POC and Commercial Scale Testing of Oil Agglomeration Techniques and Equipment for Recovery and Cleanup of Organic Carbonaceous Materials from Various Waste Materials and Fine Coal Processing Streams Combined with Remediation of Contaminated Soils and Sludges

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1. ABSTRACT

This paper summarizes:

- The results of work on development of DOE/ARC sponsored project (Contract DE-AC22-95PC95152) on POC-testing of oil agglomeration techniques and equipment for recovery and cleanup of fine coal from fine coal processing streams.
- The progress on a commercial size demonstration project on aggregation of coking coal fines, using coal derived tar, for co-feeding to coke ovens.
- The progress on a commercial size demonstration project on recovery of organic carbonaceous materials from Manufactured Gas Plant (MGP) contaminated soils and cleanup of these soils.

2. INTRODUCTION

In 1993, the ARC responded to US DOE request for proposals on development of Proof-Of-Concept (POC)-scale equipment for fine coal processing. The terms and conditions included in DOE request required that:

- The technology should have a near term implementation status.
- The equipment for fine coal processing should be demonstrated at a commercial coal preparation plant in the United States.
- There should be large reserves of coal available for processing, using the new techniques/equipment, at a selected commercial coal preparation plant.

ARC proposal entitled "POC-Scale Testing of Oil Agglomeration Techniques and Equipment for Recovery and Cleaning of Fine Coal from Fine Coal Processing Streams" was selected and awarded under PETC/DOE Contract No. DE-AC22-95PC95152. Since the contract was suspended for one year and reactivated on May 1, 1997, very little work has been done during the last three months. The authors are, therefore taking the liberty to also describe the progress on two other related projects; one in the area of aggregation of coal fines [1] and the other on recovery of solid and liquid organic carbonaceous materials from contaminated soils and cleanup of soils [2].

3. WORK PROGRESS

3.1 POC-Scale Testing of Oil Agglomeration Techniques and Equipment for Recovery and Cleaning of Fine Coal from Fine Coal Processing Streams.

The project commenced in June 1995, and was suspended in June 1996, when two coal producers (first Cooney Bros. Coal Co., and, subsequently, PBS Coals, Inc.) made decisions not to proceed with the project due to obtaining long term large contracts that did not require cleaning the coal fines in order to meet specifications for blended product to be delivered to the clients. The results of work carried out by ARC on fine coal samples submitted by both companies identified above were presented during DOE Contractors' Review Conference held in Pittsburgh in September 1996.

In July 1996, ARC approached selected coal producers and, following a period of protracted negotiations, signed on February 13, 1997, a Host Site Facility Agreement with Drummond Company Ltd. of Alabama. On May 1, 1997, US DOE formally reactivated the project. By July 1997, a new project management plan, revised statement of work and cost plan were prepared and submitted to DOE for approval. On August 19, 1997, following DOE approval of the changes proposed by ARC, a modification to the existing contract was executed and the work commenced on laboratory evaluation of samples of coal fines submitted by Drummond Company Ltd. Four samples will be evaluated at ARC laboratories and one of them will be selected for POC-scale testing at Drummond's Shoal Creek preparation plant.

3.2 Aggregation of Coking Coal Fines for Co-Feeding to Coke Ovens.

Cretaceous prime coking coals, for which there is a great demand among Japanese steel makers, have superior coking propensities but, unfortunately, generate large amounts of fines on grinding, prior to charging into the coke ovens. Excessive amounts of fines in coke oven results in operational problems and under extreme conditions may lead to dust explosions during charging the coke oven. Consequently, the Japanese coke producers usually remove, by screening, the very fine fraction of coal from coke oven charges. Since the amount of removed fines can reach up to 30% of the whole coal prepared for charging, the problem of utilization of these fines becomes of primary importance.

In 1993, ARC licensed to MES the Aglofloat® technology for fine coal beneficiation and size enlargement. In 1995, MES constructed at Chiba Shipyard a 0.5 tph pilot plant based on Aglofloat® technology and placed a major emphasis on investigating in this plant various approaches to size enlargement of fine coal particles. Based on experience obtained during operation of this pilot plant combined with ARC experience in the area of fine coal processing, MES designed for their client a commercial size 84 tph plant for aggregation of very fine fractions of coal separated during preparation of coke oven charges. The block diagram of the 84 tph plant designed by MES is presented in Fig. 1. Dry, very fine fraction of coal separated from coke oven charges is directed to a paddle mixer and blended with preheated coal tar at elevated temperature. The coal tar used in the process originates from the coke ovens and is applied as a bridging liquid/binder. The coal/tar mixture exiting the paddle mixer is fed into a slurry tank where it is conditioned/homogenized in aqueous phase. The homogenized slurry is pumped to a horizontal Shell-type pelletizer that generates 1-4 mm diameter agglomerates, which are separated from water phase by screening and dewatered by centrifugation.

