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Project Summary

Fourth Symposium on the Transfer and Utilization of Particulate Control Technology: Volume III. Economics, Mechanical Collectors, Coal Characteristics, Inhalable Particulates, Advanced Energy and Novel Devices

F. P. Venditti, J. A. Armstrong, and M. D. Durham

Summarized herein is Volume III of three volumes of proceedings of the Fourth Symposium on the Transfer and Utilization of Particulate Control Technology held in Houston, Texas, October 11-15, 1982. Volume III papers discuss theoretical and applied aspects of particulate control technologies other than fabric filtration and ESPs.

Volumes I and II are described in two separate project summaries.

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

The papers in these three volumes of proceedings were presented at the Fourth Symposium on the Transfer and Utilization of Particulate Control Technology in Houston, Texas, October 11-15, 1982, sponsored by the Particulate Technology Branch of the Air and Energy Engineering Research Laboratory of EPA at Research Triangle Park, NC.

The symposium brought together researchers, manufacturers, users, government agencies, educators, and students to discuss new technology and provided an effective means for the transfer of this technology out of the laboratories and into the hands of the users.

The two major particle control technologies—fabric filters and electrostatic precipitators (ESPs)—were the primary concern of the symposium. These technologies were discussed from perspectives of economics, new technical advancements in science and engineering, fundaments, and applications. Several papers dealt with the interaction of sulfur dioxide control and particulate control. Additional topic areas included mechanical collectors, coal characterization, inhalable particulate matter, novel devices, and advanced energy applications for particulate control.

The symposium was conducted as a series of parallel sessions, each containing four to six related papers. The sessions were scheduled to avoid conflict due to

simultaneous sessions dealing with the same topic. Each series of related sessions represented a thread of technology. These parallel threads, extending over the total period of the symposium, provided a highly integrated approach to the total subject of particulate control technology, with strands of specialized technologies. These strands of specialized technologies, or perspectives, provided the basis for the division of the papers into three volumes, each volume containing a set of related session topics so as to provide easy access to a unified technology area.

Volume III Papers

Volume III, summarized here, is a collection of papers describing a variety of aspects of particulate control including economics, mechanical collectors, coal characteristics, inhalable particulate matter, advanced energy applications, and novel devices. Economic comparisons of the costs of particulate control devices are made in a series of papers. A section on mechanical collectors describes theoretical and applied aspects of cyclones and mist eliminators. The effect of coal characteristics on the design and operation of particulate control devices is also discussed. Several papers deal with a wide variety of topics relating to inhalable particulate matter including emission factors, measurement techniques, source emissions and fugitive emissions. The application of particulate control devices to nonconventional temperature and pressure conditions is described in a section on advanced energy applications. Most of these papers deal with hot gas cleanup in pressurized fluidized bed combustor gas streams. Novel particulate control technologies are described in the final section.

Keynote Address

Particulate Control Technology and Where It is Going

K. E. Yeager
Electric Power Research Institute

This keynote address underscores the key role of particulate control technology in any practical strategy for reducing the emissions associated with coal utilization. Its importance results from the long-standing and successful cooperative efforts among user, supplier, and government to achieve control methods which are as reliable, simple and low cost as possible. Opportunities are discussed for capitalizing on this established and accepted base to solve the current and emerging set of air pollution issues facing the utility industry.

Second A - Economic Comparisons

A Comparison of a Baghouse vs. ESP's With and Without Conditioning for Low Sulfur Coal Applications

William H. Cole
Gibbs & Hill, Inc.

The new source emission standard of 0.03 lbs/10^6 Btu for electric utilities suggests that the selection of particulate removal equipment will increasingly favor the baghouse as compared to conventional ESP's for low sulfur coal applications. This paper investigates a third alternative of a relatively small ESP used in conjunction with SO_3 gas conditioning for new generating units, which typically require efficiency levels of 99.70 percent or higher. The three alternatives are compared for a 500 MW unit burning low sulfur western coal. Emphasis is placed on the comparable economics of investment, and present worth of annual costs including fixed charges, incremental energy, bag replacement, sulfur feed stock, and maintenance. Cost sensitivity is illustrated for assumed escalation rates from zero to 10 percent. A preliminary review indicates that ESP's in conjunction with gas conditioning offer an attractive alternative to a conventionally sized ESP or baghouse, and may restore the dominance of ESP's in equipment selection.

