FY94-XV-51
MITIGATION OF AIR TOXICS
FROM LIGNITE GENERATION FACILITIES

CONTRACTOR: Energy & Environmental Research Center

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PARTICIPANTS

Sponsor	Cost Share
United States Environmental Protection Agency	$180,076
Electric Power Research Institute	20,000
Montana-Dakota Utilities	20,000
Minnesota Power	20,000
Basin Electric Power Cooperative	20,000
Cooperative Power Association	20,000
ND Industrial Commission	99,924
Total	$380,000

Project Schedule - 1 Year
Contract Date - 1/28/94
Start Date - 1/28/94
Completion Date - 4/30/95

Project Deliverables
Status Report - 5/15/94 ✓
Status Report - 8/15/94 ✓
Final Report - 10/31/95 ✓

OBJECTIVE / STATEMENT OF WORK

The objectives of this project are: 1) to determine the trace element concentrations of six lignite coals, and 2) to propose and test the most promising trace element mitigation methods. Coal from active Fort Union lignite mines will be analyzed for trace elements. Coal samples from the following mines will be analyzed: Beulah, Savage, Gascoyne, Center, Freedom and Falkirk. The following elements will be determined: antimony (Sb), arsenic (As), beryllium (Be), cadmium (Cd), chromium (Cr), cobalt (Co), lead (Pb), manganese (Mn), mercury (Hg), nickel (Ni) and selenium (Se). In addition, fluorine (F) and chlorine (Cl) contents will be determined. Small-scale combustion testing will be done with three selected precombustion sorbents. Pilot-scale combustion testing (75 lbs./hr of lignite - 550,000 Btu/hr) will be done, evaluating the most promising precombustion, post-combustion and gas-conditioning agents.

STATUS

Coal was obtained from six lignite mines. Representative samples from the six lignite sources were prepared and analyzed. Proximate, elemental ash, trace elemental ash and Computer-controlled Scanning Electron Microscopy (CCSEM) analytical results of the six samples are summarized in the following table.

Property	Units	Beulah	Falkirk	Freedom	Center	Gascoyne	Savage
PROXIMATE ANALYSIS (As-Received Basis)							
Moisture	wt.%	30.60	29.50	26.80	29.90	34.40	28.90
Ash	"	8.78	11.69	8.20	14.55	8.66	7.50
Sulfur	"	1.28	0.75	0.69	1.53	0.57	1.25
Volatile Matter	"	31.10	30.89	32.52	29.63	30.26	31.82
Fixed Carbon	"	29.52	27.89	32.48	25.93	26.67	31.78
Heat Content	Btu/lb	7327	7024	7810	6833	6907	7493
ELEMENTAL ASH (SO_3 Free Basis)							
SiO_2	wt. %	36.64	48.16	42.02	47.96	36.36	28.87
Al_2O_3	"	15.91	14.96	15.29	15.34	12.79	16.75
Fe_2O_3	"	10.4	5.22	7.99	13.56	6.23	5.30
TiO_2	"	0.5	0.57	0.41	0.52	0.89	0.49
P_2O_5	"	1.09	0.22	0.65	0.17	0.61	0.92
CaO	"	18.48	18.05	19.34	9.91	23.62	28.34
MgO	"	8.8	10.38	6.7	6.78	14.77	18.41
Na_2O	"	7.39	0.79	7.28	3.69	4.25	0.48
K_2O	"	0.79	1.64	0.33	2.07	0.49	0.43
TRACE ELEMENTAL ANALYSIS (Dry Basis)							
As	ug/g	10.17	6.26	4.02	18.93	1.73	2.39
Cd	"	0.04	0.09	0.04	0.08	0.05	0.05
Cr	"	12.02	26.18	11.94	21.32	11.07	6.59
Pb	"	0.80	1.39	0.48	1.04	0.51	0.85
Ni	"	12.71	38.60	14.54	24.48	19.02	10.57
Hg	"	0.13	0.06	0.07	0.12	0.23	0.06
Se	"	1.27	0.99	0.60	1.09	1.07	1.09
Sb	"	<0.2	0.53	<0.2	1.25	<0.2	<0.2
Be	"	0.54	0.58	0.35	1.19	0.28	0.39
Co	"	3.12	15.20	3.36	9.25	3.92	2.81
Mn	"	56.51	100.61	57.31	55.15	117.57	77.72
F	"	<25	<25	<25	<25	<25	<25
Cl	"	<25	46	<25	101	114	<25

