developed for the oxidation of SO2 in a flowing system. The effects of contact time, gas composition, and temperature on the oxidation rate of SO2 over the vanadium catalyst 'BOV' were studied. The applicability of the Taylor Lenher formula was shown. The apparent heat of activation was determined as 20,000 cal for high temperatures and 55,000 cal for low temperatures. The point of inflection was at 440 deg. The results were compared with those known for a platinum catalyst. It was shown that for temperatures higher than the point of inflection, the course of the reaction on platinum and vanadium catalysts occurs almost identically. Upon temperature decrease to the point of inflection, the rate of oxidation on a vanadium catalyst falls rapidly in proportion to the sharp increase in apparent heat of activation to 50,000 cal. In this temperature interval, the total rate of the process determines the rate of freeing the catalyst surface from the SO3 being formed. On the basis of these conclusions, the practical use of vanadium catalysts is considered. Formulas and diagrams are given, establishing the optimal curve of temperature change along the layer of contact mass. This curve provides for the maximum rate of the process, shows the time of contact necessary for carrying out any part of the oxidation, and also provides for finding the optimal composition of the gas mixture giving maximum productivity under these conditions.

14539

Adadurov, I. E., M. V. Apanasenko, L. M. Orlova, and A. I. Ryabchenko

EFFECT OF THE COMPOSITION AND DISPOSITION OF THE CONTACT MASS ON THE CATALYTIC ACTIVITY OF CHROMIUM CATALYSTS. (Vliyaniye sostava i raspolozheniya kontaktnoy massy na kataliticheskuyu aktivnost' khromovykh katalizatorov). Text in Russian. Zh. Prikl. Khim., 7(8):1356-1362, 1934. 3 refs.

In spite of their high quality, chromium-tin catalysts have the disadvantage that the activating mixture requires unavailable amounts of tin. Attempts to decrease the requirement of catalytic material by applying it to a carrier have not yet led to favorable results. Efforts to replace tin with other activators have not produced any promising patents for industrial use. Only aluminum oxide at temperatures beginning at 530 deg has given a conversion close to the theoretical yield of approximately 90%. The maximum increase in the amount of sulfur dioxide converted into sulfur trioxide per unit volume of contact mass using a chromium-tin catalyst can be attained by coordinating the reaction with its kinetics and by arranging the contact material according to particle size in the contact apparatus. Arranging the catalyst particles according to the movement of the gas with the largest particles at the top of the apparatus increases contact by 4-5%. The same kinetic principles applied to a two-stage contact process (loading the first converter with a chromium mass activated with aluminum oxide, operating at 550 deg, the second converter with a chromium-tin catalyst, operating at 450 deg) resulted in a productivity increased by 250%. Thus, it appears possible to operate a contact process on a combination chromium catalyst.

14625

Davtyan, O. K., B. A. Manakin, and E. G. Misyuk

TEMPERATURE DEPENDENCE OF SULFURIC ACID FORMATION RATE DURING CATALYTIC OXIDATION OF SULFUR DIOXIDE ON ACTIVATED CARBON BY THE WET CONTACT METHOD. (Temperaturnaya zavisimost' skorosti obrazovaniya sernoy kisloty pri kataliticheskom okislenii sernistogo angidrida na aktivirovannom ugle zhidkostno- kontaktnym metodom). Text in Russian. Nauchn. Ezhegodnik Odessk. Gos. Univ., Khim. Fak., no. 2:113-115, 1961. 2 refs.

The formation of sulfuric acid was studied experimentally in a laboratory percolating device in which an incoming SO2-O2 mixture serves to lift the solvent so that it trickles over the catalyst before returning to the solvent reservoir. The partial pressures of the gas mixture were 200 and 400 mm Hg in two series of experiments over 10 deg temperature intervals ranging from 0 to 60 C. The temperature coefficient in all cases varied from 1.2 to 1.3, i.e., within the range typical for a diffusion process.

14626

Chzhi-tsayn, Syao, V. I. Smirnov, and I. T. Sryvalin

THERMODYNAMICS OF SULFATE ROASTING OF CONVERTER SLAGS IN A BOILING LAYER. (Termodinamika protsessov sul'fatiziruyushchego obzhiga konverternykh shlakov v kipyashchem sloye). Text in Russian. Tr. Ural'sk. Politekhn. Inst., no. 98:67-71, 1960. 9 refs.

Data from the literature are used to make thermodynamic calculations for reactions of elemental metals (nickel, cobalt, copper, iron), metal sulfides, metal oxides, and metal oxide-silicon dioxide complexes with sulfuric acid and sulfur dioxide at 573-973 K. Isobaric potential is plotted for a number of reactions. Reaction of metals with sulfuric acid is in the sequence: cobalt, nickel, copper. Isobaric potentials for reactions between metal sulfides and sulfuric acid are comparable for iron, cobalt, and nickel but considerably higher for copper. The reaction sequence for the sulfating of metal oxides is found to be: cobalt, nickel, copper, iron. Sulfating of silicates is characterized by much more negative isobaric potentials, being nearly the same for iron, cobalt, and nickel. It may be concluded that under similar conditions, oxides, metals, and sulfides will sulfate more readily than will silicates, ferrites, and aluminates. It is noted that the drop in isobaric potential decreases with increasing temperature in the case of sulfur dioxide but increases with sulfuric acid, the isobaric potential plots intersecting at 450-500 C. Hence, sulfation with sulfuric acid will predominate at practicable roasting temperatures (600-700 C).

14641

Kapustinksy, A. F.

THERMODYNAMICAL THEORY OF SULPHURIC ACID PROCESSES. Compt. Rend. Acad. Sci. URSS, 53(8):719-722, 1946. 16 refs.

