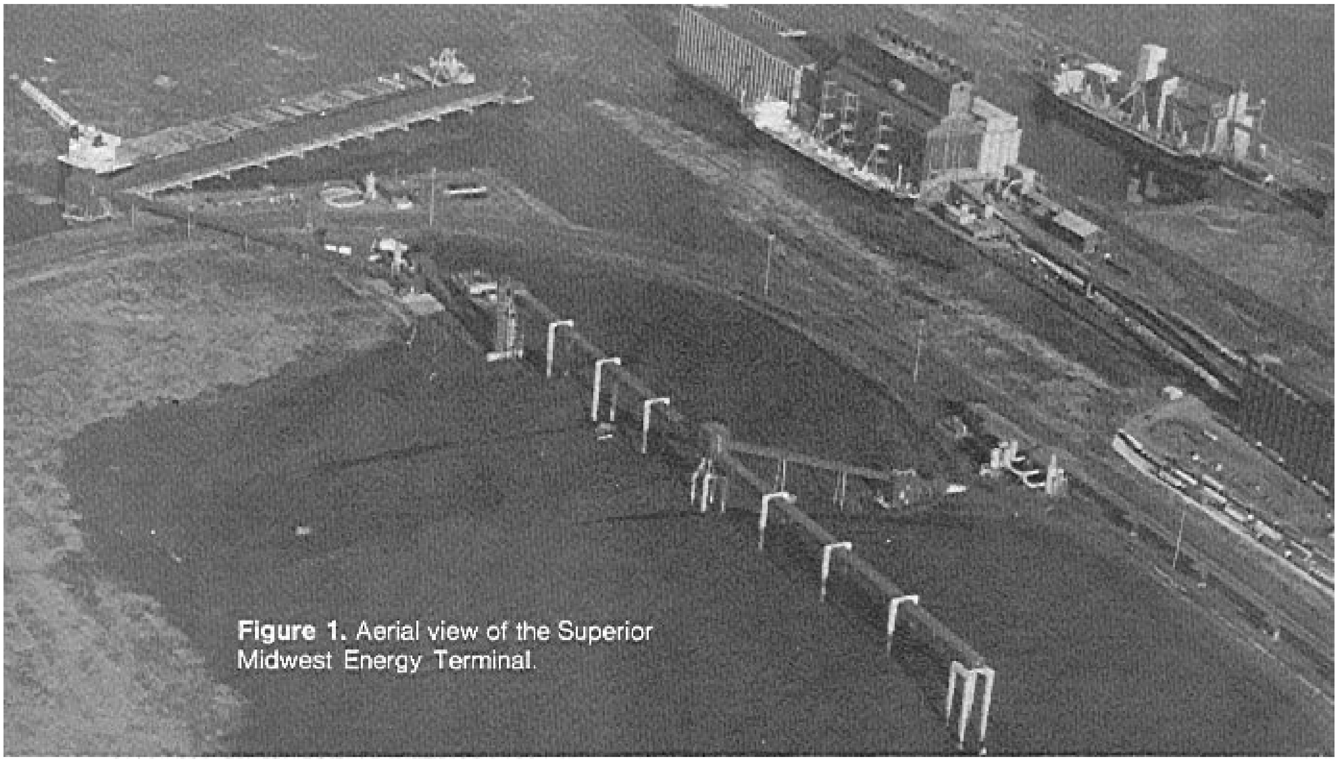

Figure 1. Aerial view of the Superior Midwest Energy Terminal.

Systems approach to dust emission control at coal piles

At Detroit Edison's Superior Midwest Energy Terminal, dust emission control has been an ongoing concern. Testing and evaluation of different systems have been carried out since the terminal was built, and emission controls have been expanded. The latest addition is a coal pile spray system

By DANIEL MAHR, ORBA Corp. and ORTRAN

Detroit Edison uses low-sulfur western coal at its St. Clair plant, and the new Belle River plant will also use this type of fuel. To provide the most economical transportation system for this coal, a combination of unit trains across the Great Plains and self-unloading vessels across the Great Lakes is used. Linking these two transportation modes is the Superior Midwest Energy Terminal (SMET) in Wisconsin.

Figure 1 shows an aerial view of the terminal, and Figure 2 shows material flow schematically. Because of the very large amounts of coal involved, and the continuously active nature of the storage pile, dust control was a primary consideration in design and operation of the terminal. The terminal was engineered by ORBA Corp., and is operated for Detroit Edison by ORTRAN, a joint venture of ORBA and C. Reiss Coal Co.