Application of the Bubble Concept to Fuel Burning Sources at a Naval Industrial Complex

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Atlantic Division
Naval Facilities Engineering Command
Utilities, Energy and Environmental Division

The Norfolk Naval Shipyard, Portsmouth, Virginia, consists of a large Industrial Ship Repair Complex. There are over 50 gas- and oil-fired industrial size boilers located in the Shipyard. These boilers serve such diversified functions as generating power, space heating, hot water, and process steam and ship system testing. Eight of these boilers exceed Virginia's particulate emission limits by as much as 90 percent. Engineering studies outlined methods to achieve compliance with Air Pollution Control Equipment at a total cost of $9 million. A change in the Virginia regulations for particulate emissions from Fuel Burning Equipment in 1979 allowed a Bubble policy to be applied. This change allowed a combination of Bubble concept and control equipment techniques to be used. The cost savings in applying this technique was approximately $6 million. Discussed are the problems and procedures in formulating an acceptable Bubble concept policy and control program to allow compliance for the boiler plants.

Section B - Mechanical Collectors

Cyclone Performance: A Comparison of Theory with Experiments

John A. Dirgo
David Leith
Harvard School of Public Health
Department of Environmental Health Sciences

This paper describes the results of tests conducted on a Stairmand high-efficiency cyclone. The cyclone was pilot plant scale with a design air flow of 0.14 m^3/s (300 cfm). Collection efficiency and pressure drop were measured over a range of air flows at ambient temperature and pressure. An oil mist was used as a test aerosol because it consists of spherical drops of uniform density, which are unlikely to bounce or re-entrain after striking the cyclone wall. At each air flow, a fractional efficiency curve (collection efficiency vs. particle diameter) was determined. Each experimental curve was compared with fractional efficiency curves generated by several cyclone efficiency models. A comparison of this type is more valid than one based on cyclone cut diameter (the particle size collected with 50 percent efficiency). This work represents the initial phase of a study of optimized cyclone design.

High Flow Cyclone Development

W. B. Giles
Mechanical Systems and Technology Laboratory, Corporate Research and Development, General Electric Company

Investigative studies of an atypical cyclone configuration, designed for high flow capacity, were performed, focusing particularly on the design aspects of inlet flow and dust disengagement. The results indicate that a performance equal to or superior to conventional design can be

achieved with a net savings in cyclone size and cost.

The design is characterized as a reverse flow cyclone with both a large inlet and a large outlet, plus increased engagement length between the cyclone body and the exhaust duct. Both of these features are seen as means to suppress large scale inlet turbulence. In addition, reduced penetration is found by locating a vortex shield in the base of the cyclone. The net result indicates an approximate two-to-one diameter reduction, relative to current art, for equal flow capability and a slight pressure loss penalty.

Cyclone Scaling Experiments

W. B. Giles
Mechanical Systems and Technology Laboratory, Corporate Research and Development, General Electric Company

A series of geometrically similar cyclones of conventional, high-efficiency design was tested to assess the normally accepted perception that cyclones act as an inertial collection device and therefore can be scaled from model to prototype size by an inertial separative parameter. These tests were conducted for three different cyclone sizes of 4, 12, and 36 in. diameter over a range of inlet velocity and at atmospheric pressure.

In using test dusts which had been shown to have a *low* propensity for triboelectric charging, good correlation was observed.

Tests were also conducted using a test dust which has been found to have a *high* propensity for triboelectric charging. The data does *not* correlate, has very high efficiency, and is characterized by relatively constant overall efficiency versus cyclone flow. The latter behavior is noted in several literature sources.

The critical user is, therefore, cautioned in the acceptance of data unless, as a minimum, the fractional efficiency can be shown to correlate with the inertial separative parameter over a range in velocity.

Test Methods and Evaluation of Mist Eliminator Carryover

Vladimir Boscak
Atef Demian
General Electric Environmental Services, Inc.

A test program was carried out at GEESI's R&D pilot plant to determine mist eliminator efficiency, carryover load and droplet size distribution from a vertical flow mist eliminator. The modified EPA Method 5 was used to determine efficiency and carryover load. The carryover load when the scrubber was operated under standard operating conditions but without mist eliminator washing was 28 to 60 mg/Nm^{3}D (0.012 to 0.024 gr/SCFD). When the bottom of the mist eliminator was washed, the carryover load above the washed section was 70 to 160 mg/Nm^{3}D (0.029 to 0.066 gr/SCFD). Mist eliminator efficiency was greater than 99%. A droplet photography technique was used to determine carryover aerosol size distribution. The average aerosol size measured above the mist eliminator was about 100 to 200 microns. Mist eliminator inlet size distribution averages about 140 microns. The carryover is probably caused by re-entrainment from the mist eliminator blades.