The manufacture of sulfuric acid, regardless of the production method and catalyst employed, is based on the equilibrium reaction SO2 plus 1/2O2 yields SO3. With the aid of known specific heats of gaseous reagents, equations for calculating the free energy and heat of the reaction were derived from previously determined equilibrium constants for the formation of sulfur trioxide from sulfur dioxide and oxygen on a platinum catalyst. Standard values of these thermodynamic functions are shown and compared with those contained in the literature. The absolute entropy of liquid sulfuric acid and its heat of formation under standard conditions are given, as well

as the absolute entropy of gaseous sulfur trioxide. The proposed thermodynamic theory of the sulfuric acid process makes it possible to represent as a single system, data constituting the basis of all sulfuric acid production methods for the oxidation of sulfur dioxide by oxygen.

14653

Kapustinskiy, A. F.

ON THE PHYSICOCHEMICAL THEORY OF OBTAINING SULFURIC ACID BY THE CONTACT METHOD. (K fiziko-khimicheskoy teorii kontaktnogo sposoba polucheniya sernoy kisloty). Text in Russian. Issled. Po Prikl. Khim., Akad. Nauk. SSSR, Otd. Khim. Nauk, Sb., 1955:22-38. 38 refs.

This study examines the formation of SO3 from SO2 and oxygen, the thermodynamics of SO3 synthesis, and the mechanisms of catalysis in this synthesis. The study of the dissociation equilibrium of SO3 at high temperatures over platinum using modern measuring techniques is described. A rigorous thermodynamic analysis of available results, based on classical thermodynamics, was made without any assumptions or approximations and was found to be in agreement with spectroscopic and calorimetric data. A structural-model approach is given to explain the catalytic action of platinum, proceeding from a proposed deformation of the molecules during adsorption, drawing on data from crystal chemistry and new information regarding molecular structure.

14845

Streicher, J. S.

THE CATALYSIS OF SO2 TO SO3. Chem. Met. Eng., 37(6):501-502, Aug. 1930.

The use of vanadium as a catalyzer in the sulfuric-acid process is discussed as a substitute for platinum. At low flow rates vanadium achieves the same conversions as platinum at given temperatures. The problem with vanadium is reaching the high rate at which the gases can be combined independently of the percentage yield. The joint action of the two factors, highest flow rates and highest conversions, is the decisive point of every contact plant. The elimination of platinum and the substitution of vanadium compounds and other catalytic compounds has an important economic aspect. In 1930, 1 kg of platinum cost $1286 and 1 kg of vanadium cost $7. The amount invested in platinum can be overlooked, considering that the additional cost of patented apparatus, machinery, license fee, and depreciation always offsets the investment. The high return value of platinum is often in calculations. Moreover, platinum does not cost 'two thousand times as much as vanadium', the true proportion of the cost of vanadium to platinum in July 1930 was 1:184.

14871

Grafton, Raymond William

PROCESS FOR THE TREATMENT OF GLAUBER'S SALT. (Courtaulds Ltd., London) Brit. Pat. 801,527. 9p., Sept. 17, 1958. (Appl. Jan. 24, 1957, 6 claims).

A process is claimed relating to the treatment of Glauber's salt, large quantities of which are obtained as a by-product in the viscose rayon industry, in order to permit the recovery of useful chemicals from the salt. To date, this salt has had little market value. The process comprises dissolving the salt in water, treating the solution with an ion-exchange resin to form sulfuric acid and a sodium resin salt, and regenerating the sodium resin salt by treatment with nitric acid. The reactions involved in this process are RH + Na2SO4 yields NaR + l/2H2SO4, and NaR + HNO3 yields RH + NaNO3, R being the cation exchange resin. The process is preferably effected in a cyclic manner. The recovered solutions are sulfuric acid, which can be used directly in the viscose rayon factory, and sodium nitrate, which can be used as a fertilizer. In one cyclic process of this invention, the ion-exchange resin is contained in a number of reactors which are arranged on a turntable, which moves the reactors in a cyclic manner so that each reactor moves in turn through four fixed zones. In another cyclic process, the reactors, instead of being arranged on a turntable, are fixed, and a single rotary valve is provided which connects the various reactors to the correct liquor feeding and withdrawal points at the appropriate stages in the cyclic process. The number of reactors in the various zones is determined by the particular reaction to be carried out and the degree of conversion required, but in general from two to five reactors in each zone seems to be sufficient for economic operation. In addition, the speed of rotation of the turntable or rotary valve and the rate of feed of the solutions supplied to the reactors must be suitably correlated to allow for adequate reaction times. Technical details of the process, a sample experimental apparatus, and pertinent diagrams are included.

15325

Suchkov, A. B., B. A. Borok, and Z. I. Morozova

THERMAL DECOMPOSITION OF A MIXTURE OF MnSO4 + FeSO4 IN A FLOW OF STEAM. (O termicheskom razlozhenii smesi MnSO4 + FeSO4 v toke vodyanogo para). Text in Russian. Zh. Prikl. Khim., vol. 32: 1618-1620, May-Aug. 1959. 8 refs.

It was established experimentally that the decomposition of ferric sulfate in a flow of steam of 500 C yields high-quality ferric oxide and regenerates a significant quantity of sulfuric acid of 96% concentration. Decomposition of a mixture of ferric sulfate and manganese sulfate in a flow of steam at 600 C followed by washing of the solid product with water yields ferric oxide free of manganese impurities.

15416

Suchkov, A. B., B. A. Borok, and Z. I. Morozova

THERMAL DECOMPOSITION OF CERTAIN SULFATES IN A FLOW OF STEAM. (O termicheskom razlozhenii nekotorykh sul'fatov v toke vodyanogo para). Text in Russian. Zh. Prikl. Khim., vol. 32: 1616-1618, May-Aug. 1959. 2 refs.

Thermal decomposition at 200-1000 C in steam was studied using sulfates of lithium, sodium, potassium, copper, beryllium, magnesium, calcium, aluminum, titanium, chromium, manganese, iron, cobalt, and tin. It was demonstrated that decomposition of certain sulfates under these conditions is an effective process for obtaining sulfuric acid and corresponding oxides and that it proceeds at much lower temperatures than ordinary thermal decomposition. A bond-theory explanation is given for differences in decomposition temperatures among these sulfates.

