Chapter 2

STRATEGIES FOR HAZARDOUS WASTE DISPOSAL AT DOW CHEMICAL COMPANY

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Introduction

Proper technique for the disposal of unrecyclable toxic substances is a problem whose solution is complex, and often controversial. It is a complex and controversial problem for two reasons: primarily, because the present technology available for the disposal of most toxic substances is not adequate, since the environmental and health threats that such substances pose have not been fully documented. Secondly, the disposal of toxic substances is compounded into a numbers game: "How much of what substances are there to dispose?"

It is especially important to keep one point in mind while reading through this paper, specifically, my opening statement on the issue of the difficulty in toxic substance disposal technology. Although it isn't perfect, it's the best technology available, and we should make use of it.

Dow Chemical produces many different types of hazardous wastes, from petroleum to organic-based wastes. Since Dow processes so many different types of wastes, the task of analyzing its strategies for each type of waste produced would be a great one indeed. Therefore, I have chosen to research Dow's strategies for the disposal of hazardous waste solvents. Solvent wastes are a problem not only for Dow, but for the small businesses and households surveyed elsewhere in this project.

Major generators of hazardous wastes, such as Dow Chemical, must continually confront the difficult problem of how adequately to dispose of those hazardous or toxic substances. All generators have a legal obligation to dispose of hazardous wastes in compliance with the "best available technology" (see Lynelle Johnson's paper on federal and state regulations of hazardous wastes).

At the beginning of this research project, I chose to study the issue of how the methods of toxic substance disposal practiced by large generators (Dow Chemical Company) could be applied to the small generators of toxic substances. A toxic waste disposal system for small generators, modelled after one which is presently in use by a large generator of toxic wastes, seemed to be the best solution to the problem of toxic wastes produced by small generators. Since in this project I was unable to accomplish exactly what I set out to do, I will instead discuss the methods of hazardous waste disposal practiced by the Dow Chemical Company, as a background to the problem of adequate disposal of toxic waste solvents.

What Is a Solvent?

Generally speaking, a solvent is a liquid which dissolves another compound to form a homogeneous liquid mixture in a single phase. In broad terms, a solvent is a component of a liquid, solid or gaseous mixture which is present in excess over all other components in the system.

In order to understand the use of solvents in any industry, it is necessary to have a clear knowledge of the properties, availabilities, hazards and utilities of common solvents used routinely for industrial purposes. It is also necessary to have the ability to dispose properly of waste solvents that cannot be reclaimed, or recycled, and otherwise become industrially unuseful. I will focus the topic of discussion on the solvents common both to Dow Chemical and the small generators of waste solvents. Then I will discuss the methods used by Dow in the disposal of these waste substances.

The properties of a solvent are an important consideration in the choice of solvent for a given purpose. Specifically, in industrial processes, attention must be given to vapor pressure, boiling point, flash point temperature, auto-ignition temperature, ease and completeness of recoverability by evaporation and condensation, completeness of separation from dissolved materials by evaporation, inflammability, explosiveness, odor, and toxicity.

Keeping these properties in mind imposes constraints on the choices available for disposal of solvents used in industrial processes. Dow Chemical feels that the routines it follows are, in practice, environmentally sound and economically reasonable. Dow scientists and engineers have a three step process for disposing of used solvents: (1) detoxifying waste solvents; (2) reclaiming and recycling the solvents which are potentially marketable; and (3) the complete destruction of the unrecyclable wastes by incineration. But why incineration? What are the effects on air quality and consequently the effects on health? Before I answer these and other questions pertaining to incineration, let us consider the other methods of waste disposal available to generators of large amounts of hazardous waste materials.

Waste Disposal Alternatives

Landfilling

Landfilling is a process by which waste materials are taken to a designated area and buried. Waste materials must be selected carefully and must be classified according to standards established by the Environmental Protection Agency, prior to being buried.

