Workshop B

V O L U M E R E D U C T I O N

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LOW-LEVEL WASTE VOLUME REDUCTION: MECHANICAL SYSTEMS

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In this portion of the workshop on Volume Reduction (VR), discussion will be centered around low-level radwaste VR systems that are mechanical in nature. For purposes of this presentation, the discussion of VR systems will be broken down into the categories of compaction, chemical digestion, and incineration, and described by different authors. Mechanical systems are those that have rotating elements as part of the primary process for liquid wastes and also those, such as shredding and compacting, that deal with dry waste.

LIQUID VR SYSTEMS

The mechanical VR systems generally operate as rotating drying devices that spread a thin film of liquid waste against a heated surface, or mix the waste with a hot inert carrier, or both.

Associated Technologies, Incorporated (ATI)

ATI is the American sub-licensee for the SGN (Societe Generale Pour Les Techniques Nouvelles) bitumen process. SGN is a licensee of CEA, the equivalent in France of our old AEC. The ATI/SGN system (Fig. 1) uses a LUWA mechanically agitated thin-film or wiped-film evaporator. This system uses bitumen (asphalt) as a lubricant and a heat transfer medium, as well as solidification binder. The evaporator jacket can be heated by either an oil fluid or by steam. The concentrated wastes are dried completely while in contact with the hot bitumen, leaving a mixture of dried waste particles embedded in bitumen. This mixture is fed in measured amounts directly into drums where it solidifies upon cooling. The system will encapsulate spent ion exchange resins, powdered filter sludge, evaporator

concentrates, chemical wastes and decontamination agents. Bead resins are ground to a fine powder while they are being pumped to a feed tank. Grinding the resins has been found to improve the drying efficiency of this system. The resins are dried by the heated bitumen, evaporating the interstitial and adsorbed water from the beads. The SGN system is operating in nuclear plants in Europe and Japan. At Barseback, Sweden, the final product contains 40% by weight of dry resins. Since there is some decomposition of the resins during drying, the effective drum loading may be somewhat better than the wt% indicates.

Hitachi, Ltd.

A system under development by Hitachi, Ltd. of Japan, employs a wiped-film evaporator to take normal evaporator concentrates of approximately 25% solids by weight and further concentrate them to a dry powdered product (Fig. 2). Testing has been done on sodium sulfate, sodium nitrate, and sodium borate.

Powder generated from the dryer is introduced into a pelletizer (briquetting machine) after confirming that moisture content is lower than the specified concentration by means of a neutron moisture gauge. Tests made by Hitachi, Ltd. have confirmed that more radsalts can be packaged in the drum with the pellets than just powder.

JGC Corporation

JGC Corporation of Japan has developed a VR system (Fig. 3) which uses a rotor in a horizontal drum mixer half-filled with heated bitumen. Liquid waste is sprayed into the drum mixer, and as the water in the waste comes in contact with the heated bitumen, it evaporates, leaving the salts and residue embedded in the bitumen. The lower half of the drum mixer shell is jacketed and heated by a fluid which is heated by an external source.

The mixer can accommodate all kinds of bitumen, ranging from "Straight Run" to "Air Blown," and the solids content after solidification is about 40% by weight.

Teledyne Energy Systems

Teledyne Energy Systems has developed and is marketing a

VR system using a blender-evaporator as a dryer (Fig. 4). This device is similar in principle to the drum dryer used by JGC, except that the mixer does not contain any bitumen. The waste product is transferred to a hopper by gravity and metered into a Teledyne-Readco mixer where solidification agents are added. The mixer can be purchased with or without a steam jacket. If cement or Dow polyester is the solidification agent, heat is not required. For thermosetting solidification agents, heat is required.

Werner & Pfleiderer Corporation (W&P)

The screw extruder/evaporator system (Fig. 5) offered by W&P works very much like the thin-film evaporator. The system was developed in Germany from the extruder/evaporator used in the plastics industry. The first unit was installed at the Research Center at Marcoule, France, in 1965. While the extruder/evaporator normally uses bitumen as the lubricating and heat transfer medium, it can be adapted for use with other thermoplastics such as polyethylene.

