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Project Summary

Application of Oil Agglomeration For Effluent Control from Coal Cleaning Plants

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This study shows the potential applicability of oil agglomeration for the control of black water effluents from coal cleaning plants processing four different coals. Removal and recovery of the coal from each of the black waters produced aqueous suspensions of mineral matter that settled more rapidly than the original black water. The sediment recovered from agglomeration appears to be less prone to acid generation during aeration than the total black water sediment.

The ash and sulfur content of the coal recovered by agglomeration is less than that of the cleaned coal. The quality of the recovered coal can be improved by chemical treatment of the sediment before agglomeration. Sodium sulfide appears to be one of the better agents to use because of the simplicity of the treatment process. Such pretreatment of the sediment can reduce the pyrites by up to 50 percent in the recovered coal over that without pretreatment. Even greater reductions in pyrite and ash are realized after pretreatment when the amount of oil used for agglomeration is reduced from 10 to about 2 percent and a two-stage air-float separation is used to recover the agglomerated coal.

The cost of the oil-agglomeration recovery of fine coal from coal preparation effluent streams would approximate $18 to $22 per ton* of coal recovered, assuming an oil price of $0.90 per gal.*

This Project Summary was developed by EPA's Air and Energy Engineering Research Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

Physical coal cleaning (PCC) processes have been used worldwide to upgrade coal quality, usually by elaborate systems to produce sulfur-free metallurgical coals and more simple systems to remove ash-forming minerals from coals used for boiler fuels. Coal cleaning processes usually treat three size ranges of coals—coarse (3 × 3/8-in.*), fine (3/8-in. × 28 mesh), and ultrafine (28 mesh × 0)—in individual circuits suited to maximize Btu recovery and the rejection of mineral matter and pyritic sulfur. Coal contaminated rejects are found in the waste streams from the fine and ultrafine coal circuits which, when combined with other wastewater discharged from the coal cleaning plant, make up a major portion of the wastewater from the process. As a result of stream pollution control and the desire of the coal industry to improve fine coal recovery, recirculation and treatment of process water is incorporated into modern coal cleaning plants.

This study was initiated to determine the applicability of oil agglomeration for effluent and solid waste control from physical coal cleaning processes. The technique has the potential of recovering coal from rejects and producing a solid waste stream made up of finely divided mineral matter free of any significant coal values. In addition, if the liberated pyritic sulfur from the coal can be separated during effluent treatment, the recovered coal quality might be significantly improved. This program also included a study of achieving greater removal of the liberated pyrite in ultrafine

(*)1 ton = 907.2 kg; 1 gal. = 3.785 ℓ.

(*) 1 in. = 2.54 cm.

and fine rejects, than possible under conventional oil agglomeration.

Background

Water immiscible liquids, usually hydrocarbons, have been used to separate coal from associated mineral matter. The two phases are separated after agglomeration or coalescence occurs and produces agglomerates of clean coal wetted by the oil and an aqueous suspension of the mineral matter nearly free of combustible material. Hydrocarbon fluids such as kerosene and fuel oils are very effective in separating the mineral matter from finely divided coal suspended in an aqueous slurry (thus reducing ash). The selective agglomeration process is also attractive because, after wet face mining, wet size reduction, and conventional coal preparation, the coal does not have to be dried because the agglomerated coal can be readily dewatered mechanically. Therefore, use of oil for agglomeration provides energy trade-offs between oil used to dewater coal and fuel used for drying coal.

A major limitation of oil agglomeration is separation of the liberated pyrite from coal. The separation is poor because the surface properties of pyrites are similar to those of coal and in some coals pyritic sulfur is uniformly disseminated in the coal in the size range of 0.5 to 20 μm. Extensive size reduction to liberate pyrites prior to oil agglomeration has had only limited success.

To keep the pyrites from accumulating in the oil phase, their surface properties must be altered to make them hydrophilic so that they will accumulate in the aqueous phase. The common pyrite depressant reagents developed for metallurgical froth flotation separations were only partially successful in altering their surface properties and enhancing pyrite removal. Using Iowa coals, chemically pretreating pulverized coal to oxidize the surface of the pyrite (to render it hydrophilic) was more effective than applying pyrite depressants. The most effective treatment sequence involved chemical comminution, float and sink separations at a specific gravity of 1.6, grinding of the float fraction, and recovery of the fine-size coal by agglomeration.