Some of the special features included to limit and control emissions are as follows:

1. Transfers from one belt to another are minimized.
2. Transfer points and conveyors are enclosed.
3. Telescopic chutes enclose the free-fall onto the pile and into the vessels.
4. High capacity reclaim takes place beneath the pile in a tunnel system.
5. A dust collection system is incorporated.
6. Dust suppression with a water and surfactant solution is used.

As the schematic diagram shows (Figure 2), coal is received from unit trains which are rotary dumped. Dual belt feeders below the track hopper meter the coal onto an elevating conveyor which discharges to the highline, reversible, shuttle conveyor. The enclosed shuttle conveyor discharges to the pile via a telescopic chute. Coal is then spread and compacted by mobile equipment. Reclaim is via rotary plows which load onto the tunnel conveyor. Coal is loaded in sequence onto the transfer conveyor, dock conveyor, and shiploader. A telescopic chute on the shiploader encloses the coal as it is loaded into the vessel.

Emission controls

Since operations began on March 17, 1976, the environmental systems have been continually reviewed and SMET has experimented with a wide range of environmental controls. Because the terminal has both dust collection and dust suppression, it was possible to compare, firsthand, these two different control methodologies. Other techniques, coal oiling and foam suppression, were also examined.

It was thought that the oiling of coal could control dust and that, unlike water suppression, it would improve the heat value of coal. While it did help on both counts, dust that was generated became a more difficult housecleaning problem. Instead of a fine powdery dust which could be washed down, the oil-coated dust left an unacceptable film.

Foam suppression was one promising alternative to reduce emissions on the receiving system. This technology first mixes a surfactant with water and then generates foam by adding compressed air, typically 60-90 psi. Several manufacturers can furnish the surfactant, generators, and pump/metering units. The foam appears to be very much like shaving cream. The surfactant is a soap-based compound and the foam generators are screen-filled canisters. Foam has superior wetting properties for fine dust particles. Fine dust particles easily break the air-filled bubbles and are there-

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by wetted. As a result, foam systems require comparatively little water to reduce dust emissions. An excellent application of foam is on the crushers of coal-fired utilities. Foam can be used to suppress dust with a minimal impact on the effective heat value of coal. For the application at SMET, however, this was not a primary concern, and foam was evaluated as one of the more expensive technologies to operate.

For mobile equipment, several alternatives were investigated. The use of electrostatic plates to attract dust particles was examined but discarded. It would not be effective on the larger dust particles. Air flow from the engine fan was reversed and deflected upward. It was thought that this would reduce air turbulence beneath the bulldozer; however, there was no apparent difference. The deflector hampered cooling, so this alternative was also dropped. Fenders and machine-mounted sprays were seen as being more cosmetic than effective. The conclusion was to treat the coal and not the symptoms. Water wagons were then examined. They are effective on small areas like a haul road, but their capacity is insufficient for a large pile.

During the summer months, when suppression was used, we discovered a beneficial carry-over effect. Once properly wetted, coal dust was sufficiently weighted so it would not become airborne at the next transfer. The dust particles were saturated. This moisture was retained in the coal for a time so it benefited the use of mobile equipment. Detroit Edison found that by adding 1% moisture to the coal during our shiploading operation, ship unloading at the plant was vastly improved. As a result, over the last few years the dust suppression system has been expanded on the reclaim and shiploading system. The rail dump and stockpiling suppression system has also been expanded. In addition, the suppression "season" has been extended. Suppression is used on the shipping system right up to the last vessel loading in December. Because the rotary car dumper feeders are located 60 ft below grade, suppression can be used on these feeders even on −20 F days. De-icing of belts is a necessity, however, to maintain conveyor belt alignment. A semi-manual de-icing system is used as the most economical trouble-free solution.

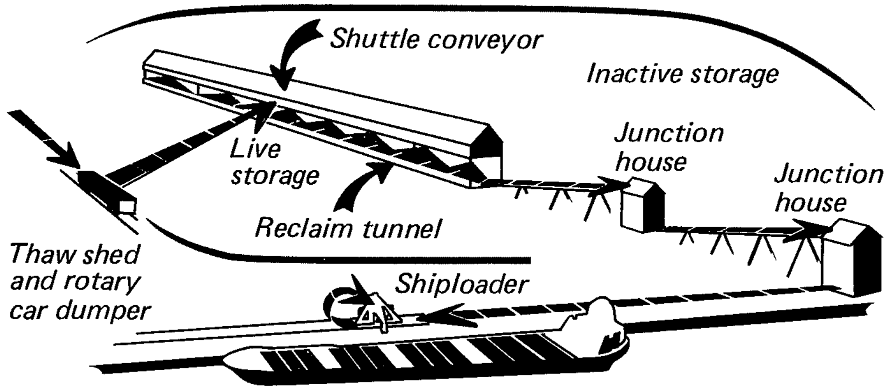

Figure 2. Materials flow (shown schematically) for transshipment of coal at the Superior Midwest Energy Terminal.

