

at a slower rate farther downwind than did the other pollutants because of the conversion of SO₂ to sulfates. At greater distances when the SO₂ concentrations become negligible, the rate of decrease in the sulfate concentrations should approach that of the lead and bromine concentrations, since the sulfate is present on the same size particles as the lead and bromine.

Since the sulfate concentrations would decrease at about the same rate as the lead, bromine and zinc concentrations if it were not for the conversion of SO₂ to sulfates, the amount of SO₂ which converted to sulfates can be calculated from the difference between the decrease in the sulfate concentrations and the decrease in the lead, bromine and zinc concentrations. When this was done, SO₂ to sulfate conversion rates of $3.3 \pm 1.7\% \text{ hr}^{-1}$ and $3.7 \pm 1.2\% \text{ hr}^{-1}$ were calculated for 1973 and 1975, respectively.

Deposition Velocity of SO₂

The processes which cause the SO₂ concentrations to decrease downwind of a source are mixing, deposition and conversion to sulfates. Since the total rate of decrease in the SO₂ concentrations and the rates of decrease due to mixing and conversion have been determined earlier, the rate of deposition can be determined by difference. When this was done, SO₂ deposition velocities of $3.8 \pm 1.7 \text{ cm sec}^{-1}$ for 1973 and $6.2 \pm 1.3 \text{ cm sec}^{-1}$ for 1975 were calculated with the method used earlier for lead, bromine and zinc.

It can be seen that beyond about 20-40 miles downwind of St. Louis the decrease in the SO₂ concentrations was due primarily to deposition. In 1975 SO₂ decreased $22.8\% \text{ hr}^{-1}$, but mixing caused only a $4.5\% \text{ hr}^{-1}$ decrease, and conversion only a $3.7\% \text{ hr}^{-1}$ decrease.

CHARACTERIZATION OF SUBSTANCES IN PRODUCTS, EFFLUENTS, AND WASTES FROM COAL CONVERSION PROCESSES

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Researchers at Pacific Northwest Laboratory (PNL) are investigating materials from synthetic fossil fuel processes. During the past year, samples have been collected from the Solvent Refining Coal Pilot Plant (SRC-I mode), Lignite Gasification Pilot Plant, Eyring Research Institute Gasifier, and Hanna III In Situ Coal Gasification Experiment. Inorganic and organic analyses have been performed, and comparisons of the data show some important differences in the potential emissions.

The objectives of this program are to identify and quantify the constituents occurring in products, effluents, and emissions from coal conversion processes that warrant consideration in the development of control measures. Sampling and analyses of emissions from four coal conversion processes during this year have shown the variety of constituents which are present in the processes. The following paragraphs detail some of our sampling methods and findings to date at these sites.

SOLVENT REFINING COAL PILOT PLANT

During the final stages of a long run to obtain several thousand tons of solid solvent-refined coal (SRC-I mode), samples were

collected at the Solvent Refining Coal Pilot Plant at Fort Lewis. This sampling trip included collecting the usual solid and liquid samples, but primary emphasis was placed on collecting gaseous and particulate samples. Since the mass balance for mercury indicated it was escaping in some volatile form, sampling during this field trip included collecting volatile forms of mercury in the process gas lines. No mercury species, however, were detected. The lines were also sampled for volatile arsenic species, but none were found. After the plant resumed operation in the SRC-II mode, several sets of water samples were collected and analyzed for compounds soluble in methylene chloride. Phenol, the cresols and xylenols were the most concentrated organic species at 20-100 ppm (see

