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

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Undoubtedly the authors have had more experience than most in the area of shredder explosions. The technology of resource recovery will require a shred-first concept in some instances. Obviously, we must learn how best to handle the explosions. They are going to occur.

The authors have investigated their topic well and have certainly had the experience of having probably handled the wide range of occurrences. This is reflected in the priority they have assigned to the various steps necessary to alleviate explosions in shredders.

Visual inspections have to be made on any sizable shredding operation, not only to look for materials that might cause explosions, but also for material that will damage the shredders themselves.

Vents are an absolute necessity. Various formulas have been developed for the sizing of vents. However, as a practical matter, they should be as big as possible — certainly, as large as the infeed and secondly, as straight as possible. At Chemung County in retro-fitting our vents, a short transition section going from the rectangular to round was installed. Then, a round section that would encompass the top of the shredder opening was installed straight up to the roof. This has two distinct advantages:

1. The area of the vent increases dramatically in the round vent.
2. The round section can be constructed in a lightweight material and still achieve a design pressure of 20 psi. This lighter weight enabled us to support the vent from the building rather than the shredder itself.

The use of water in a system as evidenced from the auto shredder experience obviously reduces the incident of explosion. In a resource recovery system adding water is detrimental for the obvious reasons. At Chemung County we have installed a MSA Model 511 vapor detector. This unit actuates a solenoid valve on a 2½ in. deluge line. The thought is that, once a 30 percent LEL is detected, the solenoid would open to discharge water in the shredder. This system has some disadvantages, such as slow response time and keeping the breather tube to the detector open and clear. It will be some time before we know how effective this system will be.

Detection/Suppression systems certainly have some drawbacks, but they have a track record of being effective in some instances. Theoretically, they have the ability to handle most types of explosions that occur in shredders. There have, however, been instances where they have not functioned as they should.

Personal protection — this particular item is of extreme importance. It is site specific and care must be taken in design to achieve maximum protection for the people who operate the system.
The air sweep concept has some merit in any shredding system. Shredders that have an air flow through their systems seem to have few explosions, although this has not been thoroughly documented or proven. It does, however, present some problem if used in conjunction with a detector/suppression system that operates on pressure increase detection. Detector/suppression systems must have a closure area in which to detect a pressure increase. This might prove difficult with a ventilating system.

In conclusion, this paper should be a must for an engineer designing a new shredding system so that these concepts could be included in any new system.

AUTHORS' CLOSURE

The authors appreciate Bob Roller's comments, and we look forward with interest in learning the results of his installation of a MSA vapor detector tied in with water deluge.

He is certainly correct that a vent with a circular cross section can be made much lighter in weight than a vent with rectangular cross section.

We do not believe that the air sweep concept for shredders will inhibit the actuation of pressure detection systems used in detector/suppression systems, as the pressure used to trigger a detector is on the order of 0.75 psi - which is much greater than is the pressure drop created by air sweeping the shredder.

On 20 May 1982, we experienced a heavy explosion at the ANSWERS facility. This explosion was caused by an acetylene bottle that escaped the attention of the pickers. The flame propagation velocity was too fast to be suppressed by the detector/suppression system. We are happy to report that there were no injuries to personnel, and there was less than $2,000 property damage. We believe that the staggered array of pillars of sandbags, as reported in our paper, seems to have been effective in breaking up the wave front, and absorbing the energy contained therein. There was very little damage to the building structure downstream from the shredder in which the explosion occurred. Damage was limited to the vibrating discharge conveyor and to the skirts of the following belt conveyor. The use of sandbags, as recommended by Russ Galgana, P. E., of Smith and Mahoney, P. C., seems to be an excellent idea.