Wet radwastes such as filter sludges, spent resin slurries, or evaporator concentrates, are each fed simultaneously with heated bitumen (~300°F) into a steam heated twin- or four-screw extruder where the water evaporates through steam domes. The solids to bitumen ratio is generally in the range of 1:1, but depends on feed density as well as other system parameters.

The residence time from feed input to discharge varies slightly, depending on the size of the unit, but is on the order of one minute. Evaporation rates for the various sizes range up to 200 liters of water per hour, with a design goal of 99.5% moisture removal. This water is returned to radwaste for reprocessing after pretreatment to remove organics prior to evaporation.

A common feature of the VR systems using bitumen as the solidification agent is that the container package is only partially filled before letting it cool for several minutes to a few hours. W&P and the ATI/SGN systems use a turntable to hold approximately six drums which are each partially filled and rotated to allow complete filling of each drum.

The W&P and ATI systems are both basically continuous processes, and the density of dry product in the output will be a

function of input density. JGC is a semi-batch system in which waste is added to the mixer until the salt concentrations are at the desired density prior to metering into drums. Both the Hitachi and Teledyne systems are batch processes that separate the drying and solidification functions whose output density will be determined by the solidification step.

DRY WASTE VR SYSTEMS

In order to minimize the shipping volume, every nuclear plant processes the dry active waste (DAW) that accumulates during operation and to a greater extent during outages.

Compactor

The mechanical process used at most plants has been the in-drum compactor. Some of the earlier plants used balers, often with wooden boxes. Several companies have offered in-drum compactors that reduce the shipping volume of DAW by a factor of about three. A specially designed in-drum compactor (by Stock Equipment Company) has been in service the last few years which offers a compaction ratio of about five. Several national laboratories and stations experimenting with larger high pressure baling machines report good results in VR, but little performance data is available. Such bales would be shipped in specially constructed containers.

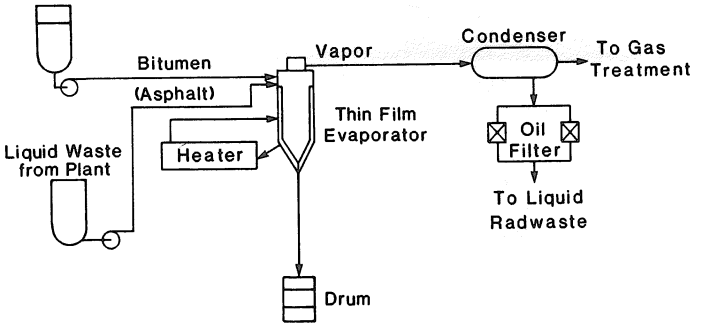
Dry Waste Shredding

Chopping and shredding of DAW is a pretreatment step for several of the incinerator designs, and in particular for the fluidized bed incinerators. Chopping and shredding waste could be used as a VR technique by itself.

DAW has a typical density of 6 pounds/ft^3. After chopping and shredding, the density is about 18 pounds/ft^3, or about 140 pounds of waste per drum, which is close to the density that can be obtained with many compactors. Newer compactors can achieve a density of approximately 30 pounds/ft^3, giving 220 to 240 pounds of waste per drum. Since trash is composed of materials with a density of about 60 pounds/ft^3, there is still room for improvement. This may be achieved in principle by combining shredded dry waste with liquid waste and solidification agent mixtures to displace the entrained air in the trash. This could make possible another factor of two in reduction

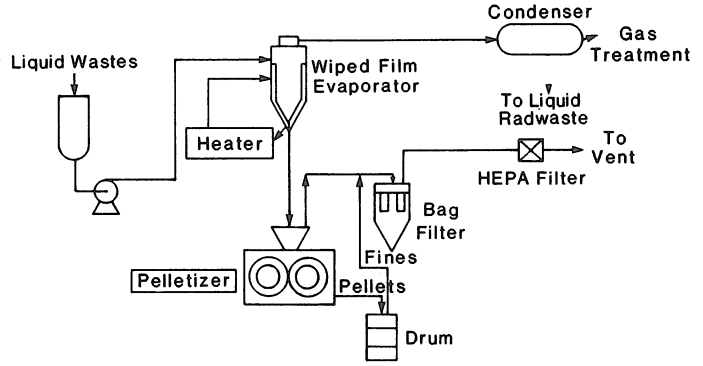
of the overall volume of DAW shipped.