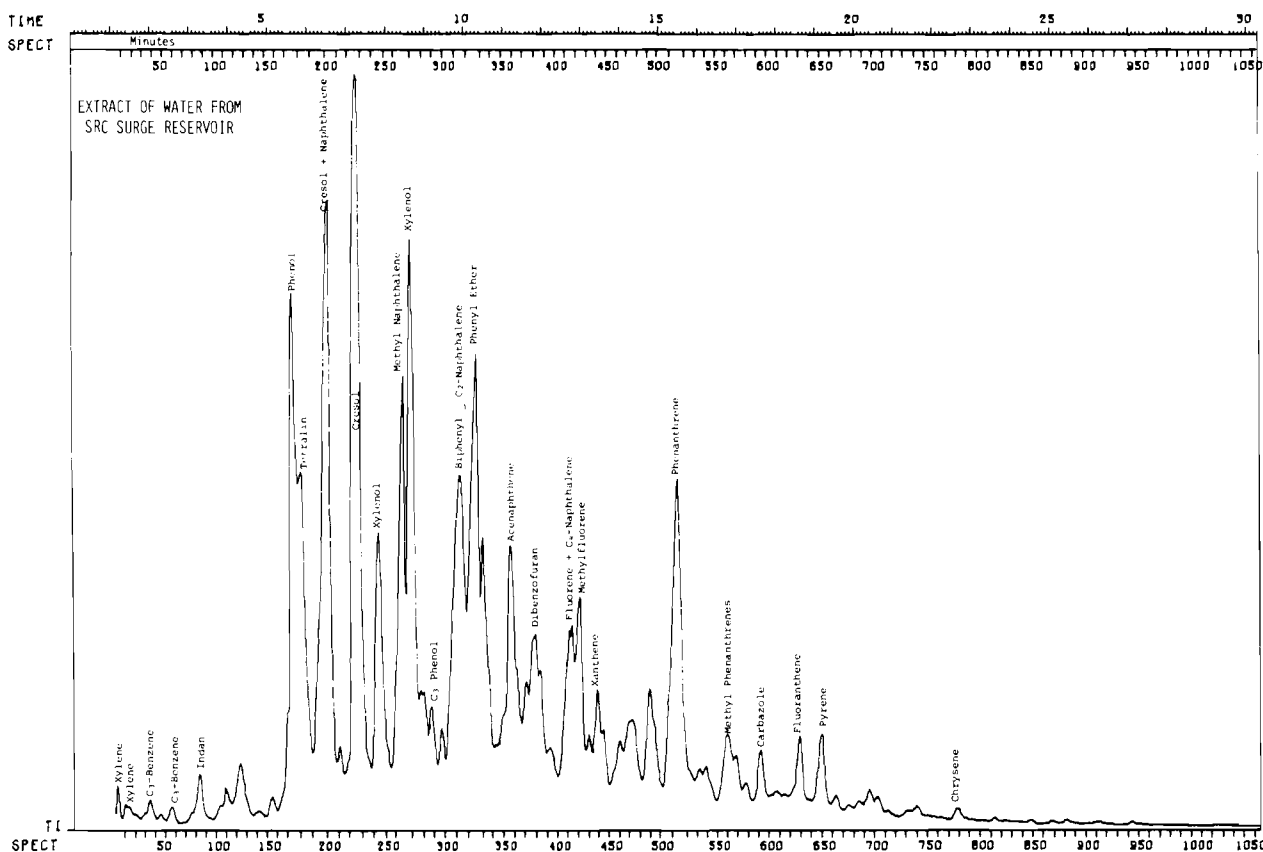
the accompanying chromatogram -- Figure 1.20). Aromatic hydrocarbons were present up to 20 ppm for some individual compounds such as methylnaphthalenes or phenanthrene. The compounds present in the SRC-II water did not differ markedly in kind or concentration from the SRC-I process.

Chemical fractions (SRC-I) from the light oil, wash solvent, and process solvent were given early in the year to biologists at PNL for biotesting studies. Of all the fractions, the polynuclear aromatic hydrocarbons and the basic fractions of the process solvent were the most active in the Ames test, and further studies with these two fractions are underway.

