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Project Summary

Symposium Proceedings: Environmental Aspects of Fuel Conversion Technology, V (September 1980, St. Louis, MO)

F. A. Ayer and N. S. Jones, Compilers

The report documents presentations at the fifth EPA-sponsored symposium on the environmental aspects of fuel conversion technology, in St. Louis, MO, 9/16-19/80. The symposium served as a colloquium on environmental information related to coal gasification, indirect liquefaction, and direct liquefaction. The program included sessions on program approach, environmental assessment, and environmental control, including the development of EPA's pollution control guidance documents. Process developers and users, research scientists, and State and Federal officials participated in the symposium.

This Project Summary was developed by EPA's Industrial Environmental 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).

This report summarizes the proceedings of the fifth EPA symposium on Environmental Aspects of Fuel Conversion Technology, held September 16-19, 1980, in St. Louis, MO.

The purpose of the symposium, sponsored by EPA's Industrial Environmental Research Laboratory at Research Triangle Park, NC, was to discuss environmentally related information on coal gasification and liquefaction. Approximately 250 participants, including process developers, process users, environmental groups, governmental representatives, and research scientists, attended the 4-day symposium.

Source and ambient multimedia test results from pilot through commercial-scale coal gasification and liquefaction facilities were presented, as well as evaluations of environmental control technologies, results of laboratory research, and the status of methodologies for environmental assessment. Development of EPA's Pollution Control Guidance Documents for coal indirect liquefaction, direct liquefaction, and low-Btu gasification was highlighted.

Abstracts of the speakers' remarks follow.

Keynote Address

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Since last year's meeting two things, which can be expected to spur synthetic fuels development, have occurred. The price of oil has again almost doubled

and President Carter has signed into law the Synthetic Fuels Corporation Bill which authorizes up to $20 billion to encourage the growth of the industry.

In spite of sporadic Agency funding for research on the environmental effects of synthetic fuels production, a core effect has been maintained that has enabled EPA to meet its commitments to formulate environmental protection guidelines for emerging synfuels technologies. The Alternate Fuels Group and Priority Energy Project Group have been established by the Administrator and have functioned to coordinate EPA's activities in this effort to use "best engineering judgement" to provide the basis for evaluation of permit applications on accelerated projects in lieu of operating data on existing plants.

The major outputs in this effort are a series of Pollution Control Guidance Documents (PCGDs), one for each of the major synfuel product areas: gasification/indirect liquefaction, direct liquefaction, oil shale, and biomass. These are targeted for the user groups: permit reviewers (both in the EPA regional offices and in comparable state government agencies), process developers or plant operators, and EPA regulatory offices which will use the data for standards preparation.

I thank you for your contributions to and interest in these efforts and your participation in this symposium.

Session I. General Approach

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The Synthetic Fuel Program of the Fuel Process Branch of IERL-RTP

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This paper deals with the overall research effort being conducted by the Fuel Process Branch of EPA's Industrial Environmental Research Laboratory at Research Triangle Park, NC. This effort has been divided into three categories: (1) development of suitable methodologies for environmental assessment of these technologies, (2) problem definition through data acquisition, and (3) research facilities to assess control technology acceptability.

EPA/IERL-RTP Program for Direct Liquefaction and Synfuel Product Use

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The direct liquefaction program at EPA/IERL-RTP covers those synfuel processes which add hydrogen to coal and form liquid hydrocarbon products directly. The processes currently under study include SRC-II, Exxon Donor Solvent, and H-Coal. SRC-I is also included in the program because of its similarity to SRC-II even though the main product from that process is a solid. The synfuel use program covers products from coal and shale synfuel processing systems. Current and planned IERL-RTP activities in the area of direct coal liquefaction and synfuel product use are described. The relationship of these activities to process developers, regulatory programs, other governmental agencies, and other EPA research activities is discussed.

Update of EPA/IERL-RTP Environmental Assessment Methodology

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EPA's IERL-RTP has developed a systematic approach for performing each aspect of environmental assessment to allow for consistent data gathering and interpretation. Environmental assessment requires the determination of contaminant levels associated with point source discharges and comparison of those determinations with target control levels. Procedures for conducting phase environmental assessments involving Level 1 and Level 2 chemical analyses and bioassays have been formalized. Multimedia Environmental Goals (MEGs) reflecting potential toxicity of specific chemicals provide the target values used for comparison. Source Analysis Models (SAMs) delineate discharge stream severities based on the components present and mass flow rates. The Level 1/Level 2 chemical analysis approach has been coupled with the categorical system for organizing chemicals addressed by MEGs.

