PREPARATION OF INDUSTRIAL SOLID WASTE INTO BOILER FUEL WITH A SINGLE HORIZONTAL SHREDDER

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In the spring of 1980, a horizontal shredder, complete with an infeed and outfeed system as represented in Fig. 1, was placed in service at the Kodak Park solid waste disposal facility in Rochester, New York. This shredder has become the primary shredder for preparing solid waste for incineration in a suspension-fired boiler. The vertical shredder, which has been in service since 1970, was then relegated to service as an operational backup.

This new shredding system represents the culmination of Kodak Park’s efforts over the past 10 years to resolve its solid waste preparation problems. Before discussing the details of this shredder installation, a brief review of the operating problems and modifications which have evolved from this experience will be presented.

SHREDDER EXPERIENCE

The shredder for the Kodak Park Solid Waste Disposal Plant was selected in 1969. Specifications required that a single shredder have the ability to shred typical plant solid waste to a 2 in. (50 mm) nominal size. The horizontal shredder manufacturers contacted at that time felt that both a primary and a secondary shredder were required to obtain this shred quality. A manufacturer of vertical shredders felt that their shredder could meet the specifications. After shredding tests with this equipment produced the desired shred quality, a vertical shredder driven by two 400 hp motors was purchased. The vertical shredder produced an acceptable shred quality which could be handled by our boiler refuse feed system. However, after operating at full capacity for several months, we began to experience considerable downtime for shredder maintenance.

REFUSE INFEED EXPERIENCE

Refuse is delivered from a collection pit by an overhead crane into a feed hopper. This solid waste consists of paper and plastic sheets, small rolls of paper and plastic, office waste, corrugated materials, fiber drums and plastic pieces. Moisture...
content is low (5 to 10 percent) and some material is quite bulky. These characteristics caused the waste material to remain stationary on the original flat conveyor located below the feed hopper.

The infeed system was then modified to provide a positive feed of material into the vertical shredder. A horizontal ram was installed in the bottom of the feed hopper, which pushes refuse into a pair of converging pinch belt conveyors. These conveyors discharge refuse into a downwardly curved duct connected to the shredder inlet. Two manually controlled vertical hydraulic rams are positioned in the curved duct, which the shredder operator can extend to break up any refuse bridging which might occur in the shredder inlet.

**SHREDDED WASTE CONVEYING EXPERIENCE**

The original shredded waste conveyor was a series of seven enclosed belt conveyors which carried this material to an elevated inlet in the storage silo. This system was plagued with several problems. The shredded material would not convey, the transfer points would plug, refuse would foul the drives, and extremely dusty conditions were experienced. Fires in the conveyors were a common experience, sometimes occurring on all seven conveyors simultaneously.

After struggling unsuccessfully with the belt conveyors, this system was removed and replaced with a classifier and pneumatic conveying system. The pneumatic conveying system and classifier operated successfully. Problems were experienced with the heavy fraction conveying system since it was necessary to install the classifier below grade beneath the shredder. A drag conveyor was installed beneath the shredder which conveys the heavy fraction on a flat pan to the inlet hopper of a vertical bucket conveyor. The drag conveyor experiences problems with heavy materials jamming the sprockets and chains. Similar problems are encountered with the bucket conveyor, which carries this material vertically to a lugger bucket at grade level.

**HORIZONTAL SHREDDER INSTALLATION**

A 60 in. x 60 in. (1.5 m x 1.5 m) horizontal top feed shredder with an 800 hp motor was installed on one end of our incoming refuse pit in 1969 to shred wood scrap which was mostly truck and container loads of dunnage, predominantly pallets and crates. It was never possible to feed wood scrap continuously this way due to excessive infeed hang-up on the infeed conveyor and in the mill throat opening, which is approximately 48 in. x 60 in. (1.2 m x 1.5 m) at the rotor. Also, the 4 in. x 8 in. (10.2 cm x 20.4 cm) grate openings frequently produced a shredded product top-size fraction containing splinters which would plug up the pneumatic feed system. Closing the grate opening would increase retention time and the probability of fires, so the wood shred operation was discontinued.

In 1977, we began looking into the feasibility of using this horizontal shredder for solid waste. Our shredding experience now indicated that the 2 in. (50 mm) shred size was not needed and material up to 4 in. x 4 in. (100 mm x 100 mm) topsize could be handled in the pneumatic conveying system without difficulty.

We tested the solid waste shred quality from the horizontal shredder with various shredder modifications such as reduced grate opening size, additional stationary grate bar shear anvils, and split hammers. Reducing the grate opening was the only modification which significantly reduced the shred size to an acceptable level. To adapt the horizontal shredder to continuous refuse preparation with bucket loading from the pit, it was necessary to disconnect the drive motor, rotate the shredder 180 degrees and reconnect the motor. This change provided ready access to the shredder hammers and allowed the horizontal infeed ram to be installed at a lower elevation.

The 8 in. x 4 in. (200 mm x 100 mm) grate openings were reduced to 3 in. x 4 in. (76 mm x 100 mm) by welding 2 in. (50 mm) thick steel bars into the grate openings. This change reduced shredder throughput and increased the horsepower requirement. We are able to shred 10-12 tons (9.1-10.9 t) of refuse per hour, but the crane operators must judiciously feed the shredder, otherwise the drive motor can be stalled.

We find that a finer shred occurs when the shredder motor is loaded at or near design current. When motor current is allowed to drop due to reduced infeed charging, the shred size increases and the incinerator conveying system occasionally plugs with this material. Shredder hammers made of manganese steel (300-350 Brinell hardness) have experienced 1200-1500 hr of operation before replacement was necessary. We have recently changed to harder Ti (450-500 Brinell hardness) and the shredder now operates smoothly.
hardness) steel hammers so we cannot comment on their operating life as yet.