Section C - Coal Characterization

Filtration Characteristics of Fly Ashes from Various Coal Producing Regions

John A. Dirgo
Marc A. Grant
Richard Dennis
GCA/Technology Division

Louis S. Hovis
Air and Energy Engineering Research Laboratory
Environmental Protection Agency

The filterability of fly ashes emitted by coal burning power stations is described, including that of several ashes generated by low sulfur western coal combustion that are best controlled by fabric filtration. Chemical and mineralogical analyses of the coals were examined to determine possible relationships between coal and ash properties and filtration behavior. Both fly ash size and coal ash content correlated strongly with the fly ash specific resistance coefficient K_2. Weaker, but discernible, correlations were shown for electrical charge behavior and method of coal firing. Coal sulfur content and ash fusion properties and chemical structures originally expected to influence particle size showed no clear-cut effects on filtration characteristics.

This paper has been reviewed in accordance with the U.S. Environmental Protection Agency's peer and administrative review policies and approved for presentation and publication.

Fly Ash from Texas Lignite and Western Subbituminous Coal: A Comparative Characterization

D. Richard Sears
Steven A. Benson
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Stanley J. Miller
U.S. Department of Energy
Grand Forks Energy Technology Center

As examples, we use two Jackson group lignites from Atascosa and Fayette Counties, Texas, and a Green River Region subbituminous coal from Routt County, Colorado.

The composition of individual fly ash particles was determined using scanning electron microscopy and electron microprobe, with support from x-ray diffraction of bulk ash. Using particle sample populations large enough to permit statistical treatment, we describe the relationship of composition to particle size and the correlation between elemental concentrations, as well as particle size and composition distributions. Correlations are displayed as data maps which show the complete range of observed variation among these parameters, emphasizing the importance of coal variability.

We next use this data to produce a population distribution of ash particle resistivities calculated with Bickelaupt's model. The relationship between calculated resistivity and particle size is also displayed, and the results are compared with measured values.

Use of Fuel Databanks for the Effective Design of Steam Generators and AQC Equipment

*N. W. Frisch**
T. P. Dorchak
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Information concerning coal properties and their variability is critical to the proper design of steam generators and associated gas cleaning equipment (precipitators, FGD and, to a lesser degree, fabric filters). For situations in which a fuel source is well defined, a databank of hundreds of coal and ash analyses may be used to assess the variability of the fuel and to develop critical sizing and design parameters.

This paper discusses a comprehensive computer approach which examines fuel databank information and generates design parameters for a set of operating conditions. Fuel parameters related to

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boiler design and operation, including fusion temperatures, T_{250}, fouling and slagging indices, etc., may be entered or generated for statistical analysis and presentation. Uncontrolled and corrected emission levels of particulate and SO_2, as well as acid dew point temperatures are developed.

In the case of ESP's, the program can indicate collection area requirements for any type of emission rate (mass, concentration or opacity basis). Gas conditioning and pulse energization options are included. Both statistical and a wide range of graphical outputs provide the user with desired guidance; a typical plot would be a mine map with fuel or ESP parameters overlaid.

Section D - Inhalable Particulate Matter

Development of Inhalable Particulate (IP) Emission Factors

Dale L. Harmon
Air and Energy Engineering Research Laboratory
Environmental Protection Agency

At the request of EPA's Office of Air Quality Planning and Standards (OAQPS), ORD is conducting a study characterizing inhalable particle (IP) emissions from various sources for the development of emission factors.

Three contracts were awarded in September 1979 to conduct source characterizations for IP from major sources. The testing phase for these contracts is near completion, and individual reports on the major sources which will include the IP emission factors are being prepared. The IP emission factors are based on existing particle size data and the IP source characterization tests. This paper gives an overview of the EPA program to develop IP emission factors.

This paper has been reviewed in accordance with the U.S. Environmental Protection Agency's peer and administrative review policies and approved for presentation and publication.

