NEW CONCEPTS FOR EXPLOSION ALLEVIATION IN SHRED-FIRST SOLID WASTE PLANTS

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ABSTRACT

This paper presents several new concepts for alleviation of damage caused by explosions in plants that shred solid waste as the first processing step.

The paper summarizes AENCO's explosion experience in shredding about 1.35 million tons of solid waste in New Castle, Delaware and about 0.1 million tons in Albany, New York, and describes modifications made in and planned for the Albany Plant.

Protection for baghouse filters associated with dust collectors is discussed briefly.

BACKGROUND

AENCO has discussed explosion alleviation in shred-first solid waste plants in a number of technical papers. AENCO's earlier conclusions were:

1. Visual inspection of the waste at well-designed picking stations is essential.
2. General Public Awareness and publicity is perhaps contraproductive, as it may cause people with distorted minds to discard material that will cause an explosion. Education of waste collectors and their drivers may be effective.
3. Explosion Vents. The first and best mechanical method to alleviate explosion damage is to provide adequate venting. The vents that AENCO had installed in the New Castle, Delaware Plant were designed to withstand 20 psi; they were installed vertically above the shredder feed chute in order that the high speed products of combustion did not have to change direction in exiting the plant; and their cross-sectional area increased from the shredder feed chute to the top of the vents which extended through the roof. Similar vents without increasing cross-section were retrofitted into the Albany Plant by Smith & Mahoney, P.C. in the fall of 1980.
4. Water Micro Fog. AENCO had installed micro-fog nozzles in the entire shredder column in New Castle, but was not certain that this micro-fog was effective. It may be impractical in very cold climates, and adds about 1 percent moisture to the shredded waste.
5. Detection/Suppression Systems should be installed even though they are not effective against all types of explosions.
6. Personnel Protection in the form of strong barricades should be provided for employers who might be exposed to a blast wave or to flying shrapnel.
7. There is no anti-explosion design that can be guaranteed to eliminate damage from explosions in solid waste plants that shred as the first processing step.

The above ideas were presented at an AENCO-sponsored seminar on explosion alleviation in June, 1979. As a result, one company that operates two auto shredders installed continuous 60 gal/min (230 l/m) water spray just above the shredder rotors. The rotor action is believed to make small droplets from this heavy water spray. Before they made this installation, the company experienced about one explosion per week in its two shredders. They have had no explosions in one year since installing the water spray. This is surely significant,
but such heavy water spray could not be used continuously when producing RDF. However, if a wide-spectrum, sensitive, fast-response explosive vapor detector were installed immediately downstream from the primary shredder, it might be well to provide a heavy water spray for, say, 30 sec whenever, say, 30 percent of the lower explosive limit (LEL) was measured by the explosive vapor detector.

AENCO has shredded a total of about 1.45 million tons (1.32 x 10^6 t) of solid waste — about 1.35 million tons (1.22 x 10^6 t) in New Castle, Delaware and about 0.10 million tons (91,000 t) in Albany. Forty-eight explosions were experienced in New Castle and two in Albany. The shredders in New Castle and in Albany are of the horizontal type.

Although we have no experience in operating vertical-shaft shredders, we have long observed that vertical-shaft shredders seem to experience fewer explosions than do horizontal-shaft shredders. We have also noted that when an explosion is experienced in a vertical-shaft shredder, damage seems to be heavy, and concentrated downstream from the shredder. We have recently learned that the Heil vertical-shaft shredders induce a downdraft through the shredder in the order of 10,000 cfm. Most horizontal-shaft shredders do not induce downdraft but, to the contrary, sometimes cause a turbulent updraft in the feed chute. We suspect that the downdraft in vertical-shaft shredders dissipates small quantities of explosive vapors, and does not provide conditions in which such small quantity of vapor reaches a concentration equal to its lower explosive limit.

**MODIFICATIONS TO ALBANY PLANT**

In about 1975, Smith & Mahoney, P.C., conducted smoke tests in a small horizontal-shaft shredder model that they built. As a result of these tests, they concluded that the shredder and feed hopper could be modified by the addition of what is described as an “air gate” to produce a positive downflow of air in a horizontal hammermill. At Smith & Mahoney’s suggestion, the Jeffrey shredders were modified by AENCO to incorporate this “air gate,” which seems to fill the same function as is provided by a cutoff blade on centrifugal fans. The installation of the “air gate” provides a positive downflow of at least 4000 cfm (113 m³/min) through each shredder, when material is not being processed through the shredder.

Additionally, in October, 1980, we had installed two low static pressure fans in the roof of the Downstream Processing Area (a large building downstream from the shredder discharge tunnel). Each fan has a capacity of about 25,000 cfm at 1/4 in. water pressure. When the shredders were operating empty without “air gates,” these roof fans induced a flow of about 6,000 cfm downward through each shredder. When the shredders are fed with solid waste, the downward airflow is now about 4,000 cfm (113 m³/min) through each shredder caused by the combined affects of the “air gates” and downstream fans.

