Case history

Combustion research center quits milling around, starts milling on-site

Because using an off-site contractor for fuel milling limited processing control, a combustion research center installed equipment on-site.

Ontario Hydro, an electric utility company, operates a research center in Toronto, Canada. The center's Chemical Research Department operates a pilot-scale combustion research system to evaluate the burning characteristics of different coals and off-specification fuels, study acid-gas abatement programs such as flue gas conditioning, and perform modeling studies.

The research system's combustor is rated for 500,000 Btu/h while burning a high-volatile, bituminous coal at 20 to 25 kg/h.

The combustor must receive consistently milled fuels, generally at a fineness of 70 percent passing 200 mesh, so the fuel-burning characteristics observed in the combustor will directly translate to full-scale plant combustors.

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Milling system supplied by Hosokawa Micron Ltd., Brampton, Ontario 416/791-3883; fax 416/791-4839.
In USA contact: Micron Powder Systems, Summit, NJ, 908/273-6360; fax 908/273-7432.

Off-site milling presents several problems

From its 1981 opening through 1988, an off-site contractor milled the center's combustor fuel. Using the contractor, however, limited the research center's experimental latitude. The center was less able, for example, to experiment with new fuel types, study fuel mixtures, and control fuel moisture levels. In addition, the contractor milled the combustor fuels in batches using varying processing parameters, which caused some variation in the fuels' physical characteristics.

The off-site contractor's scheduling constraints also limited the immediate availability of milled combustor fuel, which slowed combustion research efforts. Finally, off-site fuel processing was expensive, costing about $1.50 (Canadian) per pound.

Research center seeks on-site milling system

The research center wanted more control over fuel processing so decided to install a continuous milling system. The center required a system that would also classify the fuel and somewhat control the fuel's moisture level to simulate the characteristics of fuel used in full-scale combustors.

The milling system would also need equipment to feed, hold, and convey milled fuels. Because of the fuels' combustibility, the system would need to be resistant to explosion and pressure shock. Explosion containment devices would have to isolate the system.

The research center considered several equipment suppliers for the system and found one whose mill design appeared simple yet well-suited to the application. A demonstration at the supplier's laboratory indicated the system equipment could meet the research center's needs, and the chosen supplier installed the system in 1988.

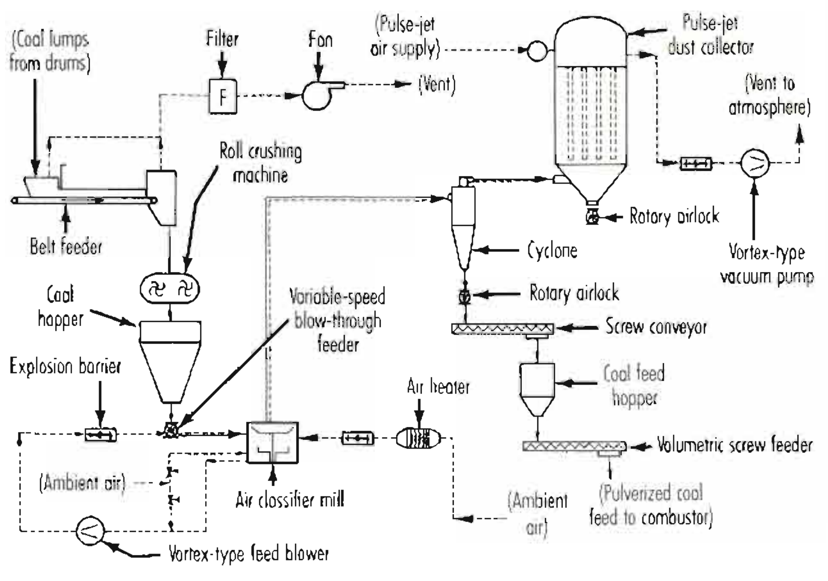
Milling system also classifies, dries material

The installed system (Figure 1) consists of a roll crushing machine, an air classifier mill, a cyclone, a pulse-jet dust collector, and accessory items for feeding, conveying, controls, and explosion containment. A sound-absorbing cabinet encloses the mill, and a fire wall contains the cabinet and other system components. The system is rated for a nominal throughput of 50 kg/h of soft or hard coal.

In system operation, a belt conveyor feeds coal lumps from drums into the roll crushing machine, which reduces the piece size to 100 percent less than ¼ inch. A magnet (not shown) removes tramp metal and a variable-speed, blow-through feeder using a vortex-type feed blower then feeds the

Figure 1

Continuous grinding system



crushed coal from a hopper into the air classifier mill. Material in the air classifier mill impacts against the grinding track of a rotor that provides a striking edge velocity up to 120 m/s. A liner within the mill minimizes component wear, which provides consistent mill parameters, such as airflow rates, and ensures consistently milled material.

The system also has a vortex-type vacuum pump that provides air to both effect classification in the air classifier mill and convey the milled coal to the cyclone. A controller varies the air temperature (up to 300°F) coming from an air heater connected to the system's air-intake circuit. The heated air removes, to some extent, excess moisture from the material as it travels through the classifier and subsequent system components. The system typically dries materials with moisture contents up to 10 percent. Because the air supplied through the air classifier mill is heated, some of the blower air diverts toward the mill's bearing jacket to cool the bearing assembly.