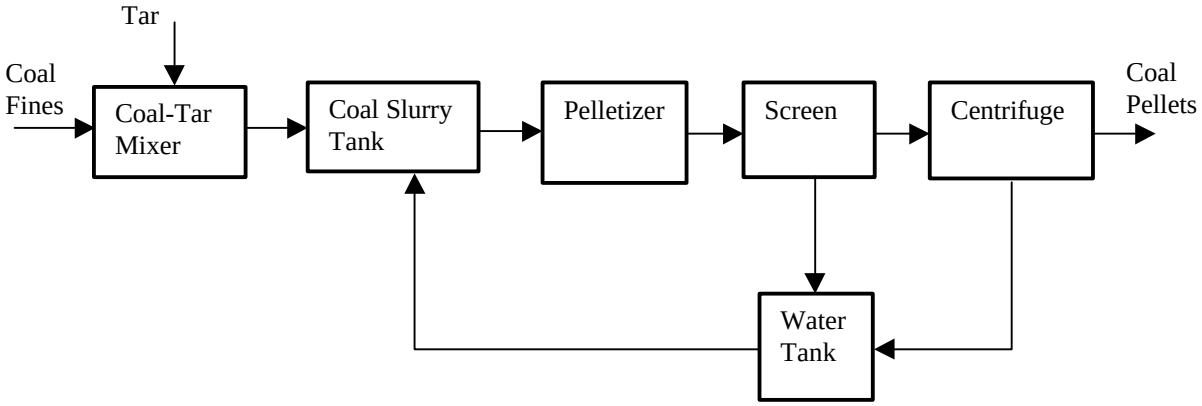

Figure 1. Block diagram of the 84 tph coal fines aggregation plant.

The construction of the coal fines aggregation plant described above was completed in 1996/97 and the commissioning of the plant is underway.
Figures 2 and 3 show the 0.5 tph Chiba Shipyard pilot plant and the 84 tph MES commercial plant.

The aggregation plant utilizes two major byproducts generated by coke ovens industry, namely coal fines and coal tar and converts them into a feedstock that can be successfully used for coke making.

Figure 2. Chiba 0.5 tph pilot plant.

Figure 3. MES 84 tph plant for coal fines aggregation.

3.3 Recovery of Organic Carbonaceous Materials from MGP Contaminated Soils and Cleanup of these Soils.

The MGP soils present a very complex, heterogeneous mixture of soils with solid and liquid byproducts generated by coke and gas manufacturing industries that were thriving in all industrialized countries in the world from the mid 1800s until late 1950s. Some of these plants, particularly the coke producing plants are still in operation and continue to contribute to major contamination of our environment.

Apart from coal derived tars (the major source of carcinogenic polycyclic aromatic hydrocarbons), various complexed cyanides, BTEX's and some heavy metals, MGP soils contain also significant quantity (2-35%) of solid combustible material like coke, char, coal etc.

The Clean Soil Process (CSP) is a technology developed jointly by ARC, EPRI, US DOE and other sponsors and designed primarily for processing MGP soils. The CSP is based on agitating the hot aqueous slurry of MGP soil and powderized coal that results in near quantitative adsorption of the tar on coal particles, oxidation of cyanides to environmentally benign compounds and separation of heavy metals and BTEX's. Tar coated coal particles can be readily separated from clean soil and combusted in a coal-fired power plants. The clean soil can be returned to the original site as an environmentally acceptable non-hazardous fill. In this context the CSP technology can be regarded as a soil remediation technology and also, as a process for recovery of energy from contaminated sites containing a variety of solid and liquid combustible materials.
It is noteworthy that significant quantities of coke, usually present in MGP soils, can be utilized as a result of CSP processing for soil cleaning so, the amount of coal from outside sources required for processing can be substantially reduced.

The CSP technology was developed to a 0.3 tph pilot plant stage at ARC facilities and in 1993, it was licensed to Thermo Design Engineering Ltd. (TDE). In 1994/95 TDE designed and constructed first commercial size 10 tph plant for processing MGP and other soils containing heavy organic contaminants.
The block diagram of the 10 tph commercial size demonstration plant is presented in Fig. 4 and the view of the plant is shown in Fig. 5.

