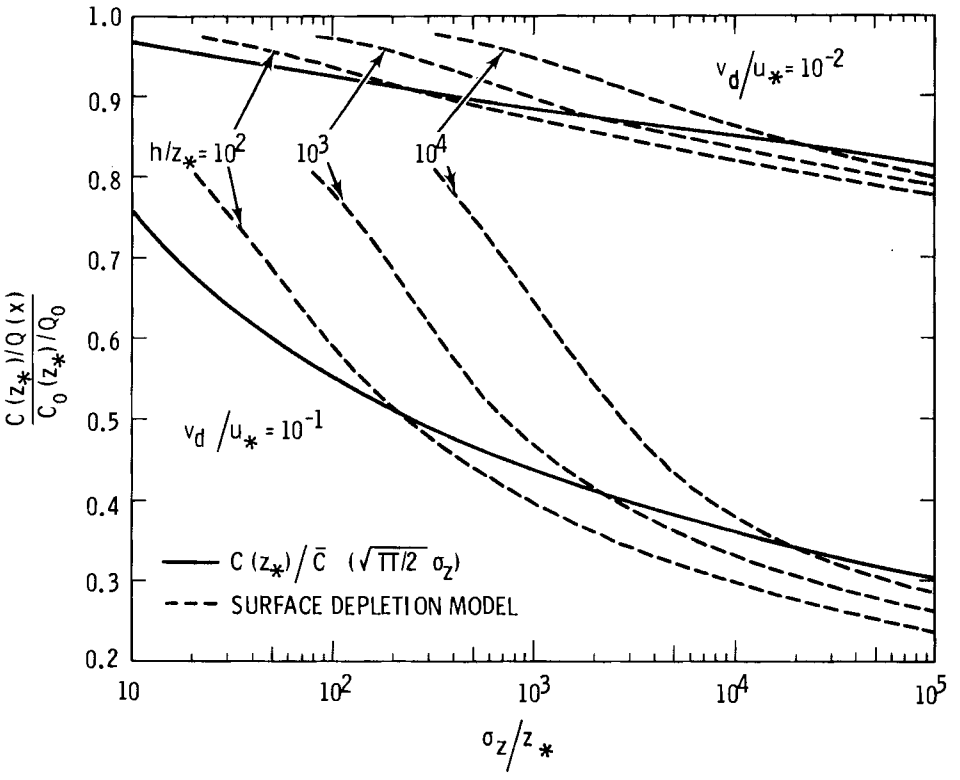

FIGURE 1.25. A Comparison of Normalized Ground-Level Concentrations Predicted by the Corrected Source-Depletion Model and by the Surface-Depletion Model

STUDIES OF MATERIALS FOUND IN PRODUCTS AND WASTES FROM COAL-CONVERSION PROCESSES

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Researchers at Pacific Northwest Laboratory (PNL) have been investigating materials from synthetic fossil-fuel processes. During this past year, solids from the Lignite Gasification Pilot Plant and samples from the Solvent Refined Coal Pilot Plant (SRC-II mode) have been analyzed for organic and inorganic constituents. Observations on these samples are summarized.

The objectives of this program are to identify and to 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 materials from a coal gasification and a coal liquefaction plant have been completed during this year, and some findings are summarized below.

Lignite Gasification (CO_2 Acceptor) Process

Before the Lignite Gasification Pilot Plant was shut down in September 1977, PNL obtained some samples of feed coal, gasifier and regenerator fines, and spent limestone acceptor for research purposes. These samples were analyzed using instrumental neutron activation analysis (INAA) and

x-ray fluorescence (XRF) for many major and minor elements. The results of these analyses are shown in Table 1.12. Some of the more volatile elements, such as arsenic and bromine, tend to partition onto the fines. Because the coal ash tends to accumulate on the acceptor, many elements found on the spent acceptor came from the coal. The gasifier fines indicated that the coal ash and the measured concentrations were higher in many elements than in the acceptor. The regenerator fines found during recalcining the acceptor were also high in most elements.

Solvent Refined Coal Process

During this year, the Solvent Refined Coal Pilot Plant at Fort Lewis, Washington, completed a series of runs in the SRC-II mode. This mode of operation produces a low-sulfur fuel oil. During one of their mass balance runs, samples of feed coal, product distillates, solid wastes, effluent water, and offgases before flaring were collected.

TABLE 1.12. Inorganic Element Concentrations in Solid Samples from Coal Gasification Process, in ppm by Weight Except as Noted.