16292

Kozhevnikova, N. V. and D. G. Traber

PETROGRAPHIC AND X-RAY EXAMINATION OF IRON OXIDE CATALYST FOR THE PRODUCTION OF SULFURIC ACID. (Petrograficheskoye i rentgenograficheskoye issledovaniye okisno-zheleznogo katalizatora dlya proizvodstva sernoy kisloty). Text in Russian. Zh. Prikl. Khim., 39(6):1272-1275, 1966. 6 refs.

Iron oxide catalysts undergo partial sulfatization by the action of sulfur dioxide and sulfur trioxide at 675-750 C. Roasting the catalyst at 1000 C leads to the formation of nonactive minerals

of the iron orthoclase type (aegirite) and solid solutions of iron oxide with quartz. Long-term (100 hrs) treatment of the catalyst at high temperatures with insufficient oxygen causes gradual accumulation of solid solutions of iron oxides with silica, which subsequently leads to a reduction in catalytic activity. X-ray data for catalysts prior to and after high-temperature treatment and after roasting are tabulated.

16377

Rzayev, P. B., V. A. Royter, and G. P. Korneychuk

KINETICS OF SULFURIC ACID CATALYSIS ON BARIUM-ALUMINUM-VANADIUM CATALYSTS. (O kinetike sernokislotnogo kataliza na bariyevo- alyumovanadiyevykh katalizatorakh). Text in Russian. Ukr. Khim. Zh., 26(2):161-167, 1960. 5 refs.

The kinetics of sulfur dioxide oxidation on barium-aluminum-vanadium catalysts were studied and found to conform to an equation derived elsewhere by G. K. Boreskov. The heat of activation was 23 kcal/mole and pertained to an internal-kinetic regime which was not distorted by the effect of macrofactors. Even with small catalyst grains (1.5-2.0 mm diameter), conversion factors below 70%, and temperatures above 500 C, an internal diffusion retardation occurred which reduced the measured heat of activation. The activity of the catalyst remained practically constant with significant differences in the degree of reduction of vanadium oxides in the catalyst. Possible causes for overestimation of the heat of activation by the diaphragm method were discussed.

20274

Collins, Conrad G., Jr.

A REVIEW OF SULPHUR FLAME TECHNOLOGY. (PART 2). Sulphur Inst. J., 6(1):18-22, Spring 1970. 52 refs. Part I. Ibid, Winter 1969-70.

The encounter and reaction of sulfur dioxide with an oxygen atom appears to be the predominant mechanism for sulfur trioxide formation according to most studies of stack gases and the hydrogen sulfide flame. The mechanism can be important only in flames with high temperature (1200 C) zones for the formation of atomic oxygen, as at lower temperatures, the slow homogeneous reaction between SO2 and molecular oxygen appears to be a two body collision reaction. Catalytic action of nitric oxide for oxidizing SO2 to SO3 is questioned in lower temperature regions where SO2 would react only with molecular oxygen, but if high temperatures prevail, such that the oxygen atom concentration is appreciable, the catalytic effect of NO may be established. Experimental work with hydrogen chloride added to the flame (nucleophilic partner) yielded 38% SO3, and HCl was viewed as a stabilizing medium for SO3. Different sulfur oxide species have been detected spectroscopically at a variety of conditions, from low temperature to the high temperature of shock waves.

21068

Lasiewicz, Krystyna, Aleksandra Pudliszak-Dziewanowska, and Juliusz Wesolowski

POROUS STRUCTURE OF VANADIUM CATALYSTS FOR SO2 OXIDATION. (Struktura porowata katalizatorow wanadowych do utleniania SO2). Text in Polish. Przemysl Chem., 43(3):140-143, 1969. 2 refs.

Vanadium catalysts used to oxidize sulfur dioxide in the manufacture of sulfuric acid were studied in terms of their pore structure. The preferred catalyst had pores with a radius larger than 5,000 A. When 90% of the pores exceeded 1,000 A, the activity of the catalyst was fairly high, while lowest activity was assigned to those with a majority of pores below 1,000 A. For pores ranging in their radius from 75 to 75,000 A, the specific volume was 0.12-0.65 sq cm/g. The range of specific surface was 2.4-6.3 sq m/g.

22098

Honti, Georges

OPTIMALIZATION OF A SULFURIC ACID PLANT WITH THE AID OF A COMPUTER. (Optimalization d'une usine d'acid sulfurique a l'aide d'un ordinateur electronique). Text in French. Ann. Genie Chim., 1967:206-214, 1967. 28 refs.

A computer program to optimalize industrial plant capabilities is presented. The program is of a general nature and can be adapted to every process and every actual factory. The individual blocks are also universally applicable and can be adapted to actual conditions and data. In the case of calculations relating to a sulfuric acid factory, the only problem is that of the catalytic converter, and the corresponding optimalization program is drawn up. A simplified version, used for checking purposes without optimalization, enables the activity of the catalyst to be checked as a function of the data relating to temperature, concentration, and linear velocity measured in the converter. Working with industrial and laboratory measurements, this program can be used to check the validity of a large number of kinetic equations. The results of some of these calculations are described. (Author abstract modified)

22154

Stopperka, K. and V. Neumann

INFRARED SPECTROSCOPIC INVESTIGATIONS OF THE LIQUID SYSTEMS SO3-H2O AND SO3-D20. 5. THE TEMPERATURE-DEPENDENT EQUILIBRIA IN THE LIQUID SYSTEM H2SO4-SO3. (Infrarotspecktroskopische Untersuchung an den fluessigen Systemen SO3-H2O und SO3-D2O. 5. Ueber die temperaturabhaengigen Gleichgewichte im fluessigen System H2SO4-SO3). Text in German. Z. Anorg. Allgem. Chem., 374(2):113- 124, May 1970. 11 refs.