The computerized Environmental Assessment Data System (EADS) at IERL-RTP is used to store environmental assessment data and to provide links between characterization and target goals. Eventually, EADs will be used to automate large portions of the assessment data analysis.

The Permitting Process for New Synfuel Facilities

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The U.S. EPA and the various state departments of health are involved in a joint partnership with shared responsibilities for protecting the environment during the development of synthetic fuels. Legislation in the form of the Clean Air Act, Clean Water Act, Resource Conservation and Recovery Act, Safe Drinking Water Act, and the Toxic Substances Control Act provide the framework for EPA's regulatory responsibilities. The current status of implementing regulations and agency policies vis-a-vis these Acts is provided in this paper. Also, important aspects of state environmental regulations are provided.

Permit applications for synthetic fuel facilities are being received by EPA regional offices and by state agencies. Synfuel EISs are being reviewed. Decisions on Best Available Control Technology are being made. These engineering judgements are also discussed in this paper.

The TVA Ammonia from Coal Project

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TVA's Ammonia from Coal Project involves retrofitting a coal gasification process to the front end of its existing 225-ton-per-day ammonia plant. The purpose of the project is to develop design and operating data to assess the technological, economic, and environmental aspects of substituting coal for natural gas in the manufacture of ammonia. Preliminary operation of the facility was begun in September 1980. In the absence of specific environmental guidelines for coal gasification processes, TVA's approach to the potential environmental problem is to meet or exceed the emission control requirements for specific components; e.g., sulfur compounds, particulates, and aqueous discharges. Also, TVA's facility contract specified limits on certain discharges based on anticipated guidelines. In addition to a discussion of the emissions control activities, a program is described that examines the environmental health and safety aspects of the Ammonia from Coal Project.

Environmental Control Options for Synfuel Processes

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Ultimately, the large scale production of synfuels from U.S. coal and oil shale will become a reality. The U.S. DOE has a charge to foster the commercialization of energy conversion technology that is environmentally acceptable. "Environmental acceptability" is perceived to extend beyond meeting environmental compliance standards at a given plant and to include the "acceptability" of subtle, longterm health and ecological effects and the composite of low level environmental effects associated with an aggregate of synfuel installations. DOE has a hierarchy of site-specific environmental assessments integral to DOE development and demonstration activity. The objective of these assessments is to provide a data base for a determination of environmental readiness by the Assistant Secretary for Environment. An evaluation of the adequacy of the environmental control technology is a key component of these determinations.

In assessment of control adequacy, many alternative approaches present themselves. Some of these control options result from a natural synergism of combining process needs; e.g., an auxiliary power plant that recovers flue gas SO_2 in a concentrated stream can be advantageously coupled to H_2S recovery from the conversion process to produce by-product sulfur via Claus, or an entrained-type gasifier can be included with a series of Lurgi gasification units to handle rejected coal fines and oxidize highly contaminated condensate wastewaters. Other control options follow for making controls more cost-effective and/or environmentally superior. Wastewater reuse to extinction (zero discharge) and the catalytic incineration of process tail gases are examples of improvements over conventional technology. In the case of small, site-oriented industrial gasifiers, process simplicity and reliability are driving forces for improved controls or the absence thereof; e.g., ingasifier sulfur scavenging to eliminate subsequent H_2S cleanup or "dry-quenching" of product gas to eliminate the difficulty of wastewater treatment.

This presentation overviews a number of select environmental control options whose technical and economic feasibility has been recently established. The direction that future resultant control technology is expected to take is outlined.

Technical and Environmental Aspects of the Great Plains Gasification Project

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The Great Plains Gasification Project will be the first commercial-size synthetic fuels plant constructed in the U.S. Construction of the first phase began in July 1980 and, when completed in 1984, will produce 137.5 million cubic feet per day of substitute natural gas (SNG). Producing this quantity of gas requires 13,000 tons of North Dakota lignite per day and water at the rate of 4,400 gallons per minute.

Planning for the project has been ongoing for 7 years. An integral part of the technical planning has been the design and selection of environmental controls. The plant is designed for zero discharge of process wastewaters to surface streams. Extensive air pollution control equipment is designed to meet all applicable emission standards and ambient air quality standards. Compliance will be maintained with the PSD Class I increments at the Theodore Roosevelt National Park, 100 kilometers west of the plant site.