When processing coal, the system's cyclone, located after the mill, captures 98 percent of the milled coal before a rotary airlock and a screw conveyor feed the coal to the combustor's coal feed hopper. A high-level switch on the hopper stops the crushed coal feed to the air classifier mill by turning off the variable-speed, blow-through feeder. A volumetric screw feeder delivers coal from the hopper to the combustor. During system operation, the pulse-jet dust collector captures any coal dust not captured by the cyclone; the dust is then stored in a sealed box for disposal.

The system has diaphragm-type explosion barriers to contain explosion shock pressures up to 10 bar. In addition, flanges, vessel walls, and other system elements are designed to contain explosion shock. Explosion-detection limit switches monitor system parameters for an explosion.

The system has a programmable logic controller that sequentially starts and stops the system equipment and automatically shuts off the entire system in case of a predetermined high material level or an explosion.

On-site milling system aids ongoing research

Since installation, the system has significantly reduced the expense of milling fuels for the pilot-scale combustor. While milling fuels through an off-site contractor cost an average of $1.50 (Canadian) per pound, the on-site system mills fuels at an average cost of less than $1.00 (Canadian) per pound.

Processed fuels are also more readily available. The on-site system immediately mills fuels, which eliminates waiting for a spot in the contractor's schedule. Now the fuels can be milled and fed continuously rather than in batches, so the fuels' physical characteristics are consistent. Because the milling system's processing parameters are known, researchers can control material variations and monitor the effects on combustion.

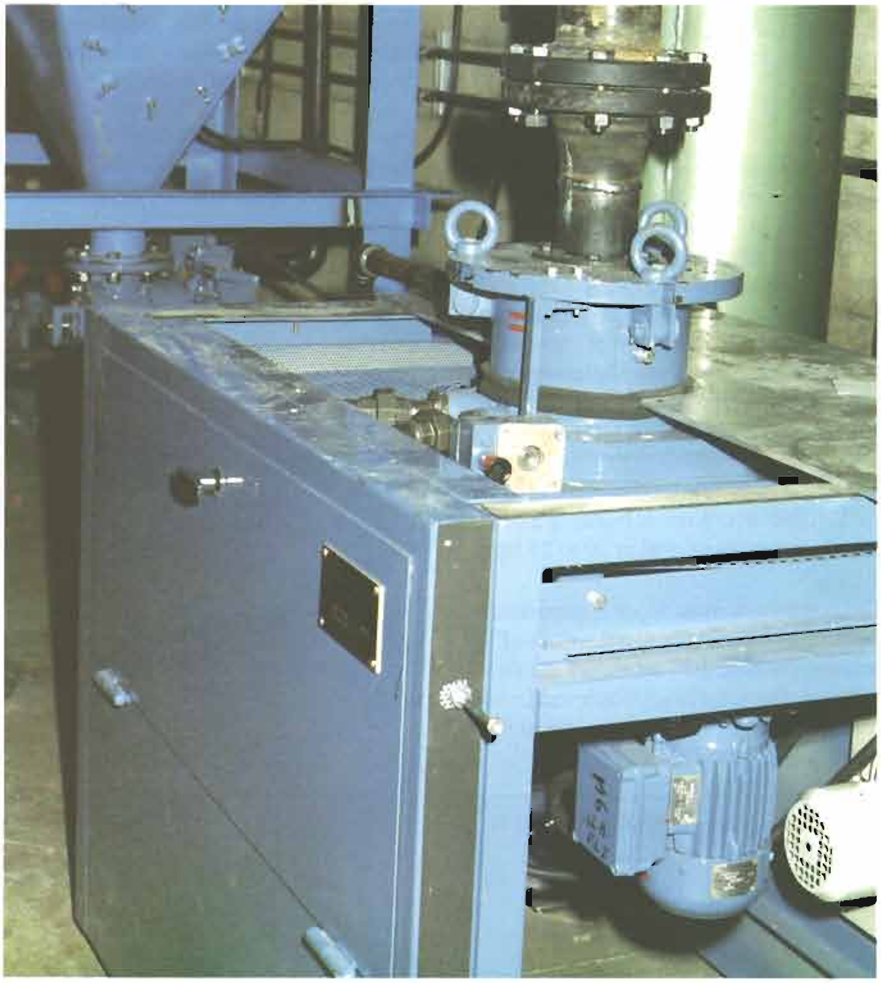
The on-site, continuous milling system has accelerated the combustion research pace by providing a quick turnaround for milled fuels. This, in turn, has allowed the research center to complete more experiments. For example:

• Researchers classified the same coal to different particle size distributions and then compared the burning characteristics to identify milling problems as the root cause of downstream combustion problems for a full-scale power-generating plant.

• Researchers used the system's drying feature to control peat's moisture content at 8 percent and evaluate its potential as a fuel for power or steam generation. The peat's combustibility was then compared to that of other fuels.

• Researchers injected aqueous slurries of limestones and dolomites into a combustor under various operating variables to determine the optimum conditions for capturing SO_x and NO_x emissions (acid rain precursors) from the combustion of several coals. A consistent feed grain reduced variations caused by the coal's physical properties.

From these and other experiments, Ontario Hydro expects to learn more about the influence of powder characteristics on the combustion of various coals and other fuels. Beyond this, the company will develop methods to improve combustion efficiency, optimize combustion process economics, and develop appropriate emission control technologies. PBE



A hopper (upper left) supplies the combustion research center's air classifier mill (in cabinet).