Earlier EPA-sponsored studies showed that coal recoveries of 90 percent or more are attainable from fine coal slurry wastes using oil agglomeration. These high levels of recovery are attainable from fresh black water sediments generated during coal cleaning; aged sediments accumulated in slurry ponds; and excavated, weathered, and partially dried slurry pond sediments. The coal was of good quality and had lower ash and sulfur content than the cleaned coal shipped from the mine.

These results, albeit for only one coal type, suggest that oil agglomeration may be further developed as a method to control effluents from coal cleaning plants. The current program was undertaken to assess the applicability of the technique to a wider range of coals and coal cleaning wastes.

Specific objectives of the work performed in this program were to:

1. Explore pretreatment methods of making the pyrite particles in black water hydrophilic.
2. Perform pretreatment and oil agglomeration to determine the pyrite rejection and coal recovery from coal cleaning plant black water.
3. Assess the performance of oil agglomeration as an alternative for effluent control from coal cleaning plants and make recommendations for further study.

Experimental Materials and Procedures

Sample Acquisition and Handling

Two sets of samples used in this study were acquired at the Breckenridge coal cleaning plant near Morganfield, Union County, KY (Kentucky No. 9 seam) and the AMAX Delta coal cleaning plant in Williamson County, IL (Illinois No. 6 seam). The third sample set, from McDowell County, WV (Pocahontas No. 3 and 4 seams), was selected because of its low sulfur content compared to the two other samples. A fourth set of samples from Belmont County, OH (Pittsburgh No. 8 seam), acquired during a previous EPA study, was used early in the program for performing experiments, until the Kentucky No. 9 sample was supplied.

Test Procedures

The oil agglomeration procedure used was found to be less subject to variations in technique than previous procedures. It incorporated an air-float separation of the agglomerated coal from the aqueous suspension of the mineral matter and a resuspension of the separated coal in clean water followed by a second air-float step. To ensure at least 90 percent recovery of a coal with an ash content lower than for the shipped clean coal, an unweathered black water sediment had to be used.

Several modifications of the procedure were studied. For example, the effect of pH was examined by adding sulfuric acid or sodium hydroxide. The pH measured before adding oil was taken as the pH of the agglomeration. The sediment was pretreated chemically at the desired agglomeration slurry concentration (usually 10 or 15 percent), before adding the oil used in the agglomeration.

Potential pretreatment techniques were screened using finely divided pyrites (minus 100 mesh) prepared by grinding coarse pyrite specimens selected from the coarse refuse gathered at the site along with the coal and slurry samples. The pretreatment screening tests were designed to determine if the treated pyrite remained in the water phase after shaking with oil. Treatment was either with known pyrite depressing agents, oxidizing agents, or exposure to microwave energy.

To determine the effects of selected process variations of oil agglomeration or the effects of chemical pretreatment of the sediment on the quality of coal recovered, a point of reference had to be established for each sediment used in this study. To do this, the results of the oil agglomeration of a slurry using a 10 percent oil concentration (based on the solids weight) following the standard oil-agglomeration/air-float procedure were considered to be baseline results with which comparisons could be made. Coal recovery, one evaluation criterion, is calculated using:

$$\text{Percentage Coal Recovery} = \left[\frac{(100 - \%\ \text{Ash})_{product} \times (\%\ \text{of Feed})_{product}}{(100 - \%\ \text{Ash})_{feed}}\right] \times 100$$

The product is the recovered coal, while the feed is the solids content of the sediment; the recovered coal product is given as the percentage of solids in the feed slurry.

Another aspect of the study which needed baseline data was the reduction of the pyrites on a moisture- and ash-free basis that occurs during the standard agglomeration/air-float treatment. This was necessary to determine the effect that pretreatment of the sediment or changes in the agglomeration conditions had on the pyrites remaining in the recovered coal. The percentage reduction in the pyritic sulfur was determined using:

$$\text{Percentage Reduction in Pyritic Sulfur} = \left[\frac{\begin{pmatrix}\%\ S_{pyr}\ \text{without}\\ \text{Pretreatment}\end{pmatrix}_{coal} - \begin{pmatrix}\%\ S_{pyr}\ \text{with}\\ \text{Treatment}\end{pmatrix}_{coal}}{(\%\ S_{pyr}\ \text{without Pretreatment})_{coal}}\right] \times 100$$

To estimate the amount of pyritic sulfur reduction during the standard agglomeration/air-float procedure (i.e., the difference between the pyritic sulfur in the sediment and that in the recovered coal), the same equation was used substituting the percent S_{pyr} in the sediment for the untreated coal and the percent S_{pyr} in the recovered coal both on a moisture- and ash-free basis.