The gasification process to be used was developed by Lurgi, an engineering firm in West Germany. The major downstream process units were also developed and perfected by Lurgi. Other patented processes incorporated in the design of the Great Plains project are U.S. Steel's Phosam-W process for removing ammonia from process wastewater and Northwest Gas Board's Stretford process for converting H_2S to elemental sulfur. Two American engineering companies, CE Lummus Company and Kaiser Engineers, are the architect/engineers for the project.

Many of the technical uncertainties surrounding a new venture such as this have been resolved through a technical consulting agreement with SASOL, the South African gasification company that has produced synthetic fuels via the Lurgi process for over 20 years. Great Plains shipped 12,000 tons of North Dakota lignite to South Africa for gasification testing in 1975, the results of which formed the basis for the gasification design being used today.

Session II. Environmental Assessment: Direct Liquefaction

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Preliminary Results of the Fort Lewis SRC-II Source Test

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As part of EPA's environmental assessment of the SRC-II coal liquefac-

tion technology, a source test and evaluation study was conducted to characterize multimedia environmental streams associated with the SRC pilot plant at Fort Lewis, WA.

Although the SRC-II pilot plant is not considered a miniature version of commercial facilities, environmental implications of the SRC-II technology can be determined with proper engineering evaluation, and sampling and analytical strategies.

The program consists of chemical and biological characterization of the SRC-II process and waste streams. Chemical analyses were performed to identify and quantitate potentially toxic inorganic and organic compounds. Biological tests were also performed to provide both health effects and ecological effects of the SRC-II streams on mammalian organisms and ecosystems. These two tests complement each other to better define the SRC-II streams relative to their environmental significance.

Chemical/Biological Characterization of SRC-II Product and By-products

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Biological and chemical tests in concert with engineering analyses of plant operations have been used to provide data for the assessment of health and environmental effects of a mature coal liquefaction industry. This report describes the methodology whereby biological testing is used to guide the chemist in the analysis of fractions of selected pilot plant materials. The principal components of an unmodified distillate blend from the SRC-II process are two- and three-ringed aromatic and heteroatomic species. Phenolic and polynuclear aromatic components are generally present at higher levels than expected in petroleum crudes. Biotesting, with the Ames test as the primary first-tier method, revealed mutagenic activity. Chemical fractionation in conjunction with Ames testing implicates the primary aromatic amines as the compound class of primary concern. Chemical biotesting of a hydrotreated distillate blend showed a significant reduction of the primary aromatic amines as well as polynuclear aromatic hydrocarbons. Hydrotreating also can result in the reduction of sulfur and oxygen-containing compounds; e.g., thiophenes and phenols.

Low-NO_x Combustors for Alternate Fuels Containing Significant Quantities of Fuel-bound Nitrogen

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This paper summarizes data generated in two EPA-sponsored programs concerned with the development of low-NO_x combustors for high nitrogen containing fuels. EPA Contract 68-02-3125 is concerned with NO_x production and control from liquid fuels containing significant quantities of bound nitrogen. It was found that fuel nitrogen content is the primary composition variable affecting fuel NO formation and that emissions from both petroleum and alternative liquid fuels correlate with total fuel nitrogen content. Conditions were identified which allow high-nitrogen fuels to be burned satisfactorily with minimal NO_x emissions. Certain coal-derived fuel gases may contain ammonia. Data is presented from a series of bench-scale reactors designed to minimize the conversion of this ammonia to NO_x. Lowest NO_x emissions were produced in a rich/lean combustor utilizing either a diffusion flame or a catalyst in the fuel-rich primary stage.

Problem Oriented Report: Utilization of Synthetic Fuels: An Environmental Perspective

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This paper discusses the potential environmental problems arising from the refining, transportation, storage, and utilization of fuels produced by a synthetic fuel industry. Scenarios defining possible buildup rates for synfuel products from oil shale and coal conversion are developed to scope the magnitude of potential exposures. The market infrastructure for the use of these products is examined and the potential public health risks during the handling, transportation, and utilization of these synfuel products are evaluated. Significant issues regarding environmental impacts and the need for regulatory attention are discussed.