Inhalable Particulate Matter Research Completed by GCA/Technology Division

Stephen Gronberg
Senior Environmental Scientist
GCA/Technology Division

GCA/Technology Division has completed literature surveys and stack tests in order to develop reliable size-specific particulate emission factors. The majority of work concerned the iron and steel, ferroalloy and iron foundry industries. Particulate emission rates and particle size distribution were measured at eight facilities. Typically, tests were conducted before and after a control device and only in-stack techniques were used. The results of these tests and information from other test programs have been reviewed, ranked, and included in a Source Category Report for each industry. The Source Category Reports provide an updated section of AP-42 "A Compilation of Emission Factors" and present background information on industry trends, engineering specifics and control devices.

This paper has been reviewed in accordance with the U.S. Environmental Protection Agency's peer and administrative review policies and approved for presentation and publication.

Results of Testing for Inhalable Particulate Matter at Midwest Research Institute

H. Kendall Wilcox
Fred J. Bergman
John Scott Kinsey
Tom Cuscino
Midwest Research Institute

Source test data collected by Midwest Research Institute for emissions of inhalable particulate matter have been presented in this paper for a variety of industrial categories. Test results for two cement plants (one wet process and one dry process), one lime plant, and one asphalt paving plant are available. Results have been presented in terms of the AP-42 format for the relative size fractions of both controlled and uncontrolled emissions from these processes. Such test results should be of interest to control device manufacturers as well as those who may need to be involved in the development of State Implementation Plans for inhalable particulate matter.

This paper has been reviewed in accordance with the U.S. Environmental Protection Agency's peer and administrative review policies and approved for presentation and publication.

Inhalable Particulate Emission Factors Test Programs

Jim Davison
Acurex Corporation

The Energy & Environmental Division of Acurex Corporation was contracted by the Air and Energy Engineering Research Laboratory (AEERL) of the U.S. Environmental Protection Agency (EPA) to obtain uncontrolled/controlled emissions data from various stationary sources of air pollution. The emission factors derived from this data will assist in the determination of the need to set a national ambient air quality standard for inhalable particulate matter.

An extensive series of particulate mass and particle size distribution tests were conducted at several major sources, including Kaiser Steel (hot metal desulfurization and BOF), and Kennecott Minerals (matte and slab tapping).

This paper presents a review of each process, test equipment and procedures, and test results expressed as emission factors relative to process operations, and as a percent of the particulate emissions less than a selected micron size.

This paper has been reviewed in accordance with the U.S. Environmental Protection Agency's peer and administrative review policies and approved for presentation and publication.

Characterization of Particulate Emission Factors for Industrial Paved and Unpaved Roads

Chatten Cowherd, Jr.
J. Patrick Reider
Phillip J. Englehart
Midwest Research Institute

This paper presents the results of an expanded measurement program to characterize uncontrolled particulate emissions generated by traffic entrainment of surface particulate matter from industrial paved and unpaved roads. The emission sampling procedure used in this program provided emission factors for the following particle size ranges: $\leq 15\ \mu m$, $<10\ \mu m$, and $<2.5\ \mu m$ aerodynamic diameter. Testing was performed at sites that were representative of significant paved and unpaved road emission sources within the following industrial categories: crushed stone and gravel processing; primary nonferrous smelting; and asphalt and concrete batching. Measured emissions in each particle size range were correlated with road and traffic parameters as a preliminary step to the development of predictive emission factor equations for industrial paved and unpaved roads. Previously collected field test data for integrated iron and steel plants and surface coal mines were also integrated into the industrial road emission factor data bases.

This paper has been reviewed in accordance with the U.S. Environmental Protection Agency's peer and administra-

tive review policies and approved for presentation and publication.

Condensible Emissions Measurements in the Inhalable Particulate Program

Ashley D. Williamson
Joseph D. McCain
Southern Research Institute

In order to meet the EPA's inhalable particulate program goal of obtaining measurements of condensible matter in process streams, a Stack Dilution Sampling System was designed at Southern Research Institute under EPA contract. The principal component of the system is a cylindrical dilution chamber in which flue gas is mixed with filtered air and the resulting aerosol-laden mixture analyzed. As the sample is cooled by dilution, condensible vapors form particles under conditions similar to those which occur in actual plumes. Field measurements have been performed at a continuous drum mix asphalt plant, two kraft recovery boilers, a coke quenching tower, and an oil-fired package boiler. Data from these tests show that significant fractions of the total emissions at some sources consist of condensible vapors.