LIGNITE GASIFICATION PILOT PLANT

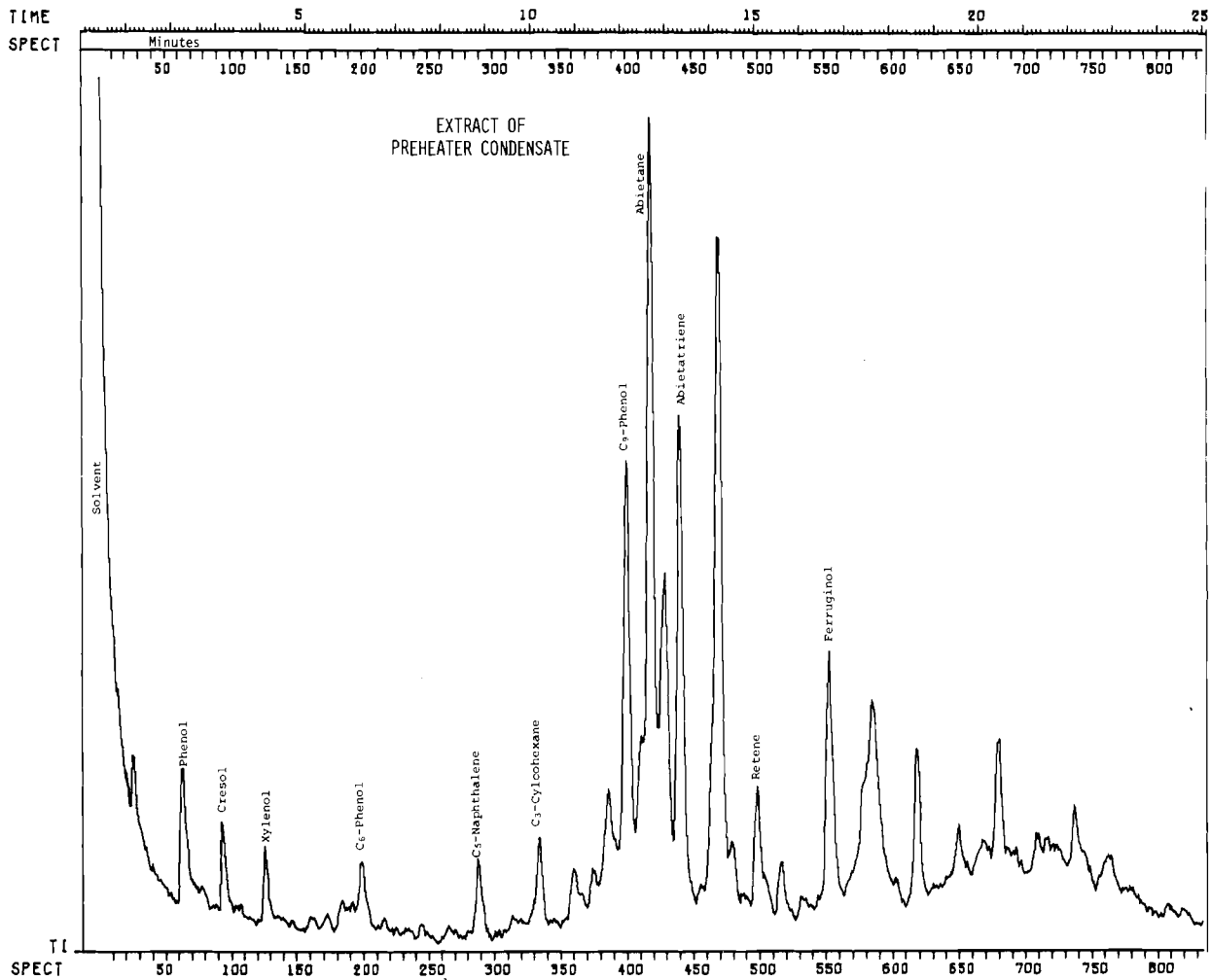
Several sets of samples (including gaseous, particulate, and aqueous effluents) were collected at the Lignite Gasification Pilot Plant in Rapid City, South Dakota. Gaseous mercury was detected in the preheater vent gas and in the overhead gas from the gasifier, and some

arsenic was present in the same overhead gas. Water quenching of this overhead gas removed the mercury and most of the arsenic. Organic analyses of the various quench waters and preheater condensate showed that the concentration organic compounds were mostly of the sub-ppm level. Quench water of gases from the acceptor regenerator contained a variety of oxygenated species including aldehydes, ketones, alcohols, and phenols. Naphthalene was the single major compound in the gasifier quench water, but the water also contained a number of other polynuclear aromatic compounds in sub-ppm concentrations. Condensate from the preheater vent line contained many volatiles evolving directly from the coal during drying, including aliphatic hydrocarbons and a series of resin-acid related hydrocarbons, such as abietane ($C_{20}H_{36}$), abietatriene ($C_{20}H_{30}$), ferruginol ($C_{20}H_{30}O$), and retene ($C_{18}H_{18}$). A reconstructed chromatogram of an extract of that condensate is shown in Figure 1.21.



Neg. PNL7712003-4

FIGURE 1.20. Reconstructed Chromatogram of a Methylene Chloride Extract of Water from Surge Reservoir at Solvent Refining Coal Pilot Plant



Neg. PNL7712003-3

FIGURE 1.21. Reconstructed Chromatogram of a Methylene Chloride Extract of Condensate from Preheater Vent at Lignite Gasification Pilot Plant

EYRING RESEARCH INSTITUTE GASIFIER

Water, solid and gas samples were collected from this small bench scale (40 lb/hr) gasifier. The water and solid samples contained sub-ppm concentrations of phenols, alkanes, and polynuclear aromatic hydrocarbons. We suspect that these compounds found in the aqueous phase were adsorbed on the fine particulates suspended in the quench water.

HANNA IN SITU COAL GASIFICATION EXPERIMENT

The *in situ* coal gasification experiment was conducted over about one month, and special emphasis was focused on sampling volatile inorganic species present in the raw product gas. During each sampling period, about 15 ft³ of gas was filtered and passed through impinger solutions. Some selective absorption traps were also used for arsenic and mercury species. The following elements were below the detection limits of about 3-100 ppb: Fe, Pb, Br, Rb, Cd, and Se. Mercury was found to be present in the gas phase only as the volatile metal, and no detectable arsenic species were found.