	Feed Coal		Gasifier Fines		Lime (Spent Acceptor)		Regenerator Fines	
Element	INAA	XRF	INAA	XRF	INAA	XRF	INAA	XRF
Na	0.40% ± 0.01		0.24% ± 0.01		640 ± 30		0.41% ± 0.1	
Si		5800 ± 1650		—		<1.4%		<2.7%
P		<1300		1.05% ± 0.19		3.4%		2.8%
S		0.60% ± 0.05		1.65% ± 0.14		9100 ± 1040		3.7%
Cl		<160		<380		<500		1000 ± 400
K		55 ± 15		470 ± 60		<300		3500 ± 300
Ca		1.61% ± 0.10		12.7% ± 0.9		47%		35.9% ± 24
Ti		550 ± 40		2590 ± 180		1200 ± 90		4300 ± 280
V				100 ± 30				114 ± 25
Cr	9.5 ± 0.2		32 ± 1	28 ± 2	28 ± 7		82 ± 5	85 ± 10
Mn		31 ± 1		170 ± 13		202 ± 15		180 ± 17
Fe	0.27% ± 0.01	0.290% ± 0.020	2.07% ± 0.05	228% ± 0.14	1.15 ± 0.01	1.337% ± 0.09	1.67 ± 0.2	1.8% ± 0.1
Co	1.4 ± 0.1		9.6 ± 0.2		4.2 ± 0.1		24.8 ± 0.4	
Ni	4.9 ± 0.6	5.7 ± 0.5	42 ± 5	44 ± 3	53 ± 8	60 ± 5	68 ± 8	67 ± 6
Cu		7.8 ± 0.3		67 ± 5		50 ± 4		69 ± 7
Zn		5.7 ± 0.3		38 ± 3		59 ± 4		58 ± 4
As	1.2 ± 0.1	1.3 ± 0.1	22.5 ± 0.5	8.6 ± 1.4	4.6 ± 0.1	5.2 ± 0.8	8.3 ± 0.3	7.6 ± 0.7
Se		1.91 ± 0.06		3.0 ± 0.4		2.8 ± 0.6		13.5 ± 1.1
Br	1.09 ± 0.08	1.0 ± 0.1	5.7 ± 0.3	4.8 ± 0.5	3.1 ± 0.1	2.4 ± 0.5	27.1 ± 0.4	28 ± 2
Rb	<2	1.3 ± 2	5.1 ± 1.0	5.7 ± 0.6		3.4 ± 0.7		17 ± 1
Sr		296 ± 5		940 ± 60		840 ± 40		1540 ± 70
Sb	0.26 ± 0.04		1.8 ± 0.3		0.32 ± 0.06		0.88 ± 0.15	
Ba	320 ± 40		1080 ± 120		300 ± 40		1350 ± 110	
La	24.8 ± 0.2		18.8 ± 0.2		9.2 ± 0.2	24.8 ± 0.3		
Hf	5.2 ± 0.3		2.2 ± 0.1		0.68 ± 0.04			2.6 ± 0.1
Pb		3.1 ± 0.2		8.6 ± 1.4		<3.8		27 ± 2
Th	1.5 ± 0.1		6.9 ± 0.1		3.2 ± 0.1		9.8 ± 0.2	
U	4.4 ± 0.4		2.6 ± 0.3		2.8 ± 0.2		4.4 ± 0.4	

The distillates were analyzed for selected polynuclear aromatic hydrocarbons (PAH). These gas chromatograph/mass spectrometry analyses were performed using argon chemical ionization in selected ion mode with a nematic crystal column. The concentrations of the PAH compounds found in the samples are listed in Table 1.13. The data were obtained from just one set of samples and may not necessarily reflect values that may occur under different process conditions. The observed concentrations were dependent on the boiling ranges of the distillate cuts and were found to be highest in the heavy distillate (boiling range 288°-454°C).

TABLE 1.13. Concentration of Selected PAH Compounds in Distillates from SRC-II Process, in ppm by Weight.

	Chrysene	Perylene	Benzo(e)pyrene	Benzo(a)pyrene
Light Distillate	0.2	—	—	0.028
Middle Distillate	3.0	—	2.3	1.0
Heavy Distillate	326	12	356	115

Mercury measurements were made in the offgas stream from the SRC-II process and are shown in Table 1.14. Because of uncertainties in the volume of gas in this process, we were unable to determine whether or not all of the mercury could be accounted for in this stream. The mecury was apparently removed by the sulfur recovery unit at the plant, as no mercury could be detected downstream from this unit or in the sulfur. The scrubber solution was found to contain considerable concentrations of mercury. Several arsenic species were also measured in the offgas stream.

TABLE 1.14. Mercury in Gas Samples from SRC-II Process.

	Total Mercury Concentration
Untreated Process Gas	20 ng/ℓ
Scrubbed Process Gas	<0.4 ng/ℓ
Scrubber Solution	2600 ng/ℓ

Some collected data are shown in Table 1.15. This table shows major and trace element data for samples of feed coal, mineral residue, product solids and liquids, process liquids, particulates, and effluent gases taken from the coal liquefaction plant. Figure 1.26 shows mass balances for six elements in the solid product mode. The balances are only approximate since operating parameters are varied from run to run. Except for mercury, titanium, and bromine, most elements appear to remain with the mineral residue. In the case of bromine, approximately 84% remains with the product, whereas approximately 56% of titanium remains with the product. In the case of mercury, 89% is unaccounted for in the solid and liquid products and is presumably emitted in the process offgas.

These studies will continue at the SRC plant in both SRC-I (solid product) and SRC-II modes, and samples that can be compared with stored materials will be collected and analyzed. With these data, some projections can be made on the composition of possible effluents from the proposed SRC demonstration plant in West Virginia.