Figure 3. Water cannons mounted 120 ft above grade at the optimum angle of 27 deg to the horizontal can wet an area 1200 ft away with a 5 mph breeze.

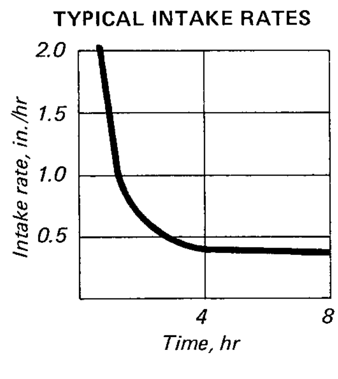

Figure 4. Irrigation system studies provide guidelines for spray system designs. Rate of absorption decreases from initial high rate to some essentially constant value after period of time (from Ref. 1).

The rotary car dumper is an important location for dust control. During the summer months, dust suppression and collection are applied at all levels. The moist dust collected is directed to a wet scrubber. During the winter months the wet scrubber cannot be used. At first, dust collection to a baghouse was relied on during the winter. Because of good experiences with suppression, we engineered a custom suppression header, the Imran Bar, and fitted it to the belt feeders. This permits dust suppression to be used during winter months at this below-grade level. Dust collection is used exclusively above grade, with the dry dust directed to the baghouse collectors.

The reclaim operation is less sensitive to weather because the shipping season begins in April when the outside temperatures are normally above freezing. If coal had to be reclaimed, though, suppression could be used on the tunnel reclaim system in the middle of winter. With a head of coal of anywhere from 30 to 90 ft, the tunnel is far below the frost depth. In fact, western coal is subject to spontaneous combustion, and the tunnel canopy area heats up to 100 F or more while the outdoor temperature can be −40 F.

At the start of the shipping season in April, 1983, SMET had nearly four million tons of coal in storage. In the next few years, even larger stockpiles are anticipated. Many coal-fired utilities which have stockpiles larger than one million tons will divide the pile into active and dead storage. Dead storage is then compacted and may be sealed with a binder to hinder weathering. Until now, SMET has not been able to divide the storage in this way. The pile is continually depleted during the shipping season and grows during the winter months when the Great Lakes freeze. The entire 2- to 4-million-ton pile remains active throughout the year. Because of the anticipated larger accumulations of coal to be stored during the next few years, a coal berm will be constructed at the perimeter of the existing pile. The use of coatings is being evaluated to protect the berm. When completed, the berm would appear to be a dry grassy hill and act as a windbreak.

Direct coal pile treatment

Building on the favorable experience with suppression, it was decided to treat the pile of coal itself. Until this point, all improvements via additional suppression were at transfers. Discharging coal onto the pile or into the ship's hold was a relatively dust-free operation, but the somewhat dry climate at Superior would, after a period of time, dry the surface of the coal pile. Wind or the mobile equipment could then generate visible dust. To provide the moisture needed to prevent this dust emission, a coal pile spray system was custom engineered.

The coal pile spray system was a major addition to SMET's fire protection/industrial water system. It receives water from an existing 12-in., 60-psi water main. A new booster pump increases the pressure to 120 psi and the water is then pumped 120 ft above grade to eight water cannons. These cannons are mounted on the shuttle conveyor towers. The cannons serving the west side of the towers are each rated at 1200 gpm. The east side cannons are each restricted to 600 gpm (they are operating in tandem) because the coal pile is limited in width on the east side. On the west side, the coal pile is at least 800 ft wide. The cannons are angled at 27 degrees to the horizontal—the optimum inclination for distance. These cannons are rated to wet a 350-ft radius when mounted at grade. When mounted 120 ft above grade, and with a 5-mph breeze, the west cannons can wet an area 1200 ft away (Figure 3). Grade-mounted systems are often inclined at 45 degrees to clear the steeply sloped sides of stockpiles. A 45-degree angle has a reduced throw, and a grade-mounted cannon would not benefit nearly as much from the effects of a light breeze. The 120-ft height of SMET's coal pile spray system has the additional advantage that it sprays a large basically flat to gently sloped area. Grade-mounted systems must often wet the steeply sloped sides of the pile which have much lower absorption rates. Water will accumulate and run off a steep slope before entering the surface (Ref. 1).