During investigations of the stability of sulfuric-acid mists, the necessity arose to obtain accurate data on the temperature-dependen equilibria of the liquid system sulfuric acid-sulfur trioxide. An infrared absorption spectrographic study was carried out of H2SO4-SO3 solutions with O to 100% SO3 in increments of 10% (except for one step with 5% SO3). Temperatures increased from 20 C by 10 deg increments up to and including the respective boiling points. To withstand the chemical attack of the solutions at the test temperatures, a special cuvette was designed in which the solution to be analyzed was placed in an annular container surrounded by a heating mantle with a thermostatic temperature control. This, in turn is surrounded by and communicates with a hollow, 2.5 micron thick (at 20 C), 25 mm diameter space bounded by two 1 mm thick, 25 mm diameter discs of pure silicon and assembled by a very ingenious method. Sets of infrared absorption spectra of H2SO4-SO3 solutions with 0.5, 40, 50, 80, and 100% SO3 are presented graphically. Their correction with the aid of data obtained by a compensation cuvette, as well as their interpretation, are discussed at some length. The information provided by the spectra is presented tabularly, confirming and supplementing previous findings.

G. EFFECTS-HUMAN HEALTH

11379

Bustueva, K. A.

TOXICITY OF SULFUR OXIDES INHALATION IN CHRONIC CONTINOUS EXPERIMENT. In: Biological Effect and Hygienic Significance of Atmospheric Pollutants, Book 1/9, V. A. Ryazanov and M. S. Gol'dberg (eds.), Translated from Russian by B. S. Levine, U. S. S. R. Literature on Air Pollution and Related Occupational Diseases, Vol. 16, pp. 82-98, 1968. ((15)) refs. CFSTI: PB 179141

Prolonged uninterrupted inhalation of air containing a mixture of SO2 and sulfuric acid aerosol affected the organism in a synergistic (additive) manner. In this connection sanitary evaluation of the simultaneous presence of SO2 and of sulfuric acid aerosol in atmospheric air of inhabited areas should be quided by a general formula which is based on the principle of simple addition. A formula is proposed as a guide in evaluating the sanitary condition of atmospheric air of populated air of populated areas which contained SO2 gas and sulfuric acid aerosol simultaneously.

16774

Amdur, Mary O.

TOXICOLOGIC APPRAISAL OF PARTICULATE MATTER, OXIDES OF SULFUR, AND SULFURIC ACID. J. Air Pollution Control Assoc., 19(9):638-646, Sept. 1969. 62 refs.

An examination of the available toxicological literature indicates that sulfur dioxide itself would be properly classified as a mild respiratory irritant, the main portion of which is absorbed in the upper respiratory tract. The literature further indicates that sulfuric acid and irritant sulfates, to the extent that the latter have been examined, are more potent irritants than SO2. The irritant potency of these substances is affected by particle size and by relative humidity, which factors are probably interrelated. There is evidence, based on animal experiments of one investigator, indicating that the presence of particulate matter capable of oxidizing SO2 to H2SO4 caused a three to fourfold potentiation of the irritant response. The aerosols causing this potentiation were soluble salts of ferrous iron, manganese, and vanadium all of which would become droplets upon inhalation. Insoluble aerosols such as carbon, iron oxide fume, triphenylphosphate, or fly ash did not cause a potentiation of the irritant of sulfur dioxide even when used at higher concentrations. The concentrations of SO2 used in these various experiments were in some cases as low as 0.16 ppm. The catalytic aerosols were used at concentrations of 0.7 to 1 mg/m3 which is above any reported levels of these metals in urban air. If the SO2 present as an air pollutant remained unaltered until removed by dilution, there would be no evidence in the toxicological literature suggesting that it would be likely to have any effects on man at prevailing levels. Studies of atmospheric chemistry have shown that SO2 does not remain unaltered in the atmosphere, but is converted to H2SO4. Such a conversion increases its irritant potency. On this basis, the toxicological literature combined with the literature of atmospheric chemistry suggest that sulfur dioxide levels be controlled in terms of the potential formation of irritant particles. Therefore control measures should be, as far as feasible, aimed at both SO2 and particulate material and not against either alone. This article is followed by a discussion by J. Wesley Clayton, Jr. (Author's Abstract Modified)

17623

Bushtueva, K. A.

EXPERIMENTAL STUDIES ON THE EFFECT OF LOW OXIDES OF SULFUR CONCENTRATIONS ON THE ANIMAL ORGANISM. In: Limits of Allowable Concentrations of Atmospheric Pollutants. V. A. Ryazanov (ed.), Book 5, Washington, D. C., U. S. Public Health Service, March 1962, p. 92-103. 7 refs. (Translated by B. S. Levine.)

Seventy-eight guinea pigs approximately one month old and weighing between 150 and 250 g were divided into groups of four and exposed for 120 continuous hours to low concentrations of sulfuric acid aerosol and sulfur dioxide, individually and in combination. A continuous 120 hr exposure to 3 mg/cu m of SO2 and 1 mg/cu m of sulfuric acid aerosol produced pathomorphological changes in the lungs and upper respiratory passages and brought about the appearance of sclerosis two to three months after exposure discontinuation. Similar changes were observed in the lungs and upper respiratory tracts in animals exposed to the combined effects of sulfur dioxide and sulfuric acid aerosol in concentrations reduced correspondingly to 1.0 mg/cu m and 0.5 mg/cu m. Changes in lung histamine content were observed and suggest the possible role of this substance in the pathogenesis and clinical symptomatology frequently witnessed during London smogs. Data obtained in the investigation, support the contention of other investigators that SO2 is the leading agent in the London smog formation.

22594

Bushtueva, K. A.