Summary of Results

Each black water sediment sample set was characterized and tested using oil agglomeration or pretreatment/oil agglomeration. Results are described below for each sample set.

Morganfield (KY) Sediments

Table 1 compares the sulfur and ash values of coal recovered by agglomeration after pretreatment with other samples of coal received from the Morganfield, KY, coal cleaning plant. These data show that:

1. There is only a modest reduction in sulfur, but a significant reduction in ash during the coal cleaning.
2. The coal recovered from black water by standard agglomeration is lower in ash than the cleaned coal shipped from the plant, but no reduction in pyrite occurs, suggesting that any liberated pyrite was isolated with the recovered coal.
3. The coal recovered after pretreatment is significantly lower in ash and pyritic (and total) sulfur, suggesting that liberated pyritic sulfur is not recovered with the coal.

Table 1. *Analysis of Coal Samples from Morganfield, KY, Coal Cleaning Plant Compared with Coals Recovered by Agglomeration (Samples Obtained October 24, 1979)*

	Percent		
	Ash (MF)[a]	*S_{pyr} (MAF)*[a]	*S_{tot} (MAF)*
Run-of-Mine Coal	23.1	1.39	3.62[c]
TVA sample[b]	19.0	--	5.70
Cleaned Coal	11.2	1.50	6.24[(b)]
TVA sample	10.3	--	4.24
Black Water Sediment	45.6	2.88	4.39
Coal Recovered by Agglomeration			
No pretreatment	7.2	1.40	3.20
After pretreatment with sodium sulfide	5.2	0.86	2.60

(a) MF = moisture-free; MAF = moisture/ash-free.
(b) Values from an average of four samples received at TVA Cumberland steam plant.
(c) These values are in error due to poor sampling; the TVA values are more representative.

Table 2. *Analysis of Coal Samples from Williamson County, IL, Coal Cleaning Plant Compared with Coals Recovered by Agglomeration*

	Percent		
	Ash (MF)[a]	*S_{pyr} (MAF)*[a]	*S_{tot} (MAF)*
Run-of-Mine Coal	25.7	1.78	3.67
Cleaned Coal	11.7	1.26	2.55
Black Water Sediment	51.1	5.07	6.13
Coal Recovered by Agglomeration			
No pretreatment	10.4	2.32	3.72
After pretreatment with sodium sulfide	7.3	1.13	2.51

(a) MF = moisture-free; MAF = moisture/ash-free.

Williamson County (IL) Sediments

Table 2 compares the sulfur and ash values for the coal recovered by agglomeration, before and after pretreatment, with the other samples of the Illinois No. 6 coal. These data show that:

1. The coal can be cleaned to lower levels of ash and pyritic sulfur than can be attained in coal recovered by standard oil agglomeration of the black water sediment.
2. Liberated pyritic sulfur is agglomerated with the coal recovered from the black water.
3. The coal recovered after pretreatment has ash and pyritic sulfur values at least as low as those of the shipped clean coal.

Reduced oil experiments were also run to evaluate the effects of concentration on the quality of agglomerated coal. These experiments indicated that:

1. The amount of coal recovered per gram of kerosene was a maximum of about 19 g coal when only 2 percent kerosene concentration was used. The recovered coal had the lowest ash of those recovered by this technique.
2. As the amount of oil used for agglomeration of sediments treated with sodium sulfide was decreased (i.e., 4.4 percent or less compared to 10 percent), the amount of pyrite in the recovered coal decreased. In the absence of sodium sulfide treatment the results are equally dramatic, suggesting that for these sediments pretreatment may not be necessary to achieve good coal/pyrite separation.
3. Two air-float separations at the same kerosene level (3.4 percent) and pretreatment conditions give lower ash and pyritic sulfur in the recovered coal than a single air-float separation.