Session III: Environmental Assessment: Gasification and Indirect Liquefaction

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Environmental Test Results from Coal Gasification Pilot Plants

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Environmental awareness and the world oil situation are having a profound impact on the U.S. Electric Power Industry. "Environmental acceptability" has been redefined and is emerging as one of the major criteria for selection of a power generation process to satisfy increasing load demand or to replace retired units. Furthermore, the fact that the cost of fuel has risen in real terms dictates that more fuel efficient plant configurations be deployed. Fuel efficiency and environmental tolerability come only at the expense of increased monetary cost.

These fundamental changes certainly are creating problems for the power industry but they are also creating opportunities for new and more appropriate power generation processes.

EPRI has high expectations that combined cycle power systems fueled by gas from coal will be cleaner and more efficient than the competing processes for equivalent capital cost. Advantages accrue to these Gasification-Combined Cycle (GCC) systems primarily from the relative ease of cleaning fuel gas, the benign nature of the waste

products, and the inherent and proven high thermodynamic efficiency of the combined cycle configuration.

These and other advantages are discussed. Coal gasification processes are identified which most effectively capitalize on these advantages. Environmental test results on these processes are summarized. Finally, the plans for commercial scale demonstration of a GCC system are reviewed. This demonstration is a critical milestone since no technology can be considered to be a real option until it has been operated at an appropriate scale.

COS-H_2S Relationships in Processes Producing Low/Medium-Btu Gas

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The chemical aspects of the distribution of sulfur between H_2S and COS in the product gas from the gasification of coal are examined. Comparing actual gasifier measurements with equilibrium computations shows that the gas stream becomes frozen corresponding to equilibrium values at high temperature, most likely corresponding to the reactor exit. This implies a sulfur distribution with a higher COS concentration than expected. The conversion of COS to H_2S occurs mainly by COS hydrolysis, which is very slow at low temperatures. Finite rate studies indicate that an effective catalytic COS hydrolysis rate constant of 10^{-17} to 10^{-16} cm^3/mol sec will allow the reaction to reach >95 percent equilibrium in small enough residence time to allow reasonable reaction vessel sizes.

It is found that the achievable H_2S/COS equilibrium ratio is determined from the product of the locally frozen H_2O/CO_2 ratio and the COS hydrolysis equilibrium constant. The governing parameters for the H_2O/CO_2 equilibrium ratios are the temperature, pressure, and the gas stream (H/C) and (O/C) ratios. The higher the (H/C) ratio and the lower the (O/C) ratio, the larger the H_2O/CO_2 ratio and thus the larger the H_2S/COS ratio. Moreover, raising the (H/C) ratio and lowering the (O/C) ratio also increases the achievable CH_4 equilibrium concentration from a catalytic methanation module.

Behavior of a Semibatch Coal Gasification Unit

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This paper describes the transient behavior of a laboratory scale fixed-bed gasifier operated in a semibatch mode. The operation is batch with respect to the coal feed and continuous with respect to gas flows. Various coals ranging from lignite to bituminous were gasified using steam/air mixtures at 1.4 MPa (200 psia) and approximately 900°C. The transient behavior of the reactor temperature at various coal bed depths was examined. Test results from nine tests involving five coals are reported. The data presented include the rate of production of various gasification products, including CH_4, CO, H_2, benzene, toluene, xylene, H_2S, COS, and thiophene, as a function of run time. It was found that the majority of the CH_4, the minor hydrocarbons, and sulfur species were evolved during coal devolatilization. These data were analyzed using a simple kinetic model which assumes that the rate of production of a compound at any time is proportional to the (potential) amount of that compound remaining in the coal. This model explains the data reasonably well during the devolatilization period. It was found that the specific rate of production of individual species was practically the same for all coals and gasification products considered; the ultimate yield was dependent on coal type. The ultimate yield of (a) CH_4 or benzene, and (b) sulfur species roughly paralleled the volatile and sulfur contents of the coals, respectively.

Carbon Conversion, Make Gas Production, and Formation of Sulfur Gas Species in a Pilot-scale Fluidized-bed Gasifier

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The steam-oxygen gasification of a pretreated Western Kentucky No. 11 bituminous coal was carried out in a pilot-scale fluidized-bed gasifier. This paper describes the experiments and summarizes measured carbon conversions, sulfur conversions, make gas production rates, and the results of material balance calculations on total mass and major elements (C, H, O, N, and S). The development of a single-stage kinetic model for the gasifier is outlined, and correlations of the experimental results using this model are presented. Quantities of sulfur gas compounds formed in the gasifier at different operating conditions are summarized and a first analysis of these results is presented.

