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ENVIRONMENTALLY ACCEPTABLE DISPOSAL OF COAL CONVERSION SOLID WASTE RESIDUALS

Progress Report
for the period April 21, 1979 to July 31, 1979

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ABSTRACT

Laboratory and report preparation activities are underway to investigate basic phenomena that would assist demonstration and commercial sized coal conversion facilities in the environmentally acceptable disposal of process solid waste residuals. Laboratory columnar and rapid leaching evaluations are being conducted in accord with RCRA guidelines and other techniques. Preparations are being made for Ames Testing of derived leachates.

ENVIRONMENTALLY ACCEPTABLE DISPOSAL OF COAL CONVERSION SOLID WASTES

Technical Progress Report for the period
May 1, 1979 to July 31, 1979

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The purpose of this project is to assist in the environmentally acceptable operation and design of proposed demonstration and commercial sized coal conversion facilities by investigating basic phenomena associated with solid wastes and process wastes produced by such processes.

Earlier in this quarter, a presentation was made at an Electric Power and Research Institute (EPRI) workshop on solid waste generation, handling and disposal from advanced energy technologies. The electric power industry is quite concerned regarding RCRA implications of existing and proposed energy production facilities. If process solid wastes are declared "hazardous" (within the legislative context of RCRA federal regulations), it is estimated that the costs associated with their disposal may jump from the current $3 to $7 per dry ton to the range of $75 to $100 per dry ton for disposal in special "secure" landfills. Such increases in costs, and associated social impacts of disposal of "hazardous wastes", could have serious

implications on the National Energy Plan.

One sample of coal conversiou solid waste was received to date from PETC. This sample came undocumented from the U.S. DOD "Chapman" type gasification facility located in Tennessee, and consisted of about 5 pounds of a fine-grain like material that was similar in appearance to ground coal. We were informed that this material was collected from the cyclone of the gasifier, and thus consisted of fly-ash (as opposed to bottom ash).

During the course of this quarter, Dr. Neufeld made contact with representatives of Hydrocarbon Research Institute (HRI) for the collection of three different samples from the H-Coal PDU. The Pittsburgh Energy Technology Center shall obtain these samples for us directly from HRI, and provide them to us as part of our research effort. These samples shall come from the vacuum still bottoms from the PDU when operated in the syncrude mode, and the fuel oil mode when operating with Illinois and Kentucky coals. In our opinion, the advantage of utilizing these samples in research, is that they are perhaps the most representative samples to date of solid residuals that will be discharged from the H-Coal Demonstration facility to be operated in Kentucky. It is not know by us at this point in time

whether plans for the H-Coal demonstration plant call for the gasification of these solid waste residuals, or for the burial (either on-site, or off-site) of these residuals in land fills.

During this quarter, one graduate student was engaged in developing appropriate laboratory techniques for conducting Ames Testing of coal conversion residuals. Dr. Keleti of the Pitt Graduate School of Public Health was kind enough to supervise the developing technique of this student. In the conventional Ames test, 5 strains of bacteria are utilized for the assessment of mutagenicity. The purpose of the 5 strains is that in the original protocol, the test was developed as a screening mechanism for a wide variety of compounds. Since coal conversion residuals have shown to influence only one of these five strains, it may be possible to conduct all future evaluations during the course of this research using this one-most sensitive bacterial strain.

Literature evaluations were conducted as to the potential for reducing toxicity (as measured by the Ames Test) by both biological and physical-chemical techniques. It is thought that perhaps some credit should be given to soil systems for the attenuation of toxicity, a point not brought out by recent EPA-"RCRA" regulations. This principal investigator has shown that soil systems have the potential

to biologically degrade phenol when applied on a temporal basis to soils in concentrations of up to 500 mg/L. Data was collected to show that soil systems have the potential to be modeled by first order kinetics with respect to phenol biodegradation. No such application to "toxicity biodegradation" has previously been evaluated.

Considerations were given during this quarter to phenomena which control the release of pollutants from land disposed fly ash and bottom ash particles. It is considered by this PI that models should be developed that incorporate intra-particle diffusion within the ash particle as perhaps the most significant phenomena in controlling salt and metal release during leaching episodes. Data reported in the literature, indicates that during the course of flooded leachate production, the concentration of dissolved species decreases as expected with time. However, during wet/dry periods (as in rain/no rain events), it is noted that the concentration of pollutants in "first-flush" leachates were often of significantly higher concentrations than what may be predicted from flooded columnar leaching studies.