McDowell County (WV) Sediments

The sulfur and ash values for the coal recovered by agglomeration before and after treatment are compared with ROM and clean coal samples from McDowell

County, WV, in Table 3. These data indicate that:

1. The coal can be cleaned to very low levels of ash and pyritic sulfur. Coal recovered by standard agglomeration results in similar ash and sulfur levels.
2. The amount of liberated pyritic sulfur in the black water is small and, during standard agglomeration, is recovered with the coal.
3. The coal recovered after pretreatment or after two air-float collections is lower in ash and pyritic sulfur than the coal recovered by standard agglomeration. It appears to be of a similar quality as the shipped clean coal.

Reduced oil concentration and soybean oil tests on the West Virginia sediments produced the following results:

1. Use of 2.8 to 3.4 percent oil concentrations reduced the pyritic sulfur content in the recovered coal from that obtained during standard agglomeration. Soybean oil appeared to be better than kerosene.
2. Treatment with sodium sulfide had little effect on the pyrite level in the recovered coal; however, after treatment the ash values were significantly lowered from those without pretreatment.
3. The yields of coal per gram of oil used were greater at the lower oil concentrations; however, the coal recoveries were lower than when higher oil (kerosene) concentrations were used.
4. The coal recovered with the soybean oil did not have any of the undesirable dusty properties of the coal recovered using kerosene as the agglomerating oil.

Belmont County, OH, Sediments

The effect of pretreatment on the amount of pyritic sulfur in coal recovered from black water sediments from a coal cleaning plant in Belmont County, OH, was studied earlier. When the current program began, the only black water sediment readily available was the preserved sediment from Ohio. This material (the result of cleaning Pittsburgh No. 8 coal) and the aged and weathered sediments excavated from slurry pond sediments had been well characterized and were well suited not only to train technicians, but also to establish the conditions for the testing on other sediments.

Engineering Analysis of Oil Agglomeration Applied to Black Water Effluent Control

Two major goals of the engineering analysis were to present a conceptual design of a process scheme requiring relatively low energy inputs, and to perform a preliminary economic analysis on the selected system.

Process Design

A coal agglomeration processing scheme was developed as shown in Figure 1. Typical coal preparation operations generate fine waste coal at rates exceeding 50 tons/hr (TPH); the waste coal is usually discharged as a thickened sludge at a consistency of 30 to 36 percent total solids (TS). The coal recovery scheme of Figure 1 is sized for an input of 50 TPH of coal and mineral matter, received from the coal plant thickener as a 34.5 percent TS slurry. In this example it is assumed that the coal fraction comprises about 50 percent of the TS. Coal particles to be recovered will contain 4 to 6 percent of noncombustible components; however, the inherent ash content of the coal particle matrix is not considered a part of the mineral fraction in this discussion. Rather, the mineral fraction referred to here consists of discrete mineral particulates, including clays and sediment, formed in waste coal sludges.

Mass flows throughout the entire coal cleaning scheme, indicated in the diagram, are based on several assumptions:

- Suspended solids concentrations of coal/mineral matter slurries prepared in the influent rapid mix tank and in the resuspension rapid mix tanks are prepared as 10 percent TS solutions.
- About 100 ppm of soda ash/sodium sulfide is added to this influent rapid mix system for the pH-control/chemical-pretreatment necessary to enhance pyrite wetting and to enhance alum flocculation and sedimentation in the treatment of turbid recycle water.
- Oil introduced into the system (0.024 ton per ton solids processed) is rapidly attached to coal particles and is conserved through the system as a component of the recovered coal float.
- Coal recoveries are assumed to be 90 percent in the static flotation basin and 95 percent in the dissolved-air flotation (DAF) unit.
- About 10 percent of discrete mineral matter introduced into the static flotation basin and the DAF system is entrained in the coal float.
- The moisture of agglomerated coal skimmed from the static and dissolved-air flotation basins is 20 percent of the total weight.
- About 90 percent of the discrete mineral and coal particulate matter in the recycle stream can be removed with flocculation and sedimentation.
- Mineral and alum sludges generated by the process scheme can be deposited in existing storage pond facilities.