Property	Units	Beulah	Falkirk	Freedom	Center	Gascoyne	Savage
CCSEM (Mineral Basis)							
Quartz	wt.%	15.7	22.6	23.1	10.3	31.3	19.4
Iron Oxide	"	2.6	0.5	0.4	0.4	0.2	0.3
Rutile	"	0.4	0.2	0.3	0.4	2.1	0.5
Calcite	"	0.2	0.5	0.7	0.1	0.2	0.2
Dolomite	"	0.1	0.5	0.1	0.1	0.1	0.0
Kaolinite	"	7.1	2.9	10.2	1.4	17.3	31.0
Montmorillonite	"	4.9	2.6	4.4	1.8	1.8	1.9
K Al-Silicate	"	11.0	27.0	16.9	24.4	7.3	5.7
Fe Al-Silicate	"	0.8	2.1	2.5	3.9	0.0	0.3
Ca Al-Silicate	"	0.9	0.9	1.2	0.7	2.0	0.4
Aluminosilicate	"	6.1	3.1	3.5	2.7	0.4	0.6
Mixed Al-Silica	"	0.1	0.7	0.4	1.3	0.6	0.7
Pyrite	"	30.2	5.7	14.0	17.9	16.3	23.0
Pyrrhotite	"	0.0	0.0	0.0	0.7	0.1	0.3
Oxidized Pyrhotite	"	0.0	0.0	0.0	0.7	0.0	0.5
Barite	"	4.1	2.2	2.4	1.0	3.8	8.1
Ca Al-P	"	0.8	0.1	1.3	0.1	3.3	0.9
Gypsum/Barite	"	0.2	0.1	0.4	0.0	0.0	0.7
Gypsum/Al-Silicate	"	0.0	0.0	0.4	0.1	1.0	0.1
Si-Rich	"	6.7	17.6	8.2	17.5	3.4	2.4
Unknown	"	7.8	10.6	9.1	14.2	8.4	2.2

The Beulah, Falkirk and Freedom mine coals were selected for pilot-scale combustion testing. Lime was evaluated as a precombustion sorbent, lignite activated carbon (LAC) as a post-combustion sorbent and SO_3 as a gas-conditioning agent in the pilot-scale combustion tests. The pilot-scale testing was done in a 550,000 Btu/hr pulverized coal-fired furnace equipped with a baghouse.

Key results from the pilot-scale tests:

- Of the sorbents tested, the injection of LAC was the most successful at reducing mercury emissions, at injection rates of approximately 5000-6000 g-LAC/g-mercury. Additional testing is required to determine optimum rates.
- The Falkirk fly ash captured nearly 97% of Hg in the coal. It appears that the Falkirk fly ash tends to capture or incorporate the vapor-phase Hg in the pilot-scale furnace/baghouse system.
- The solid phase trace elements, mainly As, Ni, and Pb, were captured relatively well by the baghouse and use of a sorbent did not significantly improve their capture.
- Use of the precombustion lime additive was effective at reducing SO_2 emissions.
- The use of sorbents did not appear to have any noticeable impact on Cl and F emissions.
- The residues (ashes) tested from all runs were determined not to be hazardous based on RCRA definition. Based on bulk ash and leacheate characterization results, no additional disposal requirements would be anticipated beyond those already required at a given utility disposal site.