This paper has been reviewed in accordance with the U.S. Environmental Protection Agency's peer and administrative review policies and approved for presentation and publication.

Section E - Advanced Energy Applications

Gas Cleaning and Energy Recovery for Pressurized Fluidized Bed Combustion

Albert Brinkmann
Gottfried Bischoff GmbH & Co.

Peter Kutemeyer
Bischoff Environmental Systems

In an effort to reduce the consumption of oil and natural gas the search for a new technology, capable of utilizing low grade fuels, as well as more fully extracting available energy from high grade coal, led to development of fluidized bed combustion (FBC).

The advantages of FBC are:

A. Lower and more uniform combustion temperatures, resulting in lower generation of NO_x.

B. Acceptably low SO_2 emissions by addition of limestone, thus eliminating expensive desulfurization equipment.

C. Smaller heat exchangers, and thus smaller boilers, due to higher heat transfer coefficients.

D. Use of low grade fuels.

The first operational FBC systems used in Germany operated at atmospheric pressure. These classic FBC plants required a relatively low capital investment and presented no development problems during installation or operation.

Demonstration of the Feasibility of a Magnetically Stabilized Bed for the Removal of Particulate and Alkali

L. P. Golan
J. L. Goodwin
E. S. Matulevicius
Exxon Research and Engineering Company

This Department of Energy sponsored program is experimental in nature concentrating on evaluating the key factors necessary for demonstrating the feasibility of this concept, viz., the ability of the magnetic material to survive the PFBC environment, and particulate removal efficiency operating at PFBC conditions. The magnetic bed material evaluation phase has been completed. The results of the materials evaluation phase indicate that coated cobalt particles are suitable for this application. The particles have been found to possess good oxidation and attrition resistance while maintaining magnetic properties at the elevated temperatures. After 1000 hours of exposure to FBC flue gas no mechanical failure of the coating has been detected while sample magnetization was reduced only 10-20%.

The test phase of the program has been completed. The first phase of testing determined filter media flow rates at various field strengths. This was followed by a series of tests to determine the gas side pressure gradients at combinations of filter media flow and field strength. The final sequence of tests operated the filter in the semi-continuous mode. While these runs are still being analyzed, initial data appears promising.

Test Results of a High Temperature, High Pressure Electrostatic Precipitator

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G. Rinard
J. Armstrong
T. Yamamoto
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University of Denver

The electrostatic precipitator (ESP) is being considered as a final gas cleanup device for pressurized fluidized bed combustion (PFBC) combined cycle power plants. In order to investigate the practical feasibility of ESP's applied to high temperature, high pressure (HTHP) gas streams, a pilot scale unit has been developed. This unit has been operated over a spectrum of gas temperatures, pressures, and dust loadings, which can be encountered in PFBC systems.

The electrical characteristics of a wire electrode and two electrodes designed by Research-Cottrell are reported. Flyash from the Curtiss-Wright PFBC was redispersed in the unit for these tests. The test results are being used to quantify the performance of HTHP ESP's and should also provide needed information for other PFBC gas cleanup devices which employ electrostatic augmentation.

Coal-Ash Deposition in a High Temperature Cyclone

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A. Rehmat
D. M. Mason
Institute of Gas Technology

Experimental evidence indicated that the increase of particulate removal efficiency in a high temperature agglomerating cyclone is hampered by the formation of cyclone wall deposits. The cyclone collection efficiency has been observed in a laboratory hot cyclone to meet the designated performance when the temperature of the dust laden gas is increased to near its coal-ash fusion temperature. Factors that are affecting the wall deposition process are examined and estimation of the relative importance of the operating parameters are presented. A simple mathematical model for the wall deposition mechanism is tentatively proposed. Experimental results on the occurrence or absence of wall deposits will be discussed.

Dust Filtration Using Ceramic Fiber Filter Media— A State-of-the-Art Summary

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W. Kuby
M. Shackleton
Energy & Environmental Division
Acurex Corporation

O. J. Tassicker
S. Drenker
Electric Power Research Institute

Filter media suitable for use at temperatures of >1,000°F, employing ceramic fibers in their construction, have been under development for several years. These filter media are intended for application in the development of energy production processes such as pressurized fluidized bed combustion (PFBC), but will also be suitable for many diverse industrial processes. Ceramic media development work to date has shown significant progress toward achievement of a commercially viable high temperature filter. Tests have shown that at high temperature, fine particles can be collected efficiently and pressure drop can be controlled using pulse cleaning. Accelerated durability tests produce promise for long filter life. More work is needed in durability testing to detect application related problems and build the data base needed to move this important product development to commercialization.