The major method for disposing of waste solvents is by placing the hazardous material in containers, and then burying them at these sites. This practice may be only a temporary answer, however, because sooner or later (through a variety of possible circumstances) the wastes may find their way back into the active environment. If this were to happen, the delicate biological and chemical balance of the environment would be upset for an indefinite amount of time.

Rigidly constructed containers cannot be guaranteed to remain intact for an indefinite amount of time. Given a scenario where a hazardous solvent is placed in a waste container and buried, we must consider the consequences of such wastes leaching out into the immediate environment of the landfill. In such an event, the first and foremost concern is the threat of groundwater contamination.

It is very difficult to trace the movement of hazardous wastes through subterranean aquifers, especially if the properties of those wastes were somehow altered since their burial and prior to their leaching into the aquifers. If the solvent is miscible in water, how concentrated will it become within the aquifer in a period of time? The answer to this question relies on accurate records of wastes disposed of at the site. The Environmental Protection Agency (EPA) estimates that of the 4.5 billion tons of wastes generated each year by agriculture, mining and industrial business, 58 million pounds of this total (1%) are hazardous waste (C.M.A., 1980). Clearly, then, it is out of the question simply to bury all that waste. To examine further this point, let us consider other consequences of landfill disposal.

Site selection for a proposed landfill may prove difficult, since such decisions will affect not only the immediate environment of the site, but will also affect the future development of such land for agriculture, urbanization and open-space recreation areas.

Indirectly related to the question of site selection and location is the question of transportation of the wastes to the area. Great strides have been made in the area of regulations which monitor the companies that transport the hazardous wastes as well as those who dispose of the material (see paper by Lynelle Johnson). Unfortunately, very little can be done by the government to reduce the danger associated with transporting hazardous materials, in some cases, great distances to remote sites. Danger of spillage due to highway or railway accidents cannot be reduced. Despite safety measures applied to tanker trucks on the highway and railroad cars on the railway system, accidents are statistically inherent in the transportation network (CMA, 1980), since accidents increase in proportion to an increase in mileage travelled to the dumpsite. Hence, transporting hazardous substances a long distance can be as inconvenient as it is expensive.

The Dow Chemical Company "strongly encourages that landfill disposal techniques be phased out as fast as possible, to develop methods to effectively destroy hazardous wastes if they cannot be used as raw materials to produce something else that is useful...." (Jones, pers. comm., 1984).

Dow strongly favors the disposal of wastes within its own plant; recycling and treating those substances which are not hazardous and can therefore be resold, and incinerating or solar evaporating those wastes which are hazardous.

For the types of solvents that Dow produces, incineration is an acceptable alternative to land burial, since at high temperatures, all of those solvents break down to inert, less hazardous constituents. The solvents which are common to both Dow Chemical and small generators of hazardous wastes are toluene, acetone, benzene, ortho-dichlorobenzene, and perchlorobenzene. The Industrial Solvents Handbook (Melan, 1977) gives the properties of these solvents.

Incineration as an Alternative to Waste Disposal

Incineration is the complete destruction of materials to their inert constituents. The incineration of waste products results in the production of a sterile residue and a reduction of flue gas to near zero visible emissions. The reduction in weight from the influent is greater than 90% (Brunner, 1980). Due to the cost-effectiveness of incineration systems, and because of land use restrictions (for landfills), the number of incineration facilities built since the 1970's has increased (Brunner, 1980).

Although capital cost is initially high, there are many unique advantages to incineration: the technology is available to meet the most stringent air pollution criterion, incineration can achieve a rapid and substantial reduction in volume; and the incineration process is compact and requires nominal land area compared to that used by land filling techniques. Furthermore, incineration can take place at the point of generation of the waste products. Thus, the need to transport solvents to a distant disposal site is eliminated. (Often, the air pollution resulting from truck hauling of wastes is greater than that of the incineration discharge!) Finally, incineration systems have a useful life of ten to fifteen years before replacement or major overhaul is necessary. Public acceptance of a continued incinerator presence is easier to obtain than acceptance of new land disposal sites, particularly when a distant area is asked to accept imported wastes.