On 11 June, 1982 an explosion occurred that did about $25,000 damage, mostly to the building downstream from the shredders. The authors estimate that the pulse duration of this explosion was perhaps one quarter to one half sec. If the flame front traveled at about 300 ft/sec, the explosive substance (believed to have been some vapor), existed in the downstream area for a distance of 75 to 150 ft before the explosion started. We believe that, prior to ignition, the explosive vapor could not have propagated in the downstream area at a rate greater than the speed of the conveyors (about 5 ft/sec). If this is the case, then the vapor existed for 15 to 30 sec prior to its being ignited (doubtless from a spark in the shredder). If this is the case, then a vapor detector, located immediately downstream from the shredder, might well have given early warning of an impending explosion. Such an early warning, tied in electrically with an immediate shutoff of the Infeed Conveyor, might have resulted in there being no spark-producing material in the shredder and therefore no ignition. In addition, there might have been sufficient time to activate a water deluge in the shredder - in order to inhibit the production of energetic sparks.

As a result of this experience, we ordered two Bacharach Instrument Company Model CD 800 W Control Units, and General Purpose Sensors Model Number 800-080.2. These sensors are of the catalytic type and can be “poisoned” by a few substances.

We installed and calibrated the above vapor detection systems in each of the two processing lines in the ANSWERS Plant on 16 August 1982. We have calibrated the system for gasoline, as we suspect that this is the most likely cause of explosions. Also, the sensors are less sensitive to gasoline than to other vapors. Thus, with the systems calibrated to sound an alarm at, say, 10 percent of the lower explosive limit (LEL) of gasoline, the systems will alarm at about 6 percent of the LEL of propane.

We have adjusted the systems to sound an audible alarm at 5 percent of the LEL. A relay in the Control Units has been set to function at 20 percent of LEL. When this relay is actuated, we automatically stop the infeed conveyor — and we intend, soon, to retrofit massive 10 sec water spray just above the shredder rotor when the relay actuates. We are uncertain where we will ultimately set the relay to stop the infeed conveyor and to actuate the 10 sec water spray, but we will probably select a value of about 30 percent of the LEL.

We have kept accurate logs of audible alarms and relay actuation in each processing line. We are averaging about ten audible alarms daily on each
processing line and about five relay actuations on each line. Thus we are measuring 5 percent LEL about ten times a day per line, and 20 percent LEL about five times a day per line. This is a much higher incidence than we had predicted.

An interesting incident occurred on September 15. The alarm bell rang on Line 2, and almost immediately the relay actuated. The operator watched as the indicator needle on the Control Unit rose to 100 percent of the LEL. Despite our relatively good air movement in the shredders, and despite the fact that the infeed conveyor had automatically been turned off as the indicator needle passed through 20 percent of the LEL, a reading above 20 percent persisted for nearly 4 min. After the LEL dropped below 20 percent, the operator resumed feeding. About 30 sec later, the LEL indicator again jumped to 100 percent. This indicates strongly that the waste stream contained two containers of volatile explosive material, which were separated on the infeed conveyor by a distance of about 30 ft (the speed of the infeed conveyor is about 60 ft/min). Had the infeed conveyor not been stopped automatically during the first high reading, it is very likely that the second container of volatile material would have been ruptured in the shredder — perhaps in the presence of sparks. An explosion would likely have resulted — which might have ignited all of the vapor from the first container that caused the original high reading, thus causing damage downstream from the shredders.

We recalibrated both systems on September 14 because the sensor in Line 1 had apparently been "poisoned" as its sensitivity had dropped markedly. The sensor in Line 2 had retained good calibration. We are not particularly concerned about the loss of this sensor because the loss is relatively easy to detect; the line in which an insensitive sensor is installed will experience many fewer alarms than will the other line. The sensors cost less than $60 each, and can be replaced in a few minutes.

On the basis of experience to date, it appears that there is much more explosive volatile material in the waste stream than we had thought. It also seems likely that the use of vapor detectors in combination with automatic shut-off of the infeed conveyor and massive short-duration water spray above the shredder rotor will eliminate some explosions. Time will tell.