NEW STUDIES ON THE EFFECT OF SULFUR DIOXIDE AND OF SULFURIC ACID AEROSOL ON REFLEX ACTIVITY OF MAN. In: Limits of Allowable Concentrations of Atmospheric Pollutants. Book 5, V. A. Ryazanov (ed.), p. 86-92. Translated from Russian. B. S. Levine, March 1962. 2 refs.

Data on the threshold reflex activity of simultaneously present sulfur dioxide and sulfuric acid aerosol were gathered by a direct continuous recording of the effect of inhalation of the gases on the cerebral cortex. Onset of electrical activity desynchronization, or alpha-rhythm suppression, was taken as the index of positive response. Sulfur dioxide brought about a well-defined desynchronization at 0.9 mg/cu m concentration. When combined with light, sulfur dioxide stimulated the development of conditioned reflexes. In such instances, desynchronization effect were even more pronounced. The maximum sulfur dioxide concentration eliciting conditioned reflexes was 0.6 mg/cu m. In other experiments, test subjects inhaled sulfur dioxide in subthreshold concentrations, with light the conditioned stimulator. After 19 associated applications, the reflex manifested itself even in the absence of sulfur dioxide, indicating that sulfur dioxide continues to stimulate reflex activity despite the extinction of the primary visible

reaction. Incidental application of sulfuric aerosol in subthreshold concentrations elicited no electrical cerebral activity changes in the form of desynchronization. Where 0.63 mg/cu m, or threshold concentrations, were used, desynchronization lasting only 1-2 seconds was observed. However, when a 0.4 mg/cu m subthreshold concentration was used as a conditioned stimulator, with light the conditioned reflex reinforcing agent, a fully conditioned reflex eventually developed. This suggests that subthreshold odor perception concentrations of sulfuric acid aerosol can be used in establishing changes in cortical activity as recorded on an electroencephalogram.

23930

Clayton, J. Wesley, Jr.

BIOLOGICAL EFFECTS OF SULFUR DIOXIDE AND FLY ASH. Edison Elec. Inst. Bull., 38(7):222-225, July-Aug. 1970. (Presented at the Edison Electric Institute, 38th Annual Convention, Boston, Mass., June 2, 1970.)

Experiments were undertaken to determine the biological effects on monkeys and guinea pigs of several concentrations of sulfur dioxide, sulfuric acid mist, and fly ash, as well as mixtures of these materials. In all of the measurements employed to assess lung performance, no adverse effects were discerned when guinea pigs inhaled 0.1, 1.0, or 5.0 ppm of SO2 in filtered air. In fact, as shown by carbon monoxide uptake, the guinea pigs breathing 5.0 ppm SO2 showed a greater ability to effect the diffusion of oxygen and carbon dioxide across lung membranes than all the animals including the controls. When the investigation was terminated after one year, the guinea pigs exposed to 5.0 ppm evidenced a reduction in the prevalence and severity of the lung changes which are the normal accompaniment of age in these animals. A slight increase in the size of the liver cells was observed, as well as an increase in liver cell vacuoles. Sulfur dioxide concentrations of 0.1, 0.5, and 1.0 ppm imposed no detriment on monkeys as indicated by body weight, lung function, blood studies, biochemical measurements, or microscopic examination of tissues. However, an accidental overexposure of 200 to 1000 ppm SO2 for about 60 minutes was responsible for a deterioration of lung function and an apparently lowered oxygen-carrying ability of the blood. Studies on fly ash particulates in which monkeys were exposed to 0.1 or 0.5 mg/cu m indicated no adverse effects of the 18-month exposure.

I. EFFECTS-MATERIALS

20820

COMMUNITY AIR QUALITY GUIDES: SULFUR COMPOUNDS. Am. Ind. Hyg. Assoc. J., 31(2):253-260, March-April 1970. 26 refs.

The major sulfur compounds detected in the atmosphere are sulfur dioxide, sulfur trioxide, sulfuric acid, sulfates, and hydrogen sulfide. The chief effects of SO2 are eye and respiratory tract irritation, and increased pulmonary resistance. At concentrations of 87 mg/cu m for 2.75 hours, SO3 proved fatal to guinea pigs. Hydrogen sulfide is a respiratory and eye irritant at low concentrations, and at high concentrations can cause respiratory paralysis. It is believed that sulfur compounds produce a more severe effect when they are adsorbed on a particle small enough to penetrate the lung. Sulfur oxides and hydrogen sulfide can also damage vegetation. Materials such as metals, paper, leather, textiles, paint, and ceramics are also damaged by sulfur compounds. It is suggested that the sulfur oxide concentration in the air kept as low as possible to prevent damage to vegetation, deterioration of materials, and to avoid the presumed adverse health effects. Methods for sampling sulfur compounds and their physical and chemical properties are also included.

24160

Maeda, Seiichiro, Hiromi Hasegawa, and Hiroya Watanabe

A NEW METHOD OF TREATMENT OF SULFUR DIOXIDE ABSORBING SOLUTION. (Aryusangasu kyushueki no shori hoho). Text in Japanese. (Steel Manufacturing Chemical Industries (Japan)), Japan. Pat. Sho 37-9451 3p., July 27, 1962. (Appl. Sept. 3, 1960, claims not given).

The dilute sulfur dioxide discharged from sulfuric acid plants or ore refineries is removed by absorption in ammonium sulfite solution. The concentrated solution of sulfur dioxide thus formed is added to sulfuric acid and regenerated. In this process of recovering sulfur dioxide, ammonium sulfate is also recovered. Normally, minute amounts of ammonium thiosulfate and ammonium polythionite are contained in the solution, causing corrosion of the container. The present invention is concerned with abating the corrosion. After establishing that corrosion was primarily caused by the two ammonium salts, it was found that the rate of decomposition of the salts was a function of acid concentration, temperature, and time. The decomposition is a one-molecular reaction that decreases corrosion when these three factors are satisfied. Container corrosion was almost completely negligible when an ammonium sulfite-SO2 solution was heated with excess sulfuric acid, so the potassium dichromate consumption was below 0.002 mol/l. In a sulfuric acid manufacturing factory, the sulfur dioxide absorbing solution contained 7-9% ammonia and 25-33% free sulfuric acid. The result of a corrosion test showed 10-15 g/sq m/nr. When the solution was kept at 90 C for 3 hours and at an acid concentration of 10 N, ammonium thiosulfate and ammonium polythionite were reduced below 0.0004 mol/l in terms of potassium dichromate consumption. As a result, corrosion was reduced to 1.2-1.5 g/sq m/nr, which was negligible.