Economic Analysis

A detailed breakdown of equipment and construction costs of the 50 TPH oil-agglomeration process scheme was de-

Table 3. *Analysis of Coal Samples from McDowell County, WV, Coal Cleaning Plant Compared with Coals Recovered by Agglomeration*

	Percent		
	Ash (MF)[a]	S_{pyr} *(MAF)*[a]	S_{tot} *(MAF)*
Run-of-Mine Coal	*26.7*	*0.28*	*0.78*
Cleaned Coal	*6.04*	*0.10*	*0.64*
Black Water Sediment	*28.5*	*0.24*	*0.83*
Coal Recovered by Agglomeration			
No treatment, screen separation/ single air-float	*7.56*	*0.23*	*0.24*[b]
Air-float twice	*5.63*	*0.19*	*0.71*
After treatment with Na_2S*, screen separation/single air-float*	*5.94*	*0.21*	*0.75*

(a)MF = moisture-free; MAF = moisture/ash-free.
(b)Data questionable.

veloped. Many of the cost estimates used were obtained from EPA documents and chemical engineering literature; all of the costs include installation except for pumps and external piping. All capital costs were adjusted for inflation to July 1980. Total equipment costs were estimated at $1.1 million, more than half of which was expended for sedimentation basins ($319,000) and for the DAF unit ($255,900). Using the equipment cost total, the fixed capital costs for the oil-agglomeration scheme were calculated using standard cost estimating procedures. The total fixed capital cost was estimated at $3.7 million.

Operating and maintenance costs were also estimated for the 50 TPH coal agglomeration plant. These costs include operating labor, equipment repair and maintenance, chemicals, oil, and electricity. Electricity costs were based on detailed electric power estimates for the process scheme. It is significant that the highest operating cost of the oil-agglomeration process scheme is in oil purchases, amounting to almost $2 million (59 percent of the total annual operating cost).

The results of the economic analysis are shown in Table 4. The total processing cost of the final oil-coal agglomer-

