

Long-Distance Transport of Coal by Coal Log Pipeline

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Coal can be compacted and transported through a water-filled underground pipeline over long distances. This mode of transportation is economical and better for the environment than conventional overland Transportation.

greater percentage of the delivered price of coal because of stricter environmental regulations.

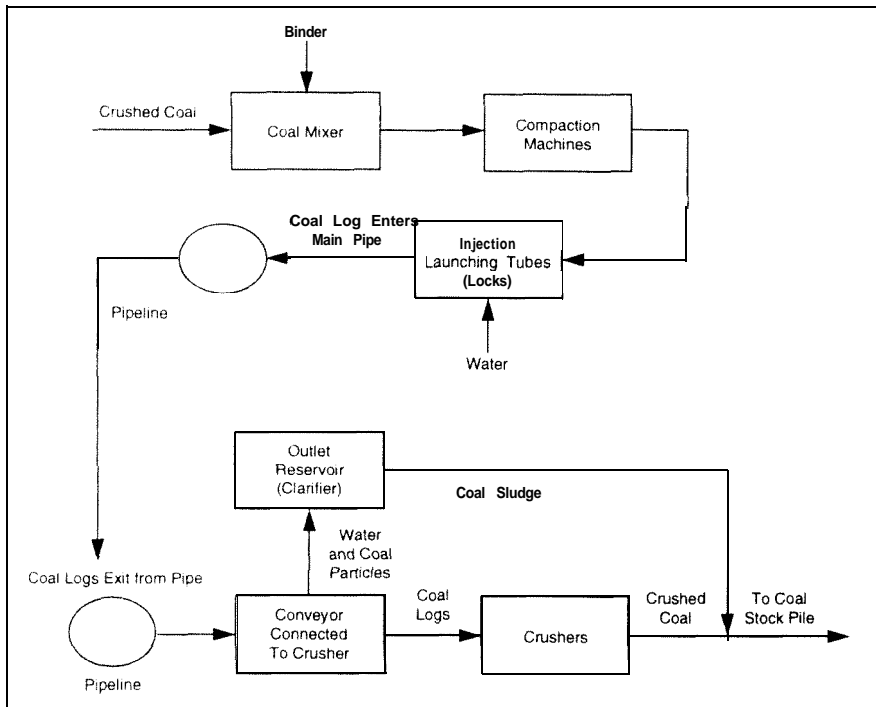
Traditionally, coal is transported long distances by barge and/or railroad, which are costly and can impact the environment. The conventional pipeline transport of coal is by coal slurry pipeline.

Concept Description

An innovative technology is being developed to transport coal through a water-filled pipeline over long distances. Called "coal log pipeline" (CLP), this technology features low water requirements and costs comparable to existing railways. The coal-to-water-mass ratio is 3 to 1.

The CLP concept presses coal into the form of circular cylinders--coal logs--so that coal can be transported by water flowing through a single underground pipe. (This method is being used in another application--transporting cylindrical capsules hydraulically through pipelines.) The coal log pipelines have advantages of relatively low-energy consumption and simple dewatering at the end of the pipeline.

The diameter of the coal log is about nine-tenths the diameter of the inside of the pipe. The log length is always greater than its diameter, with ratios of about 1.8. Coal-log specific gravities are preferably slightly greater than one, about 1.3. The coal logs are propelled by a pump by-pass system and travel butted together, as



Coal Log Pipeline for Advanced Coal Transportation System

Introduction

Each year in the United States, one billion tons of coal are mined. Delivered coal costs two to four times its price at the mine, depending on the mine location, the distance to the coal consumer, the availability of existing freight transport, and the shipping quantity. In fact, transportation costs are becoming even a

trains. For pumping purposes a certain amount of space is required between these coal log "trains."

After the coal logs are transported to their destination, they come out of the pipe onto a moving screen where the logs are separated from the water. The logs are crushed for subsequent burning to meet the fuel specifications for different boilers (see the figure). For a power station with a fluidized-bed combustor, only simple crushing is needed. For a power station with pulverized coal or cyclone-type boilers, the logs may be pulverized to pieces that are <2 in.

In general, coal logs can be manufactured by one of two processes: with and without binder. Coal logs made with binder at room temperature--emulsified bitumen--require <2 weight % binder. The binder has a high heating value and serves as a lubricant. These logs can be fabricated either by a fast single-punch press with multiple stations or by a large rotary press. Because of its costs, the amount of the binder used is kept to a minimum. Coal logs made without binder are heated to about 100°C, with compaction pressures of ~ 20,000 psi. Experimental testing suggests that there is an optimum moisture level, depending on the type of coal. The final compaction process chosen will depend on the process's capital and operating costs.

Economics and Market Potential

In 1993, the University of Missouri conducted an economic study of total CLP systems (e.g., components, legal aspects, and water rights and permitting) (Liu et al. 1993). The university upgraded the study to include new commercial costs for components. The cost methodology was also modified to include conservative methods used by the pipeline industry. These economic trade-off studies indicate that the proposed CLP system (grind-

ing, compaction, injection, transportation, and end-of-pipeline handling processes for logs and water) is cost competitive with other modes of coal transport.

Compared with the better-known coal slurry pipeline, the CLP features one-third to one-fourth the water usage and twice the coal throughput. The unit cost (dollars per ton) of transporting coal through a CLP is ~50% of the cost of a corresponding coal slurry pipeline.

The CLP can compete with existing coal transportation systems at distances from 50 to 1,000 miles. An 8-in. CLP has a throughput of about 2.5 million tons per year. When no adequate coal transportation system exists, then a pipeline's cost competitiveness becomes even greater with rail or truck, a typical condition in Third World countries.

Key Experimental Results

The CLP system was tested at the University of Missouri and included 1) coal log hydrodynamics, 2) fabrication methods for logs with the minimum amount of binder, and 3) methods to inject and control the flow of logs.

Flow tests quantified pumping requirements of logs at about lift-off velocity, the extent of abrasion of the coal logs, and potential problems regarding startup and/or flow around bends. Coal logs were tested by circulating them through both small and large loops. Abrasive effects were minimal when logs traveled at about lift-off velocity. Coal logs tested at lift-off velocity in the small test loop for 1 hour provide a relative index for the satisfactory long-range transport of coal logs flowing through a smooth, straight commercial pipeline. Compaction tests to fabricate coal logs were conducted on bituminous and subbituminous coals. In binderless compaction, testing shows that

the particle size and moisture content must be controlled.

Future Development Needs

In 1995 the University of Missouri will update the 1993 (Liu et al.) economic analysis of CLP to include coal log manufacturing costs and cost data obtained since 1992. The update will be used to evaluate several sites that are being considered for the first demonstration project. Based on a national survey of coal and utility companies, this "demo" will be about 50 miles long and transport a few million tons of coal per year.

All the components of a CLP are being developed at the university. The university is designing a machine to rapidly produce coal logs, and several companies have indicated an interest in manufacturing coal logs. To ensure the rapid commercialization of a CLP, a 12-mile prototype system needs to be designed, constructed, and operated, ideally located on an abandoned coal field near a power plant.

References

Liu, H., R. Zuniga, and J. L. Richards. 1993. *Economic Analysis of Coal Log Pipeline Transportation of Coal*. CPRC Report No. 93-1, University of Missouri, Columbia, Missouri.

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