In the second half of 1995 and in 1996 the 10 tph plant was extensively tested with various soils contaminated with coal tars, coal-derived pitches or heavy oil/bitumen [3]. The plant performed very well and the results showed that the effectiveness of soil cleanup exceeded the expectations based on pilot plant testing. The results also confirmed low processing costs for the soils tested.

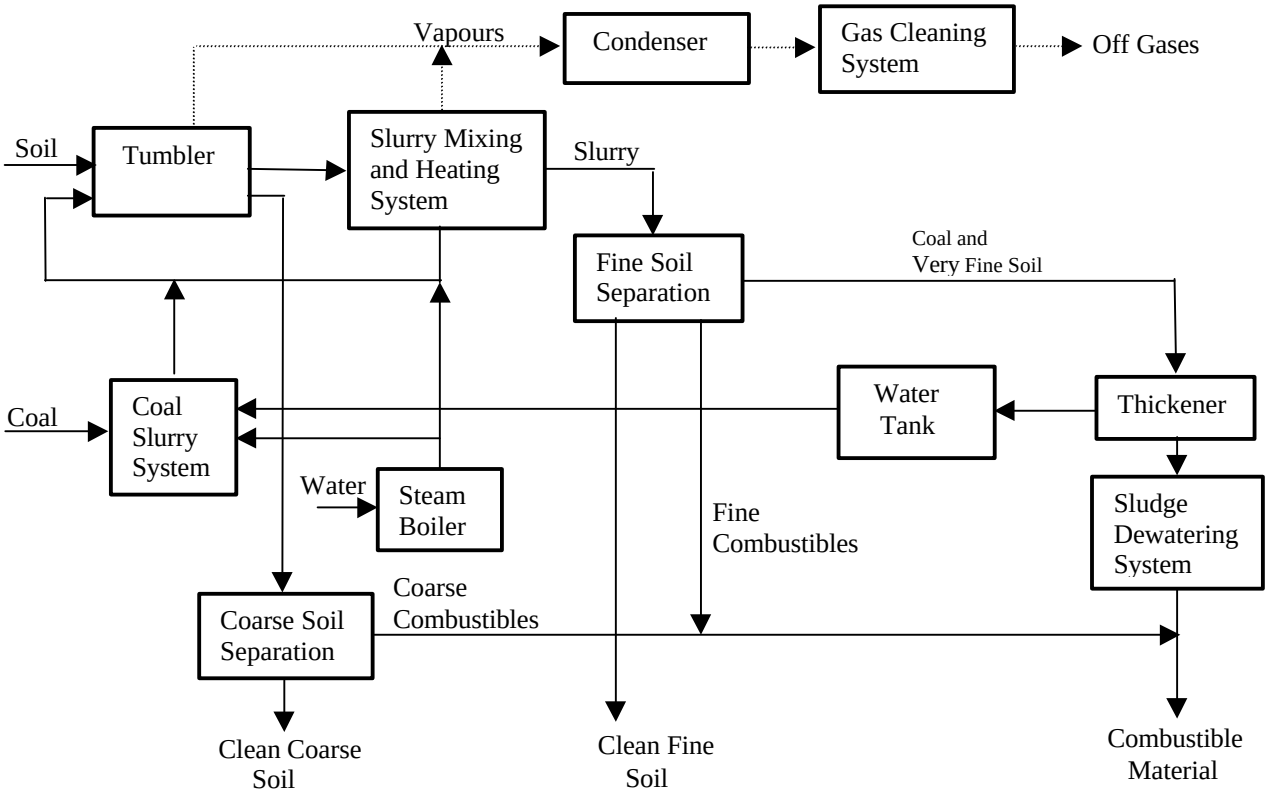

Figure 4. Block diagram of the 10 tph CSP plant.

Figure 5. TDE 10 tph CSP demonstration plant in Edmonton, Alberta.

4. CONCLUDING COMMENTS

Considerable progress has been made during the last three years on commercial scale development of oil agglomeration techniques and equipment for recovery of organic carbonaceous materials (e.g. cokes, chars, coals, tars, heavy oils, heavy residua) from various waste materials (contaminated soils, sludges, emulsions etc.) as well as utilization of byproducts (coal tar, coal fines) from coke oven/steel industry for coke making. For a variety of applications the oil agglomeration appears to be a low cost, environmentally safe, flexible technology that can be readily integrated with existing technologies, customized and adapted to accept a variety of feedstock materials, generate value added products and remediate contaminated soils and sludges.

5. REFERENCES

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