High Temperature and Pressure Particulate Filters for Fluid-Bed Combustion

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T. E. Lippert
Westinghouse Research and Development Center

O. J. Tassicker
S. Drenker
Electric Power Research Institute

The only technological barrier to the commercialization of Pressurized Fluid-Bed Combustion (PFBC) is the efficient removal of particulates at high temperature and pressure. The Electric Power Research Institute has sponsored work at the Westinghouse Research and Development Center to investigate several filtration devices for this application. This effort has included high pressure and temperature pilot-scale testing of multi-element ceramic bag filters of both the woven and felted type. The current program also includes screening testing of high alloy sintered metal and tubular porous ceramic filter candles at temperatures in the range of 800-900°C and at pressures of 11 atm. Subsequent to these tests long duration life testing of a single woven ceramic bag will be carried out to optimize bag life with respect to cleaning regimen.

Moving-Bed Ceramic Filter for High-Efficiency Particulate and Alkali Vapor Removal at High Temperature and Pressure

D. Stelman
A. L. Kohl
C. A. Trilling
Energy Systems Group
Rockwell International Corporation

A moving-bed ceramic filter for high-temperature cleanup is described. The concept employs a high-efficiency ceramic filter that is cleaned continuously by the slow downward motion of a thin layer of granular material. Laboratory tests have been conducted with a variety of dusts carried in gas at temperatures up to 1500°F and at atmospheric pressure. The observed particle removal efficiency from a 1500°F gas containing 1 grain/scf of 1.6 micron median diameter particles was found to exceed 99.96%. The pressure drop across the filter was only 3.5 in. of water at a gas velocity of 13 ft/min. It remained essentially constant as a result of the continuous removal of the filter cake from the face of the ceramic filter by the slowly moving granular bed. In addition to particle removal, the filter offers the potential for alkali vapor removal through the use of reactive getters in the moving bed material.

Testing and Verification of Granular Bed Filters for Removal of Particulates and Alkalis

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D. F. Ciliberti
R. O. O'Rourke
Westinghouse Electric Corporation

The work described has been funded by the Department of Energy (DOE) under Contract DE-AC21-80ET17093.

The Granular Shallow Bed Filter (GBF) is proposed as a device to clean particulates from Pressurized Fluidized Bed Combustion (PFBC) gas streams. The GBF is a device in which the dust-laden gas passes through a shallow granular bed, depositing the particulate matter on the surface of the granular media. The bed medium is cleaned by a reverse flush that gently fluidizes the bed and elutriates the collected particulate matter from the system. Described herein are analyses and data that reflect on the GBF concept as it would apply to a PFBC and preliminary results of testing done on a six-element subpilot-scale GBF unit.

Results of systems analysis have shown an overall economic incentive for the GBF in PFBC compared to all-cyclone gas cleanup. Based on this analysis, performance goals for the GBF have been identified. A six-element, 24-bed, subpilot-scale GBF has been built and tested at both ambient and simulated PFBC conditions. Ambient flow tests were used as a basis to characterize the backflush system and evaluate candidate bed media. At simulated PFBC conditions, the test unit has been operated over 170 hours (cumulative), through 475 cleaning cycles in three test phases. Test variables have included bed media, filter flow face velocity, backflush conditions, and dust loading.

Baghouse Operation in Georgetown University Coal-Fired, Fluidized-Bed Boiler Plant, Washington, D.C.

Victor Buck
Pope, Evans and Robbins, Inc.

David Suhre
Georgetown University

Since 1979, Georgetown University has operated the nation's first commercial sized, coal-fired, fluidized-bed boiler plant for over 10,000 hours, utilizing a baghouse for particulate emissions control.

In plant startup, the bags are first coated with limestone dust by operating the forced draft and induced draft fans to fluidize the bed. This is followed by firing of No. 2 fuel oil to preheat the boiler and the limestone bed. Upon achieving 100 psig boiler steam pressure, coal is introduced into the preheated bed and ignited by the oil burner to initiate boiler operation.