J. EFFECTS-ECONOMIC

11791

A STUDY OF PROCESS COSTS AND ECONOMICS OF PYRITE-COAL UTILIZATION. Little (Arthur D.) Inc., Cambridge, Mass. and Dorr- Oliver, Inc., Stamford, Conn., Contract PH 86-27-258, 251p., March 1968. CFSTI: PB 182303

The economics of utilizing iron pyrite (FeS2) from coal beneficiation were investigated; the prices that might be paid coal operators for low-sulfur coal and an acceptable grade of pyrite feed material for use in sulfuric acid manufacture were determined. The net financial benefits to operators are estimated at $1.16 to $1.57 per ton of coal processed. A premium of $1.10-$1.20 per ton of coal should be paid by nonutility users and by utilities subject to stringent air pollution abatement restrictions. Of this amount, approximately $0.30 represents the net value of the coal to a user; the balance represents the premium connected with achieving lower sulfur content in the stack gas and reduced sulfur dioxide pollution of the atmosphere. It is emphasized that considerable tonnages of pyrite-bearing coal must be processed to support a 1500-ton-per-day sulfuric acid plant. Assuming a feed stream containing 85% pyrite, a requirement of 1550 pounds of feed per ton of 98% acid produced, an original sulfur content of 4%, and a coal yield of 90%, 5.1 million tons/yr of coal will have to be beneficiated to yield 1% sulfur-content coal. Investment and operating costs have been calculated for every combination of the three major variables associated with sulfuric acid production: plant capacity, feed composition, and plant type. The results show manufacturing costs to be $5.51 to $25.40 per ton of acid and plant investment, $3.7 to $35.5 million.

17203

Oels, Heinriche

AIR POLLUTION PROBLEMS IN WEST GERMANY AND THE ROLE OF INDUSTRY. (Luftforurensningsproblemer i Vest-Tyskland industriens innsats). Text in Norwegian. Tek. Ukeblad (Oslo), 116(45):1245-1247, Dec. 1969.

West Germany has been occupied in the last decade with reducing emissions of dust and smoke. Effectiveness of dust filters has increased threefold, and filtration is more economical. The dust content can now be reduced to 150 mg/cu m for an emission rate of 100,000 cu m/hr. In 1950, the dust output from the West German cement industry was 3.5% of the clinker produced; in 1967, it was 0.15%. Dust output from the manufacture of calcium carbide was reduced to 3 mg/cu m of exhaust gases. Attention now centers on reducing sulfur dioxide emissions. An electric power plant in Essen absorbs it with a new type of activated carbon, recovering the SO2 for the manufacture of H2SO4, the cost per 1000 kWh being about 1 DM (25 cents), and this can be further reduced. Government standards now limit the sulfur content of fuel oils to 1.8%. About 20% of the total SO2 emission in West Germany comes from sulfuric acid plants. A new 'double contact' process can reduce SO2 emissions of such a plant from 17 to 3 kg per ton of H2SO4 produced. Nitrogen oxides emitted from nitric acid plants have been reduced by 50% with special absorption equipment. New legislation sets a maximum average of 2 mg/cu m for fluorine emissions, or 5 mg for short intervals. Readings as high as 2.7 mg have been recorded above the Ruhr from January 1, 1966, to December 31, 1968. During that period, industry in North Rhine-Westphalia invested 4,000,000,000 DM on air pollution problems related to existent operations and about 275,000,000 DM on those related to new ones. Exhaust purification for the 2-year period cost 3,000,000,000 DM, plus an additional 30,000,000 for research this in comparison with a gross national product of 300,000,000,000 DM per year. The total amount spent by industry is small compared with the damage caused, which amounts to 50 DM per capita per year, or 3,000,000,000 for the entire republic, not including losses due to sickness or sanitation problems.

21206

Schwartz, Irvin

ENVIRONMENTAL CONTROL. Chem. Week, 106(24):79-86, June 17, 1970.

Methods and costs of air pollution control are reviewed with emphasis on the efforts of the chemical processing industry. The magnitude of the task is shown by Public Health Service estimates of the amount of pollutants poured into the atmosphere each year: particulates, 15 million tons; sulfur oxides, 30 million tons; hydrocarbons, 24 million tons; carbon monoxide, 87 million tons; nitrous oxides, 17 million tons. Within the chemical processing industry, the percentage of capital outlay for air pollution control equipment is expected to remain constant, but the kind of equipment is expected to change. Expenditures for particulate controls account for more than one-third of industry expenditures. Gaseous emission controls, currently less than 2% of sales, is expected to jump to 40% following development of Federal gaseous emission criteria. The Health, Education, and Welfare Dept. guidelines for air quality criteria issued to date are listed. The cost of compliance with the HEW 'suggestions' are estimated. For the sulfuric acid industry, this estimate is $26-39 million capital expenditure and $1.5-2.8 million/year operating cost. For the phosphate fertilizer industry, the estimates are $3.1-6.7 million and $1.3-2.7 million. The four basic means of collecting particulates, fabric filter, electrostatic precipitator, cyclones, and scrubber are described, along with their capabilities and cost. The three basic systems for gaseous emission control, scrubbing, adsorption, and incineration are similarly treated. By-product recovery is evaluated as a means of reducing the effective cost of air pollution control. In contradiction to the National Research Council-National Academy of Engineering's statement 'commercially proven technology for control of sulfur oxides from combustion processes does not exist', half-a-dozen sulfur oxide-sulfuric acid conversion processes are listed.