At least one utility has committed funds to testing of a shredder. At tests conducted by Shred Pax Corporation, stainless steel filter cartridges are widely used in PWR's, and stainless steel encased HEPA filters were processed through a shredder. The advantage of shredding the liquid filter elements is primarily the larger quantity of low activity elements that could be shipped in-drum in a solidified matrix. Present practice at many PWR's is to ship one filter cartridge per 55-gallon drum with a concrete sleeve.



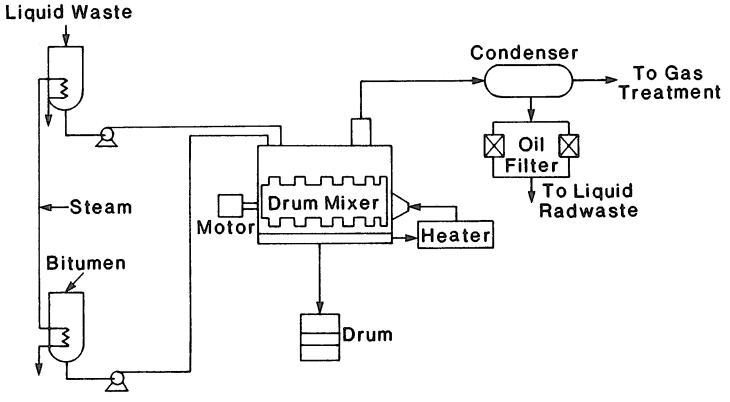
Thin Film Evaporator/Dryer (ATI/SGN)

FIGURE 1



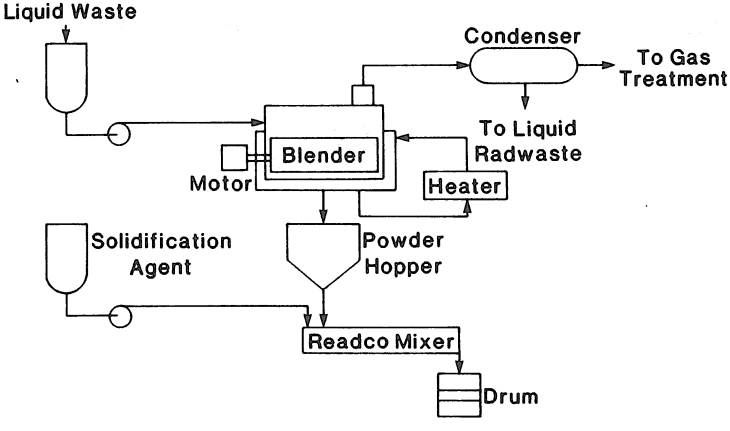
Wiped Film Evaporator/Dryer
(Hitachi)

FIGURE 2



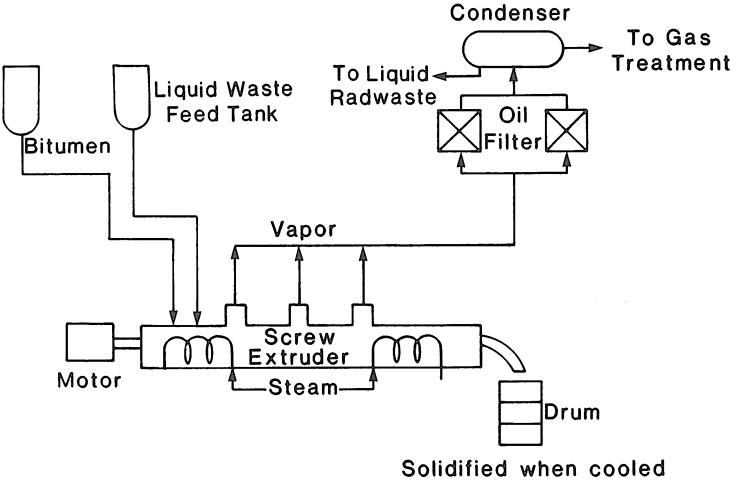
Drum Mixer (JGC)

FIGURE 3



Blender-Evaporator/Mixer (Teledyne)

FIGURE 4



Screw Extruder/Evaporator System
(W&P)

FIGURE 5