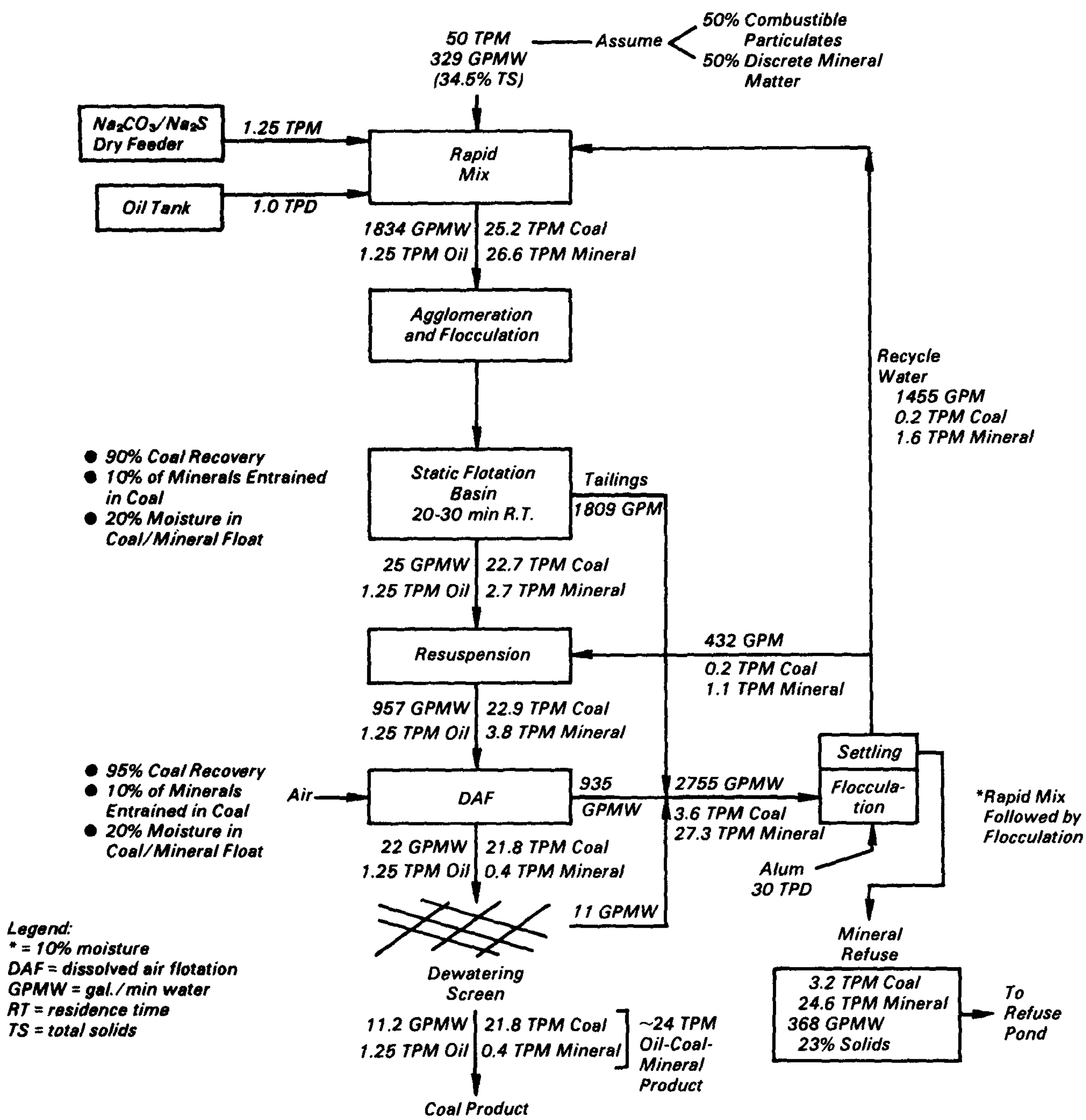

Figure 1. *Conceptual flow scheme of a 50 TPH oil-agglomeration waste coal recovery plant.*

ated product was calculated at $19.42 per ton. Assuming the agglomerated coal product has an energy value of 14,000 Btu per lb*, the per unit energy cost of product recovery is about $0.69 per 10^6 Btu ($0.73 per GJ).

As shown in Table 4, the largest single cost incurred over the life of the coal separation system is the oil demand. About 58 percent of the per ton cost of coal recovery is traceable to the large purchases of oil that would be required for agglomeration. Thus, the economics of this system are highly sensitive to the dosages of oil used. Therefore, a reexamination of the trade-offs between oil dosage rates and product recoveries is needed to determine the profitability of the system at various levels of oil expenditures. Such an optimization, however, may result in reducing coal recovery efficiencies for the sake of controlling oil costs. A more detailed study would be needed to determine the potential for system improvements to reduce oil demand and to optimize the operation of existing coal agglomeration systems.

(*)1 Btu = 1.055 kJ; 1 lb = 0.454 kg.

To further illustrate the relative importance of various parameters to the economics of oil-agglomeration coal recovery, a sensitivity analysis on each factor is presented in Table 5. A 25 percent increase in the cost of oil either through rising commodity prices or through increased dosages would increase the per unit coal recovery cost by more than 14 percent. In contrast, comparable increases in the costs of other chemicals, such as alum and soda ash, and in energy would result in less than a 1 percent increase in oil/coal production cost.

The second most influential parameter controlling waste coal recovery costs was operating labor and associated overhead. A 25 percent increase in this parameter would likely predispose an 8.0 percent increase in product cost.

To summarize, this preliminary analysis would indicate several fundamental observations that generally characterize oil-agglomeration economics. The first observation is that the total fixed capital cost is far outstripped by the lifetime operating cost (labor + chemicals + electricity + oil + tax + supplies, etc) by a ratio of more than 14:1. This rather large imbalance in the economics would suggest a great potential for cost improvement through further process research and development to reduce sensitive operating cost parameters, such as oil demand and labor requirements.

Table 4. *Summary of Results of the Economic Analysis of a 50 TPH Oil-Agglomeration Waste Coal Recovery Plant*

	Cost, $ (1980)
I. Fixed Capital Investment	$ 3,746,400
II. Total Payments on Loan (inflation adjusted)	4,473,800
III. Lifetime Operating Costs	
Labor and overhead	13,372,000
Supplies	964,000
Electricity	648,000
Chemicals	
Oil	38,880,000
Soda Ash/Na_2S	722,000
Alum	1,842,000
Tax	7,492,000
TOTAL OPERATING COST	$63,920,000
IV. Lifetime Depreciation Credit (inflation adjusted)	711,100
V. Total Coal Recovery Over Lifetime = 3,484,800 tons	
VI. Cost per Ton Product $\frac{(II + III - IV)}{(V)}$	$19.42

Conclusions

This study shows the potential applicability of oil agglomeration for the control of black water effluents from coal cleaning plants processing four different coals. Removal and recovery of the coal from each of the black waters produced aqueous suspensions of mineral matter that settled more rapidly than the original black water. The sediment recovered from agglomeration appears to be less prone to acid generation during aeration than the total black water sediment.