The baghouse has proven to be an efficient particulate collector. However, excessive pressure drop across the baghouse has proven to be an ongoing problem. Various baghouse modifications have been implemented and different bags tested. This paper presents the results of this operation.

Section F - Novel Devices

Particle Capture Mechanisms on Single Fibers in the Presence of Electrostatic Fields

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F.-L. Chen
D. S. Ensor
Research Triangle Institute

L. S. Hovis
Air and Energy Engineering Research Laboratory
Environmental Protection Agency

Fabric filtration, although simple mechanically, is a complex phenomenon. As part of an effort to isolate the mechanisms significant in fabric filtration, simple experiments have been devised to evaluate the effects of electrostatic fields on particle capture. A series of experiments, with charged and neutral particles with various applied fields, were conducted to determine the location of deposits on the fibers. In particular, the location of the attachment of the aerosol, with respect to the direction of flow, was found to be strongly dependent on the applied field. The implications of these data, comparison to theory, and implications when applied to fabric filtration are described.

This paper has been reviewed in accordance with the U.S. Environmental Protection Agency's peer and administrative review policies and approved for presentation and publication.

Pilot Demonstration of Particulate Removal Using a Charged Filter Bed

Paul H. Sorenson
Air Correction Division, UOP, Inc.

The concept of fine particulate collection in a gas stream using a highly porous, charged fiber bed was first developed at Battelle Pacific Northwest Laboratories while studying the collection process by charged spray drops. Laboratory testing by Battelle using highly resistive, charged submicron aerosols showed that extremely high collection efficiencies were possible by this process. Air Correction Division, UOP, Inc., has undertaken a program to develop the concept under field scale conditions. A transportable 4000 cfm pilot plant was constructed and installed on a slipstream of a lignite-fired utility boiler at the outlet of an existing precipitator. The collection efficiency of the bed was monitored as a function of bed face velocity, gas temperature, and particle charge levels. This paper reports the results of the program.

Pilot Demonstration of Magnetic Filtration with Continuous Media Regeneration

Carroll E. Ball
David W. Coy
Research Triangle Institute

A mobile pilot plant with a nominal flow capacity of 3,060 m^3/hr (1,800 cfm) was designed and built to evaluate the use of high gradient magnetic filtration (HGMF) for particulate emission control on an electric arc furnace (EAF). A five-month test program was conducted at Georgetown Steel Corporation's plant in Georgetown, South Carolina, to test the performance of the HGMF. A 500-hour long-term test was scheduled and later changed in order to perform additional characterization studies.

The pilot-plant collection efficiency was less than expected for the stainless steel wool matrix packed to a density of 1.5 percent by volume. The matrix was then changed to an expanded metal, packed to a density of 3.5 percent by volume, which resulted in much lower pressure drop measurements, but even lower collection efficiencies. The expanded metal matrix was then packed to a density of 6.0 percent by volume, which gave higher collection efficiencies than the steel wool and a slightly lower pressure drop.

During the field test operations, there were no significant problems with the HGMF mobile pilot-plant equipment.

The report describes the design and construction of the continuous HGMF mobile pilot plant, as well as some of the background work in high gradient magnetic filtration done at RTI. The field start-up and performance characterization of the mobile pilot plant are discussed in detail. The experimental data and data analysis are given, as well as an economic evaluation and comparison of the HGMF with other particulate control devices.

This paper has been reviewed in accordance with the U.S. Environmental Protection Agency's peer and administrative review policies and approved for presentation and publication.

Section G - Plenary Session

Novel Particulate Control Technology

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A review of pulse energization and precharging is attempted in view of their inherently great potentials for particulate control and the current controversies around these two technologies. They may provide three major advantages when properly designed and applied. These are "energy-saving," "back corona correction for high resistivity dusts," and "performance enhancement for medium resistivity dusts." The physical backgrounds of these technologies are examined with special attention to the technical potential nanosecond pulses. Different designs and operation modes of these technologies are discussed in consideration of various application areas and dust resistivity levels, with an intention to provide a guide-line for correct use of these technologies.

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***Dale L. Harmon** is the EPA Project Officer (see below).*
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National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

The EPA Project Officer can be contacted at:

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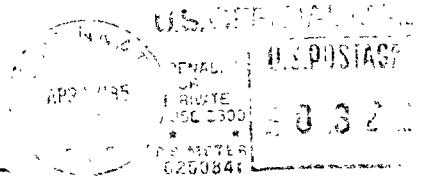

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