Modderfontein Koppers-Totzek Source Test Results

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A source test program was conducted at a Koppers-Totzek (K-T) coal gasification facility operated by AECI Limited at Modderfontein, Republic of South Africa. The EPA's interest in the K-T process stems from the fact that the process economics and demonstrated commercial reliability make it a very viable prospect for some U.S. applications. The responsibilities for sampling, analysis, and engineering descriptions of the Modderfontein plant were shared between TRW and GKT, Gessellschaft für Kohle-Technologie mbH of Essen, Federal Republic of Germany. GKT is the wholly owned subsidiary of the German-based parent company which is the developer and licensor of the K-T process. EPA's phased approach for environmental assessment was followed. Level 1 and Level 2 data were collected along with priority pollutant screening data. Much of the effort was focused on wastewater streams. The wastewater treatment, consisting of a clarifier and settling pond, was adequate to produce a final discharge that had lower pollutant levels than the fresh input waters supplied to the plant. The complete data are presented in this paper along with brief descriptions of the K-T process and the Modderfontein plant. The Source Test and Evaluation, intended as an initial effort, was somewhat limited in scope.

An Environmentally Based Evaluation of the Multimedia Discharges from the Lurgi Coal Gasification System at Kosovo

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An international program has been under way in the Kosovo region of Yugoslavia to characterize the environmental problems associated with a commercial Lurgi coal gasification system. The study was conducted over a 3-year period as a cooperative endeavor between scientists from Yugoslavia and U.S. EPA/Radian Corporation. It was undertaken because the Lurgi gasification process has a significant potential for use in the U.S. In this study, the plant's key streams (feed, process, product, and discharge) were characterized, and key pollutants in the plant's gaseous, aqueous, and solid discharges were identified and quantified. Multimedia discharges were prioritized according to both mass flow and discharge severity.

This paper focuses on the severity of the discharges, as determined by the EPA-IERL SAM/IA model for evaluating pollutants on the basis of their potential for causing adverse health effects. Key pollutants in each discharge medium are identified and significant streams, as prioritized, are discussed.

Study results indicate that all discharge media (gaseous, aqueous, and solid) present a significant potential for polluting the environment and also that effective controls for many discharge streams are imperative.

Ambient Air Downwind of the Kosovo Gasification Complex: a Compendium

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In an attempt to obtain environmental impact data for a commercial scale coal gasification facility, the Aerosol Research Branch of EPA's ESRL-RTP conducted a 16-day continuous ambient air study in the Kosovo Region of Yugoslavia. Five sampling sites were established around and ≃2 km outside the fence line of the Kosovo medium-Btu Lurgi gasification complex.

Organics in total particulate matter; total and fine particle mass, inorganics, and elemental species; trace metal in size-fractionated particles; and vapor-phase organics were determined. Physical and chemical analyses were carried out on particulate matter using gravimetric analysis, ion chromatography, and scanning electron microscopy. Elemental analysis was done using the inductively coupled argon plasma emission technique, proton-induced x-ray emission, and combustion analysis. Both particle catches and vapors trapped on Tenax resins were subjected to organic analysis using gas chromatography. The chromatographic fractions were identified and quantified using flame ionization detection, sulfur and nitrogen specific detectors, and mass spectrometry. A comprehensive quality assurance and quality control program was implemented to ensure the validity of the samples collected and analyzed.

A number of U.S. and Yugoslavian laboratories participated in the ambient air sampling and analysis phases of this study. This paper is a compendium of the major results and conclusions obtained by the participant laboratories.

Characterization of Coal Gasification Ash Leachate Using the RCRA Extraction Procedure

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Gasification ash constitutes the single largest solid waste stream from coal gasification facilities, and its disposal is subject to regulations promulgated under RCRA. Ashes from a Lurgi gasifier, Wellman-Galusha gasifier, and Texaco gasifier were subjected to the RCRA Extraction Procedure test. The results are reviewed in light of similar data on boiler ashes. Those findings indicate that these materials will not be considered toxic based on the 100X primary drinking water standard criteria.