The shredder became operational as our primary shredder in April, 1980, and has processed approximately 40,000 tons of material through November, 1981. The shred quality has been acceptable for conveying through 5 in. (12.5 cm) diameter pneumatic lines into the incinerator. Only one type of material, small pint and quart-size plastic bottles, does not shred to an acceptable size when hammer wear progresses beyond a certain stage. When this condition exists, we landfill these bottles when they appear as concentrated loads in the incoming refuse pit.

**SHREDDER INFEED SYSTEM**

After our successful experience with ram-feeding refuse into the vertical shredder, we sought to improve this technique further when designing the horizontal shredder infeed system. We designed a system consisting of a feed hopper mounted above a horizontal compactor. The horizontal compactor discharge is attached to an expansion chamber whose size was dictated by the restraints of the infeed hopper and shredding locations. This chamber is connected to the inlet of a vertically positioned compactor mounted on the horizontal hammer mill shredder inlet.

During normal operation, the ram of the vertical compactor is stationary in the retracted position. The ram of the horizontal compactor pushes refuse into the expansion chamber. The incoming refuse charge then pushes the accumulated refuse in the chamber into the chute of the vertical compactor where this material falls by gravity into the hammer mill shredder inlet.

When bridging occurs in the vertical chute, the operator extends the ram of the vertical compactor, pushing refuse into the shredder inlet.

When material which is difficult to feed must be shredded, the horizontal and vertical compactors can be operated in sequence automatically so that the material is continually force fed from the infeed hopper to the shredder inlet.

This infeed system has performed satisfactorily in feeding refuse to the shredder. However, two problems have arisen which were not encountered with the vertical shredder installation. We have experienced fine dust emissions and metal scrap projectiles being hurled out of the shredder through the horizontal compactor and infeed hopper with high velocity into the refuse pit area, which is typical of top feed horizontal shaft swing hammer shredders. Since the projectiles were a serious safety hazard for the operators, we sought an immediate solution to this problem. We installed a hinged 1/2 in. (13 mm) thick steel plate in the expansion chamber with small clearances on the vertical sides and 6 in. (153 mm) clearance at the bottom. With the hinge located at the top of the plate, the refuse ahead of the horizontal compactor ram pushes the plate forward to enable refuse to enter the chamber and the vertical chute into the shredder. This hinged plate scheme has not affected our refuse feeding capability and has eliminated our projectile problem. Based on visual observation, we feel that this hinged plate has also reduced fine dust emissions from the shredder.

On one occasion, fine dust emissions from the shredder accumulated in the windings of the open construction shredder motor. This dust accumulation ignited and began to smolder. The motor was opened and the dust was removed. No damage occurred in the motor windings. To alleviate this problem, dust-stop filters were installed on the motor air intake openings. To resolve this dust problem further, a dust-tight partition was installed between the feed hopper area and the shredder motor area.

**SHREDDED WASTE CONVEYING SYSTEM**

The shredded waste conveying system consists of a tightly enclosed inclined vibrating conveyor located below the shredder in a basement which discharges into an air-swept classifier. A horizontal vibrating conveyor resting on tracks to permit horizontal movement is positioned beneath the classifier to convey the heavy fraction. The discharge lip of the horizontal conveyor is positioned over the edge of the bucket of a vertical hoist. The vertical hoist lifts this bucket to its dumping elevation, where its contents are dropped into a lugger located at grade level.

In operation, the shredded material exiting the shredder falls onto the pan of the vibrating conveyor to be carried into the classifier. The tight enclosure around the conveyor allows the vacuum present in the classifier to pull air through the shredder, thereby providing shredder heat removal and an assist in moving the fluffy refuse. The classifier causes the light refuse fraction to be swept vertically upward off of the vibrating conveyor along with the conveying air for delivery to
the refuse silo. The more dense heavy fraction falls onto the vibrating heavy fraction conveyor where this material is carried horizontally to the bucket of the vertical hoist.

A television camera aimed at this bucket monitors the heavy fraction level. When the shredder operator observes a high level on the television monitor, he starts the vertical hoist cycle. In this cycle, the horizontal conveyor vibrator is stopped. This conveyor is then retracted to clear the lip of the hoist bucket and the hoist bucket begins its vertical travel. At the top of its vertical travel, the bucket is tipped and the heavy fraction material drops into a load lugger. After completing its dump, the hoist bucket is returned to its position beside the horizontal conveyor. This conveyor is then repositioned over the lip of the hoist bucket and the conveyor vibrator is started.

While the horizontal conveyor is retracted with its vibrator out of service, heavy fraction material continues to fall into it. After completion of the dump cycle, the horizontal conveyor then begins vibrating and this accumulated material is conveyed to the hoist bucket. A timer is actuated when the hoist cycle begins and an alarm serves to notify the operator when the dump cycle extends beyond a preset time.

The tight enclosure around the inclined vibrator conveyor is critical to smooth conveying of the shredded waste. On one occasion, one conveyor side shield became damaged and the operator removed it. This produced a reduction in refuse flow to the classifier, causing a buildup on the conveyor pan and providing a spot for hot metal particles to ignite the refuse. We also feel that maximum air flow through the shredder is critical for reducing dust emissions and cooling the shredder hammers and grates.

**SUMMARY**

Hopefully, this scenario of our problems and the approach taken in resolving them will be of interest to those concerned with solid waste preparation. The technology which has evolved in solving our particular solid waste preparation problems has been expensive and time consuming. The commitment of the management of Eastman Kodak Company to provide a reliable solid waste disposal operation has been the key to our success.

**Key Words**

Hammermill
Materials Handling
Refuse Derived Fuel
Shredding