Table 5. *Sensitivity of the Cost of Oil Agglomeration Coal Recovery to Percentage Changes in Selected Parameters*

Parameter	Base Value[a]	% Change in Parameter	New Cost, $/ton Coal	% Change in Cost
Chemicals Cost				
Oil	$2.59/ton product[b]	+25	22.21	+14.4
Soda Ash/Na_2S	$0.048/ton product	+25	19.47	+0.3
Alum	$0.12/ton product	+25	19.55	+0.7
Capital Cost (Fixed)	$3.75 million	+25	19.69	+1.4
Operating Labor Overhead and Supplies	$1.09 million/yr	+25	20.99	+8.1
Energy Cost	$0.19/ton product	+25	19.47	+0.3
Days of Operation/yr	300	−25	20.59	+6.0

[a]Base cost of recovered coal = $19.42/ton.
[b]"Product" is the resulting oil/coal mixture produced by the process.

The ash and sulfur content of the coal recovered by agglomeration is less than that of the cleaned coal. The quality of the recovered coal can be improved by chemical treatment of the sediment before agglomeration. Sodium sulfide appears to be one of the better agents to use because of the simplicity of the treatment process. Such pretreatment of the sediment can reduce the pyrites by up to 50 percent in the recovered coal over that without pretreatment. Even greater reductions in pyrite and ash are realized after pretreatment when the amount of oil used for agglomeration is reduced from 10 to about 2 percent and a two-stage air-float separation is used to recover the agglomerated coal.

Findings in this study suggest the following environmental and conservation advantages of the modified agglomeration process for the separation of the coal from the mineral matter in black water effluents:

- The recovered coal is easily dewatered despite its fine size.
- Chemical treatment of sediments before agglomeration tends to reduce the pyrite content of the recovered coal.
- Black water from cleaning low sulfur coals that contain fine and uniformly dispersed pyrites is less responsive to pretreatment probably because the pyrites are not present as liberated particles.
- The quantity of oil used for agglomeration affects the amount of pyrites and ash recovered with coal. Smaller amounts favor lower pyrites and ash in the recovered coal as well as high yields of coal per unit weight of oil; however, total recoveries are diminished.
- Use of a vegetable oil for agglomeration gives coal yields and recoveries equally as good as kerosene over an oil concentration range of from 2 to 10 percent. The recovered coal is less dusty.

Problems inherent in recovering coal from aged and weathered black water sediments, and the very high recovery of coal from fresh black water, led to the conclusion that a process to control effluents from a coal cleaning plant should be designed to treat the discharge at the rate it is generated rather than to treat the sediments accumulated and weathered in ponds.

Engineering analysis results which considered unit processes that could be combined with oil agglomeration effectively and economically to treat black water discharges are:

- Oil agglomeration could be implemented using unit processes and equipment conventionally employed by municipal water and wastewater treatment plants and by the coal industry.
- The cost of the oil-agglomeration recovery of fine coal from coal preparation effluent streams would approximate $18 to $22 per ton of coal recovered, assuming an oil price of $0.90 per gal.

Recommendations

Continued development of oil agglomeration could lead to better control of effluents from coal cleaning plants and recovery of the energy value they contain, especially on samples of black water from processing plants in other regions and/or seams such as western coals.

An experimental program could establish process parameters and equipment needed to minimize the coal content in the coal cleaning plant effluent. This could be done on a scale suitable for developing detailed process flow sheets and refining preliminary cost estimations for add-on or replacement effluent control systems. The data base could be increased sufficiently to permit detailed evaluation as to whether the technique should be considered on a pilot plant scale for on-site studies.

Continued studies could also determine not only the fate of the sediments resulting from the oil agglomeration process but also the impact of successful chemical pretreatments on the pyrite loading of the sediments and their acid-generation potential.

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The complete report, entitled "Application of Oil Agglomeration for Effluent Control from Coal Cleaning Plants," (Order No. PB 86-119 567; Cost: $16.95, subject to change) will be available only from:
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