Comparison of Coal Conversion Wastewaters

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This paper presents analytical results from the aqueous process condensates from an oxygen-blown, lignite-fired Lurgi gasifier, an air-blown, bituminous-fired Chapman gasifier, and a coke oven process. Results show strong similarities between the two gasifier process condensates. The similarities include gross chemical parameters and concentrations of specific organic compounds. Extraction of the three condensates using diisopropyl ether resulted in a 99+ percent removal of total phenols and a 75 percent average removal of the total organic carbon (TOC). Further extraction with an exhaustive technique removed an average of only 9 percent of the remaining TOC from the two gasifier waters. The <500 MW to >500 MW ratio was approximately 2 for the remaining refractory organics. The results of a brief study using activated carbon to remove the refractory organics indicated that the TOC levels could be further reduced, but the levels remained relatively high. The occurrences of eight nitrogen-containing organic species were compared using a gas chromatograph equipped with a Hall Electrolytic Conductivity Detector in the nitrogen-specific mode. The occurrences of phenolic species were also compared using a gas chromatograph equipped with a flame ionization detector. The three process condensates contained the same phenolic and nitrogen heterocyclic compounds.

Session IV: Environmental Control

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Ranking of Potential Pollutants from Coal Gasification Processes

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Potential pollutants associated with coal gasification processes were studied based on data from EPA's environmental assessment research program. An environmental assessment methodology based on health and ecological Multimedia Environmental Goals (MEGs) is described and applied to product, by-product, process, and waste streams. A list of chemical species that were measured or qualitatively identified in coal gasification streams is given. Maximum concentrations of each quantitated species in each medium (solid, liquid, gas, tar) are given. Production factors have been computed and normalized on the basis of coal input rate to facilitate comparisons. Chemical species have been ranked by potential hazard to health and ecology. Priorities for monitoring, regulation, and control technology development may be established from these lists.

Effect of Sludge Age on the Biological Treatability of a Synthetic Coal Conversion Wastewater

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Aerobic biological processes appear to be the focal point of any overall scheme for treating coal conversion wastewaters since a significant number of the major constituents of these wastes are biodegradable. Accordingly, suitable design and operating criteria for biological treatment facilities need to be developed. The studies described in this paper were conducted using a synthetic wastewater which was formulated to be representative, in its organic composition, of actual wastewaters from coal gasification and coal liquefaction processes. The wastewater contains 28 organic compounds, inorganic nutrients, and pH-buffers.

The synthetic coal conversion wastewater was fed to several bench-scale activated sludge reactors, operated at different solids retention times (sludge ages). Effluents from the reactors were analyzed by gas chromatography and high-performance liquid chromatography to assess the degree of removal of the various constituents in the raw feed, and to identify reaction products following biological treatment. Additionally, acute toxicity studies using fathead minnows were conducted to evaluate the biological impact of the treated wastewaters on aquatic life. Acute mammalian cytotoxicity and Ames mutagenicity analyses were also performed on the reactor effluents to assess their potential impact on human health. This paper presents selected results of some of these analyses.

Treatment and Reuse of Coal Conversion Wastewaters

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This paper presents a synopsis of recent experimental activities to evaluate processing characteristics of coal conversion wastewaters. Treatment studies have been performed with high-Btu coal gasification process quench waters to assess enhanced removal of organic compounds via powdered activated carbon/activated sludge treatment, and to evaluate a coal gasification wastewater treatment train comprised of sequential processing by ammonia removal, biological oxidation, lime-soda softening, granular activated carbon adsorption, and reverse osmosis. In addition, treatment studies are in progress to evaluate solvent extraction of gasification process wastewater to recover phenolics and to reduce wastewater loading of priority organic pollutants. Biological oxidation of coal gasification wastewater has shown excellent removal efficiencies of major and trace organic contaminants at moderate loadings; addition of powdered activated carbon provides lower effluent COD and color. Gasification process wastewater treated through biological oxidation, lime-soda softening, and activated carbon adsorption appears suitable for reuse as cooling tower makeup water. Solvent extraction is an effective means to reduce organic loadings to downstream processing units. In addition, preliminary results have shown that solvent extraction removes chromatographable organic contaminants to low levels.

Pilot Plant Evaluation of H_2S, COS, and CO_2 Removal from Crude Coal Gas by Refrigerated Methanol

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Acid gas removal systems are a necessary part of coal gasification processes. Carbon dioxide must be removed from gasifier product gas to improve the energy content of the gas and several sulfur compounds must be taken out to protect downstream process catalysts as well as reduce potential sulfur emissions.

At North Carolina State University, an integrated coal gasification/gas cleaning test facility is being used to study the environmental and process implications of several different acid gas removal solvents. Details of the plant facilities and operating procedures may be found in a recent EPA technical report (Ferrell et al., EPA-600/7-80-046a, March 1980). This paper presents some of the initial results from acid gas removal pilot plant operation, discusses several aspects of methanol use for acid gas removal, and outlines future experimental work on this part of the process.