A copy of the Oak Ridge National Laboratory "Duguid and Reeves" computer model was obtained in tape form, copied onto the University of Pittsburgh Computer System, and returned to Oak Ridge. This program was originally

developed to calculate the concentration of plutonium in three dimension when this material is disposed of in trenches in special landfills. In the course of doing such calculations, it is assumed by the program that the species concentration at the solid-liquid boundary (C_o) is always constant. This assumption may be valid for plutonium leaching where the release of material is at a very low rate over time, however, this assumption is most likely not valid considering "first-flush" phenomena that exists in conventional landfill design and operation.

A mathematical model is being developed during the course of this research to calculate intra-particle pollutant concentrations in terms of leachable fraction, and relate these profiles to particle surface concentrations. In this manner, an estimate of surface pollutant concentration may be evaluated over time, which may be linked to a ground water transport model such as the "Duguid-Reeves" approach. The developed computer model will however, be modified to accept a time dependency in concentration at the particle/water interfacial boundary.

A meeting was held at PETC with Professor Shapiro, Mr. J. Bern, and Dr. Ronald D. Neufeld (PI) of the University of Pittsburgh, and the technical staff of the PETC Environment and Conservation Division. A table of contents of the forthcoming solid waste report had been earlier submitted

to Dr. Earl Evans, TPO, for his approval. After some discussion, approval was obtained for the submitted table of contents. It should be noted that the table may be changed during the course of our activities; substantial changes however, shall be made only with the approval of the Technical Project Officer.

As indicated above, literature review and theoretical concept modeling activities comprised much of this reporting quarter. Since only one sample of coal conversion solid wastes was received to date, the laboratory portion of this project proceeded somewhat slower than originally hoped for. This did however, have the advantage of allowing project personnel to investigate some aspect of Ames testing that could prove useful during the course of the project. It is envisioned that with the receipt of the HRI "H-Coal" samples, laboratory activities during the next quarter should hasten.

COMPLIANCE WITH CONTRACT REQUIREMENTS:

As indicated above, as of this date, only one sample of solid wastes was received from the PETC technical project officer. The original contract received from PETC indicated that two solid waste samples were to become available by June 30, 1979. It is anticipated that other solid waste samples will

become available during the course of this project due to the initiative of both the technical project officer, and the principal investigator.

The level of effort expended by the principal investigator on this project, and the level of effort of graduate students expended on this project to date are in conformance with the original contract documents received from PETC. Two additional University faculty members have participated indirectly in this project by advising graduate students in the science and art of conducting bioassay tests on derived leachate materials.

APPENDIX A

Comments on Ames Testing Procedures

The standard protocol for the Ames testing of chemical mutagens includes the following procedures:

a: Neutralization of the sample

b: Use of five tester strains of histidine defective mutagenic strains of Salmonella, i.e. TA98, TA 100, TA 1535, TA 1537, and TA 1538.

c: Tests are carried out by the whole plate method (for liquid extracts) in duplicate with four different concentraion rates as follows: 0.1 ml, 0.5 ml, and 1.0 ml of full strength extract, and 1.0 ml of ten times concentrated extract.

d: Tests are carried out with and without metabolic activation, ie..with and without "S-9" rat liver microsome mixture.

e: Toxicity tests on TA 1537 with concentrated sample extracts to determine dose limitations for final tests.

Proposed Deviation from the above Protocol as follows:

1) Use five tester strains with and without metabolic activation as above for initial determination of the most sensitive bacteria to that particular sample. Exploratory tests to be conducted with replicates.

2) Use only the most active strains for the required number of replicates to obtain a statistically significant result with required confidence limits.

3) Tests will be carried out with only single strength of the sample, in only one quantity (1.0 ml). The philosophy here is that in situ leaching does not concentrate the contaminent, thus concentration should not be part of our testing program. Data is desired as to whether or not the substance is potentially mutagenic, and no dose/response curve is required for this purpose, thus only one quantity of extract shall be utilized in each whole plate count.