21308

Ferguson, F. A., K. T. Semrau, and D. R. Monti

SO2 FROM SMELTERS: BY-PRODUCT MARKETS A POWERFUL LURE. Environ. Sci. Technol., 4(7):562-568, July 1970.

The non-ferrous smelting industries currently recover less than one quarter of the sulfur in the ores treated by the 26 smelters west of the Mississippi. The rest, almost 1.6 million long tons of sulfur a year, is being emitted as sulfur oxides. Pollution control could be advanced significantly if smelters could make and market any of the following by-products: elemental sulfur, sulfuric acid, liquid sulfur dioxide, and ammonium sulfate (or bisulfite). The results of an analysis of the potential market are reported. The total market for liquid sulfur dioxide in the western United States is so small that no market or producction data was developed. The 1970 cost of producin elemental sulfur at the smelter (45-100 dollars per ton) provides little opportunity to complete with Frasch mine produced products at 10-30 dollars. Sulfuric acid with its smelter-produced cost of 4-25 dollars per ton can complete as long as transportation costs are held to a minimum. This requires that the market be within a few hundred miles of the smelter. Even with this stipulation, the total market including potential growth through 1975 could absorb only 40% of the potentially producible sulfuric acid. Emission reductions of 60-65% could be obtained. Together with the current and potential market for ammonium sulfate, an emission reduction of 65-70% is possible.

22397

SULFUR THAT GETS AWAY. Chem. Week, 98(21):26-28, May 21, 1966.

Several processes under development for recovering sulfur now emitted in stack gases are noted; this potential resource is related to a present shortage of sulfur for industrial use in the U. S. and other areas. A major cause of the shortage is the increasing demand due to new foreign and domestic capacity for sulfuric acid and fertilizer. Sulfuric acid producers are hardest hit by the shortage. U. S. governments efforts to discourage rising sulfur prices are outlined. Drilling of offshore sulfur deposits is receiving increasing attention, and a worldwide search for more sulfur from a variety of sources is underway.

K. STANDARDS AND CRITERIA

06349

AMBIENT AIR QUALITY OBJECTIVES - PART 500 (STATUTORY AUTHORITY: PUBLIC HEALTH LAW. 1271, 1276). New York State Air Pollution Control Board, Albany, Dec. 11, 1964, 11 pp.

Ambient air quality objectives are tabulated for various pollutants. The objectives vary according to subregions which are determined by land use. Included is a list of references for the sampling and analytical methods employed in the measurement of particulates, sulfur dioxide, hydrogen disulfide, fluorides, beryllium, oxidants, carbon monoxide, and sulfuric acid mist.

19750

Pennsylvania State Dept. of Health, Harrisburg, Air Pollution Commission

PENNSYLVANIA AMBIENT AIR QUALITY STANDARDS. 6p., Oct. 20, 1969. 10 refs.

Annual, 30-day, 24-hr and/or 1-hr air quality standards are given for 12 pollutants (suspended and settled particulates, lead beryllium, sulfates as H2SO4, sulfuric acid mist, fluorides as HF, sulfur dioxide, nitrogen dioxide, oxidants, hydrogen sulfide, and carbon monoxide) in accordance with the requirements of the Pennsylvania Air Pollution Control Act of 1960. These standards, which will be reviewed at least once a year, are for single-point measurements; they represent minimum, and not necessarily desirable quality. The 24-hr standard for SO2 is 0.10 ppm; for suspended particulates, 195 micrograms/cu m. An antidegradation policy is stated to the effect that where present air quality is significantly higher than the established standards, the difference will be conserved, based on a long range forecast of probable land and air uses in areas of high air quality. Sampling and analytical procedures to be employed for measuring ambient levels are specified for each of the 12 pollutants.

L. LEGAL AND ADMINISTRATIVE

05407

T. Toyama

AIR POLLUTION AND HEALTH IMPEDIMENT. Japan J. Ind. Health (Tokyo) 8, (3) 45-8, Mar. 1966. Jap. (Presented at the 39th Annual Meeting, Japan Society of Industrial Medicine, Ube, Japan, Apr. 7-9, 1966.)

The 39th Annual Meeting of the Japan Society of Industrial Medicine was held on April 7-9, 1966 in Ube, Yamaguchi-ken, Japan. The theme of one of the symposia was planning programs for air pollution control in which air pollution and health impairment and the engineering and practice of air pollution control were discussed. The main health impairments covered deal with effects of pollution on the respiratory system and acute diseases resulting therefrom. Prior to World War II there were no legal problems in pollution control but by 1963, it was necessary to establish laws covering soot and dust control. City planning and building restriction ordinances have come into effect. Dust and soot fall have decreased by one-sixth in the past sixteen years. Millions of dollars have been paid by factories and industries for the establishment of dust collectors and SO2 counter-measures. Waste gas disposal in nitric and sulfuric acid plants has been brought under control since 1964. Re-use of the waste gases has played an important role in the economic feasibility of air cleaning.

10998

Putnam, B. and M. Manderson

IRON PURITES FROM HIGH SULFUR COALS. Chem. Eng. Progr. 64(9):60-65, Sept. 1968.

The major sources of SO2 emission are coal fired power generation facilities, followed by other industrial facilities and space heating. It also appears that power plants will become increasingly important potential contributors of SO2 emissions. Therefore, reduction of emissions from coal fired power generation facilities is of principal concern. The National Center for Air Pollution Control authorized two commercial firms to investigate the economics of utilizing iron pyrite (FeS2) obtained from coal beneficiation, such as in sulfuric acid manufacture. The evaluation includes technical, marketing, and economic considerations and emphasizes the three major coal producing regions in the U. S. believed to have significant quantities of pyrite associated with the coal: central Pennsylvania, southern Illinois, and northeast Ohio.