A programmable controller is used to operate the coal pile spray system and an operator can select any sequence. This provides the flexibility to vary the number of cannons that will operate and the duration of their operation. The operator can then vary the system selectively to suit wind conditions, treat particularly dry areas only, or avoid wetting bulldozer operators. The system has an automatic drain feature so that the cannons can be used during some of the sunny, warmer midwinter days and then be easily drained before nightfall.

In designing a pile spray system, agricultural irrigation manuals are a good reference. Dry soil will absorb water at a relatively high rate in the first few minutes to first hour of operation. This rate then diminishes until, after a period of time, it becomes constant as illustrated in Figure 4. The duration of irrigation is dependent upon the depth to be wetted. Frequency is dependent upon recent climate conditions (Ref. 1). Having a flexible system that can be programmed to suit current conditions is a real asset. Figures 5 and 6 illustrate moisture penetration and a typical irrigation schedule.

Quantifying runoff is important to designing a pile spray system. Runoff must be collected. Then it must be reused, evaporated, or treated and discharged. Civil manuals are a good reference to use. The amount of runoff can vary from 15% for clean sandy type materials to 70% for compact clayey materials. Particle size and distribution are most influential. For instance, sandy materials with some clay or silt would have 50% runoff instead of 15% (Ref. 2).

To determine whether a pile spray system is desirable, two primary concerns should be addressed. First, the material's particle size and distribution should be examined. Smaller particles are more likely to become airborne. If the pile has a wide particle distribution, see if the material can be screened and the coarse fraction used as a top cover. This is most appropriate for dead or inactive storage areas. Otherwise, consider a pile spray system. Second, if the facility is established in a semiarid location, consider sprays. Hydrology handbooks (Ref. 3) can help in determining this. Use maps of the mean annual precipitation and pan evaporation. Whenever pan evaporation exceeds annual precipitation, which is particularly common in the western U.S. states, a pile spray system should be considered. If it is decided to install a pile spray system, an elevated design should be considered because of the advantages described above.

When standing at grade level and looking up, SMET's 12-story operating spray system is an impressive sight. It is hard to believe that the total cost for this addition in 1981 dollars was only $400,000. **END**

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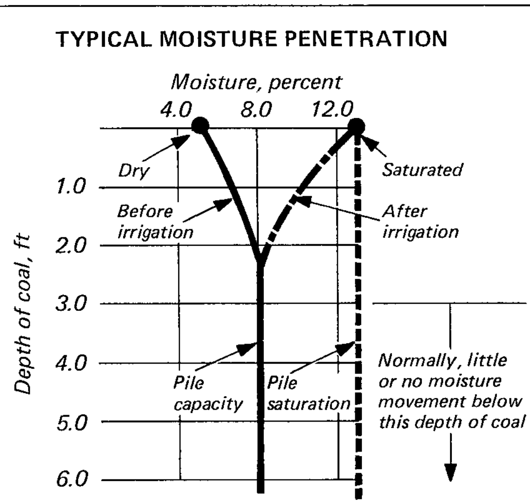

Figure 5. Typical moisture penetration of a coal pile.

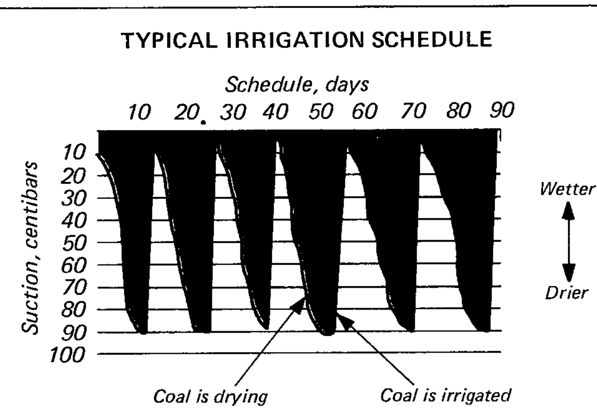

Figure 6. Typical irrigation schedule for a coal pile (will vary with weather and pile conditions). Suction is measured by a tensiometer. As the coal dries, the tensiometer sucks water, creating a partial vacuum. Larger vacuums indicate dried coal, as shown in the shaded areas.