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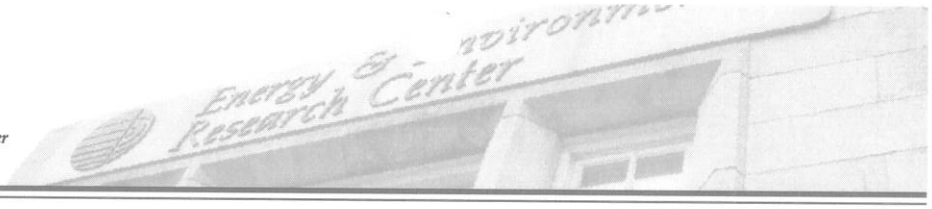

FEASIBILITY OF HYDROTHERMAL DEWATERING FOR THE POTENTIAL TO REDUCE CO_2 EMISSIONS AND UPGRADE LOW RANK COALS

Final Report

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FEASIBILITY OF HYDROTHERMAL DEWATERING FOR THE POTENTIAL TO REDUCE CO_2 EMISSIONS AND UPGRADE LOW-RANK COALS

EXECUTIVE SUMMARY

The feasibility of implementing a hot-water-drying (HWD) process for the cobenefit of low-rank coal (LRC) drying/upgrading and CO_2 reduction was evaluated. A material balance and an economic analysis were performed using information obtained in the literature and bench-scale HWD experiments performed at the Energy & Environmental Research Center (EERC). Two Powder River Basin subbituminous coals from the Antelope and Buckskin Mines in Wyoming and two lignite coals from the San Miguel and Falkirk Mines in Texas and North Dakota, respectively, were hot-water-dried in a bench-scale (7.6-L) autoclave. To simulate the centrifugation, filtration, hydroclones, and/or flashing methods that are used in commercial- and pilot-scale HWD systems to remove excess water from HWD coal slurries, the bench-scale hot-water-dried coal slurries were air-dried as described in ASTM Method D 2013, and the proximate, ultimate, and heating value results were reported on an as-determined basis and compared to the untreated coal analysis results on an as-received basis.

Summarized in Table ES-1 are the removal efficiencies of moisture, Hg, Cl, O_2, and Na_2O and improvements in heating values resulting from the HWD of Antelope, Buckskin, San Miguel, and Falkirk LRCs. HWD was effective in removing moisture and increasing the heating value of the four coals. An economic analysis, however, indicates that using HWD for reducing CO_2 emissions from coal is not economically viable given historical carbon credit prices in Europe. If carbon credit prices were to rise and consistently stay in the $100 to $200 range, then HWD would be a viable technology for CO_2 emission reductions. HWD was also effective in removing Hg, O_2, and Na_2O from most of the coals except the San Miguel coal. Cl was effectively removed from the Antelope coal by HWD. Although not reported, it is anticipated based on the water solubility of chloride minerals that HWD would also be effective in removing Cl from the other coals.

Trace element screening analyses (Ni, Al, Be, Ba, Ca, Cd, Cr, Cu, Fe, K, Mg, Mn, Na, Si, V, Zn, As, Ti, Zn, Co, and Pb) of process waters from the HWD of Antelope and San Miguel coals indicated that only Ca and Na were present in significant concentrations ($\geq$400 ppm). None of the heavy metals regulated under the Resource Conservation Recovery Act exceeded the

Table ES-1. HWD Removal Efficiencies and Heating Value Improvements, %

	Antelope	Buckskin[1]	San Miguel	Falkirk
Moisture	30	65	86	64
Heating Value	127	20	45	33
Hg	79	42	2	37
Cl	64	UA[2]	UA	UA
O_2	22	14	2	27
Na_2O	26	>86	<1	61

[1] Average of two HWD treatments.
[2] Unavailable.

concentration limits established by the U.S. Environmental Protection Agency. As indicated in Table ES-2, the gaseous products from the HWD of coals were predominantly CO_2, O_2, N_2, CH_4, and CO. The San Miguel coal also evolved significant amounts of H_2 and H_2S during HWD.

Table ES-2. Composition of Gaseous Products from HWD Coals, Mole %

Gaseous Component	Antelope	Buckskin	San Miguel	Falkirk
Hydrogen	0.66	0.58	0.89	0.38
Carbon Dioxide	90.6	86.0	74.1	91.7
Propane	0.10	0.11	0.12	0.05
Propylene	0.12	0.09	0.08	0.06
Isobutane	0.01	<0.01	<0.01	<0.01
N-butane	0.01	0.01	0.01	<0.01
Hydrogen Sulfide	<0.01	0.71	16.5	0.29
1-Butene	0.01	<0.01	<0.01	0.01
Isobutylene	0.02	0.04	0.06	0.02
t-2-Butene	0.01	0.01	0.02	<0.01
Ethylene	0.15	0.13	0.11	0.06
Ethane	0.16	0.18	0.18	0.05
Oxygen	0.71	1.94	1.15	1.24
Nitrogen	2.90	6.65	3.69	3.96
Methane	1.26	1.39	1.71	0.68
Carbon Monoxide	3.29	2.18	1.40	1.53
Total	100.01	99.98	100.00	100.05