11242

M. C. Manderson

SULFUR OUTLOOK INTO THE EARLY 1970'S. Preprint, Arthur D. Little, Inc., Cambridge, Mass., ((28))p., 1968. (Presented at the 61st Annual Meeting, American Institute of Chemical Engineers, Symposium on Sulfur, Sulfuric Acid and the Future, Part I, Los Angeles, Calif., Dec. 1-5, 1968, Paper 5-A.)

In 1967, the United States consumed 9.3 million long tons of sulfur equivalent. Ninety percent of the total amount of sulfur consumed was in the form sulfuric acid. The major end uses of sulfuric acid were used in producing nitrogenous and phosphatic fertilizers. The Free World increase in sulfur consumption has been higher than that of the United States since 1950, 51% per year compared with 3.6% per year. Over the next seven years Free World consumption is expected to grow at 5% per year, from the 1967 level to 36 million long tons to 39 million long tons. About 5.5 million long tons of new sulfur capacity will emerge outside the United Sates over the next 2 1/2 years. Sulfur production in U. S. will grow from the 1967 level of 9.3 million long tons to 14.1 million long tons by 1970 and to 15.8 million long tons by 1975. The amounts of sulfur from lower cost sources will be adequate to meet U.S. needs by 1970, including net exports of one million tons per year. It is believed that sulfur prices will seek lower levels which are more in line with mimimum return requirements.

24033

Damon, W. A.

THE CONTROL OF NOXIOUS GASES AND FUMES DISCHARGED FROM INDUSTRIAL UNDERTAKINGS. World Health Organization, Copenhagen (Denmark), Regional Office for Europe, Proc. Conf. Public Health Aspects Air Pollution Europe, Milan, Italy, 1957, p. 103-130. 26 refs. (Nov. 6-14.)

The greatest contribution to air pollution arises from the combustion of fuel for domestic and industrial purposes and from motor traffic. Its damaging effects include injury to plants, deterioration of property, and possible or proven hazards to the health of humans and animals. British air pollution legislation is embodied mainly in three Acts of Parliament: the Alkali etc. Works Regulation Acts, first enacted in 1863; the Public Health Acts, 1936; and the Clean Air Act, 1956. Evolution of the chemical industry has caused a variety of changed and new pollutants. Fluorine compounds can be washed in alkaline solutions, followed by electrical precipitation. The escape of SO2 from the exits of sulfuric acid plants depend on the efficiency with which the the process is conducted. In four stage contact plants burning brimstone, recourse to scrubbing the exit gas with either soda or ammonia may be necessary. Power stations remove SO2 from waste fuel gases by scrubbing with slightly alkaline water. Sulfur dioxide arising from the roasting of copper as in the production of iron oxides is normally absorbed by passage through towers packed with limestone. Hydrogen chloride may be recovered at a useful strength by arranging a counter current series of absorbers. Hydrogen sulfide may be scrubbed with caustic soda to produce sodium sulfide; it may be absorbed by passage through hydrated iron oxide which can be regenerated to produce spent oxide containing up to 50% sulfur; or it can be stripped out by means of a solvent and regenerated in concentrated form for treatment in a Claus Kiln. Gases containing chlorine may be scrubbed with an alkaline solution or by contact with milk of lime; passage through a tower packed with scrap iron is also effective. Nitrogen peroxide may be recovered in the form of nitric acid by water washing; but for every three molecules of nitrogen peroxide thus absorbed there is evolution of one molecule of nitric oxide which must be reoxidized to nitrogen peroxide.

25520

Wright, G. A.

ENVIRONMENTAL POLLUTION. J. New Zealand Inst. Chem., 34(5): 171-179, Oct. 1970.

A condensed account of four speeches which were presented at a symposium on Environmental Pollution in Auckland, May 12, 1970 are given, together with a brief summary of the discussion. The concern today with total quality of our surroundings is not merely with pollution of water by sewage, toxicants, nutrients and other unwanted materials, nor with air pollution by industrial and other gaseous or smoky garbage escaping into the atmosphere; the world is becoming concerned also about noise and heat pollution and the general man-made changes in our surroundings which frequently bring deterioration in living. Air pollution legislation in New Zealand requires scheduled chemical processes to employ the 'best practicable means' to control the discharge of pollution to the atmosphere, but there have been criticisms of the effectiveness of such legislation when compared with, for example, legislation that specifies emission standards. In New Zealand, animal dropping from nearly sixty-million sheep, from eight-and-a-half million cattle, and from over half a million pigs will be spread on the ground for a long time to come and much of this will be washed by rain into the waters. There must be a tripartite compromise between the natural desire of the public to enjoy an unpolluted atmosphere; the legitimate aspirations of industry to avoid unremunerative expense; and national health and global rights, requirements and interests. To take one particular example to illustrate improvements in technology, mention is made of a contact sulfuric acid plant with the Chatelier principle having been applied to it.

N. GENERAL

04845

H. C. Wohlers

SULFUR OXIDES AS AIR POLLUTANTS. Preprint. 1965.

Air pollution by sulfur oxides, SO2 in particular, is reviewed in its various aspects. Health effects of SO2 include respiratory ailments which can occur to a greater or lesser degree, depending upon concentration of the gas in the air and the susceptibilities of those effected. Air concentrations of less than 0.3 ppm are considered harmless to vegetation; the effects of higher concentrations result from the interaction of such factors as time and environment with concentration. The corrosive effects of SO2 and H2SO4 aerosols in urban areas are particularly noticeable in materials deterioration. H2SO4 aerosols play a part in visibility reduction in urban air. Based upon an estimate of 390,000,000 tons of sulfur per year deposited as sulfate in rain, 30% of the sulfur emissions are considered to be man-made. Precipitation is the most efficient process by which sulfur is removed from the air. Guidelines for better control of this problem are suggested.

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