Pollution Control Guidance Document for Low-Btu Gasification Technology: Background Studies

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The U.S. EPA is currently preparing a Pollution Control Guidance Document (PCGD) for low-Btu gasification (LBG) facilities which use atmospheric-pressure, fixed-bed gasifiers. The PCGD is intended to aid industry and government in their efforts to commercialize LBG technology in an environmentally acceptable manner. This paper presents some of the preliminary results of background studies performed to support the development of the LBG PCGD.

A model plant approach was used to assess the environmental control needs for LBG facilities. The plant configuration and coal feed combinations for which pollution controls were identified and

evaluated were selected based on existing and proposed plants in the U.S. The major variables examined were coal feed type (anthracite, lignite, and high- and low-sulfur bituminous coals) and degree of product gas purification (production of hot, cooled, and desulfurized low-Btu gas). In all, 11 combinations of these variables (i.e., model plants) were selected for study. Each model plant had a nominal capacity of 45 MJ/s (150 x 10^6 Btu/hr) of low-Btu gas.

Multimedia pollutant sources and pollutants of potential concern were identified and quantified for each model plant. The bases for these determinations were field test data and calculated emissions projections. The EPA's low-Btu gasification environmental assessment program was the major source of the field test data, but results from other government and industry test programs were also used.

Control/disposal options were identified and evaluated for each discharge stream. Factors that were considered included the need for control, current industry practices, control equipment performance, capital investment requirements, annual operating costs, energy impacts, and secondary environmental discharges.

Development of a Pollution Control Guidance Document for Indirect Coal Liquefaction

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Synfuels present both an opportunity and a problem for EPA in terms of developing a new environmentally acceptable industry. The opportunity is for EPA to encourage environmental controls to be incorporated/developed as an integral part of the first plant designs rather than as "add on" technology in an existing industry. The problem is that an adequate data base for promulgation of defensible regulations for synfuel plants does not now exist and will likely not exist until after the first plants have been constructed and operated for some period of time. EPA has responded to this situation with the "Pollution Control Guidance Document (PCGD)" concept, in which the best thinking of the various EPA R&D program and regional offices is to be provided to permitters and to industry in the form of "guidance" for an interim period rather than as regulations.

The Indirect Liquefaction (IL) PCGD is one of the first such documents which EPA is preparing with the technical support of various contractors. TRW, Radian, Versar, and RTI are involved in the preparation of the data base for the first technical draft of the IL PCGD.

This paper summarizes the technology basis for control levels identified.

Initial Effort on a Pollution Control Guidance Document: Direct Liquefaction

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Development of the pollution control guidance document (PCGD) for direct coal liquefaction is proceeding in parallel with the permitting and construction of the first demonstration-size liquefaction plant, the SRC-II unit in Ft. Martin, WV. In addition to the SRC-II process, the PCGD will provide guidance for the other major liquefaction technologies: SRC-I, H-Coal, and Exxon Donor Solvent.

The control technology guidance will be related to baseline designs prepared for each of the four liquefaction processes, sized at 100,000 bbls/day production. The baseline designs are composed of material balance flowsheets and uncontrolled waste stream calculations, using plant configurations which are most likely to occur in future commercial size plants. Variations of the baseline designs will be considered if they affect control decisions. A range of feed coals have been selected for the baseline cases, with at least one common coal type that could be used by all four processes. The present effort is focused on identification of the pollutants of concern using pilot-plant test data from coal liquefaction developers, DOE, and EPA sponsored testing programs. These data will be evaluated with a variety of engineering analysis methodologies, so that the subsequent examination of control options can be carried out.

The range of control options—air, water, solid waste—will be selected from those methods that have a known track record in related industrial applications; e.g., petroleum refining, coke ovens, and mining.

The control technologies will be characterized parametrically according to the inlet stream compositions and quantities, and their percentage release of specific pollutants. Finally, the cost of control will be developed according to the same parameters, with a range of costs obtained depending on the complexity and efficiency of control.

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The complete report, entitled "Symposium Proceedings: Environmental Aspects of Fuel Conversion Technology, V (September 1980, St. Louis, MO)," (Order No. PB 81-245 045; Cost: $44.00, subject to change) will be available only from:
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