We intend to install roof fans of somewhat higher capacity in an effort to induce more downflow through the shredders — and in a further effort to “wash” any accumulation of vapor in the Downstream Processing Area. The roof fans are installed in a crudely “plenumed” volume, so that they have little tendency to entrain and to discharge dust to the atmosphere. The plant is also equipped with two dust collection systems of the baghouse type, and the dust collection pickup points are located relatively close to the burden at the several conveyor transfer points. By keeping the pickup velocity on these dust collection hoods less than about 1.5 to 2 ft/sec (0.5 to 0.6 m/sec), the tendency of the dust collection system to pick up paper and plastics is minimized.

**FENWAL SYSTEM**

The Albany Plant is equipped with a FENWAL Explosion Prevention System. We consider that this system was somewhat effective in reducing the effects of the first explosion, but seemed to have little effect on the second one — we suspect that the second explosion was caused by discarded fireworks that contained their own supply of oxygen. We intend to retrofit one additional FENWAL bottle in the duct just after the first dust pickup point, in order to minimize the likelihood of an explosion spreading to the baghouse.

**BAGHOUSE FILTER**

At the suggestion of a Cargill Safety Engineer, the circuit logic of the baghouse filters has been modified. In the event of an explosion or a fire, the induced draft fan in the dust collector is operated, but the bag pulsers are switched off. Fire detectors and sprinkler protection have been retrofitted in the baghouse. The reason for leaving the
ID fan running and switching off the pulpers is to encourage dust in the baghouse to remain on the bags instead of being pulsed into suspension where, if ignited, it might cause an explosion that would destroy the baghouse. We consider it better to risk the loss of all bags by fire than to risk the loss of a complete baghouse by a dust explosion.

SHREDDER DISCHARGE AREA

Each of the shredders discharges into a Vibrating Discharge Conveyor. These conveyors are installed in a heavily-reinforced concrete tunnel which is 15 ft (4.6 m) long x 9 ft (2.7 m) wide x 12.5 ft (3.8 m) high. The tunnel cross-section expands on each end to a cross-sectional dimension of 17 ft (5.2 m) wide x 16 ft (4.9 m) high. Including the expanded end sections, the tunnel has an overall length of 42 ft (12.8 m). During the second explosion, which occurred on 8 July, 1981, significant amounts of products of combustion exited each end of the tunnel at relatively high velocity, thus raising the pressure in each of the two large rooms on either end of the tunnel. This rise in pressure was sufficient to dislodge building siding and to crack windows located some 80 ft (24 m) from one end of the tunnel. Smith & Mahoney were reluctant to install a high-strength bulkhead on either end of the tunnel, as such bulkhead would have to designed to withstand 20 psi (137 kPa). It was feared that such bulkhead might allow excessive overpressures to damage the concrete tunnels.

As an alternative to a bulkhead, Smith & Mahoney recommended two labyrinth temporary walls made of sandbags on the East end of each tunnel. We have installed two such walls each 4 ft (1.2 m) wide, running transverse to the major tunnel direction. Each sandbag wall terminates about 3 ft (1 m) from one tunnel wall, thus leaving two access doors for cleaning purposes. The two access doors are on opposite ends of the tunnel. Thus, escaping products of combustion must make at least two right angle turns in exiting one end of the tunnel. The sandbag walls will absorb a good deal of energy from the products of combustion, and may provide suitably low exit velocities and overpressures in the room at the East end of each tunnel.

The Discharge Conveyor exits the other (West) end of each tunnel. Again, simple smoke test experiments performed by Smith & Mahoney suggest that staggered pillars of sandbags would provide blast protection for personnel in the area west of the tunnel, by inducing turbulence in the escaping products of combustion.
products of combustion, thereby dissipating much of their energy. Figure 1 is a photograph of one of the sandbag walls, and Fig. 2 is a photograph of an array of sandbag pillars installed by AENCO in the Albany Plant.

There has been no explosion in the Albany Plant since the installation of the sandbag walls and sandbag pillars. Therefore we cannot assess their effectiveness “under fire.”

CONCLUSIONS AND RECOMMENDATIONS

1. Explosions are still inevitable in plants that shred solid waste as the first processing step.
2. With the possible exception of Water Micro Fog, AENCO’s earlier recommendations on alleviation of explosions in such plants seem to be sound.
3. It seems desirable to induce a positive down-draft of air through primary shredders — by modifying the shredders and by the use of induced draft fans downstream from the shredders.
4. The downstream induced draft fans should be installed in a somewhat “plenumed” volume, baffled as necessary, to avoid entrainment of excessive dust.
5. The purpose of the downstream induced draft fans is to “wash” the air in the building downstream of the primary shredders in the hope that a lower explosive limit (LEL) of explosive vapors will not be reached — thus lessening damage to the downstream building in the event of an explosion in the primary shredder.
6. The idea of using walls of sandbags, or an array of pillars of sandbags to absorb the energy of the products of combustion during an explosion may have merit.
7. The idea of detecting a relatively low concentration of explosive vapor immediately downstream from the primary shredders — and immediately activating massive water spray above the shredder rotor for a short time — may have merit. Such a system has not yet been installed in the Albany Plant, but is being considered.
8. The control logic for baghouse filters associated with dust collection systems as discussed herein seems to have merit.
9. The authors cannot guarantee the effectiveness of any mechanism or procedure for alleviating damage from explosions in shred-first solid waste processing plants under all circumstances. The authors offer the above ideas in the hope that they may be helpful to others in the solid waste industry, and may stimulate better ideas.
Key Words
Baghouse
Dust
Explosion
Hazardous