Industrial Incineration Processes

In preparation for incineration, the wastes must undergo several treatment processes prior to the actual incineration. These treatment processes and their functions are described in Figure 1.

The incineration system in operation at Dow Chemical and other petrochemical plants is called the Fluid Bed Incinerator, which was first developed by Standard Oil in the first part of this century for catalyst recovery in oil refining. Its use is increasingly gaining popularity in the United States (Olexey, 1975).

The Fluid Bed Furnace is a cylindrical, refractory-lined shell, with a shelf-like supporting structure which holds a bed of sand. The waste is introduced within the fluid-bed (Figure 2). The air flow must be carefully controlled to prevent the liquid waste from floating on top of the bed. This flow of air, called fluidization, provides maximum contact with the waste liquids for optimum burning. The drying process is almost instantaneous, since moisture flashes into steam upon

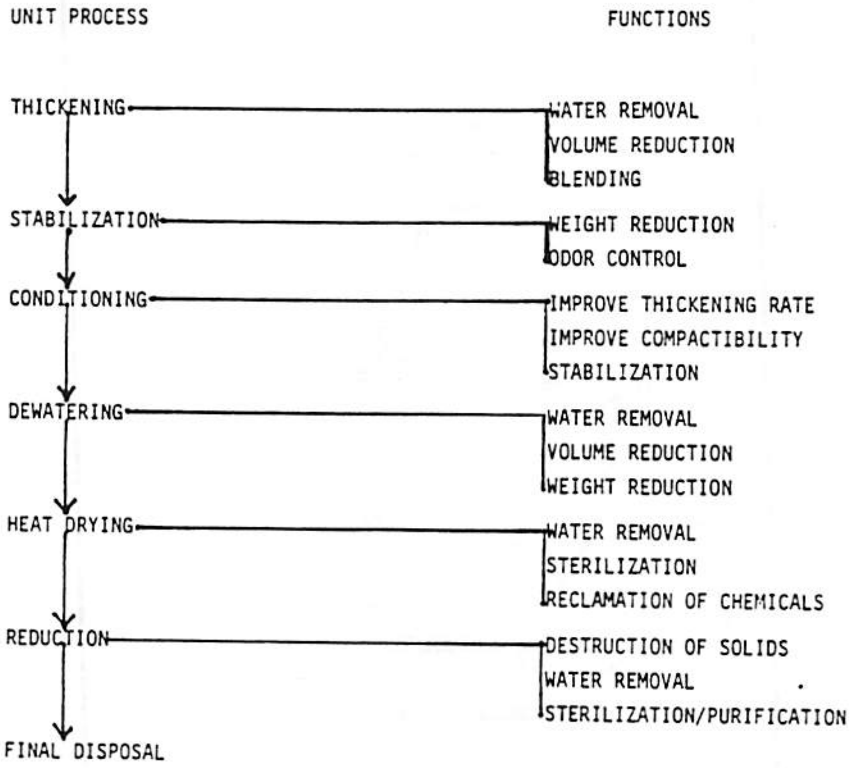

Figure 1. Description of Incineration Treatment Processes and Their Functions.
Source: Brunner, 1980.

entering the hot-bed.

The furnace itself is an extremely simple piece of machinery, with virtually no moving parts. Since the furnace contains so much sand, it is effectively a heat sink, which can be shut down with a minimal heat loss. It has a very tight system, and the sand will retain heat to allow start-up after a weekend shut-down, with need for only one or two hours of re-heating before the waste products are introduced at 1200°F.

Because of the mixing of air and waste within the fluid sand bed, excess air requirements are low, from 20 to 40%. The air above the sand bed is kept at a constant 1200 to 1500°F, which allows the residence time of the flue gases at those temperatures to be very short, and at the same time obtains a complete burn-out and elimination of odors.

The wastes are force-fed into the furnace with either a positive displacement pump or a screw/plunger type feeder. The problem with force feeding a furnace is that there is a tendency for the wastes to dry and harden within the feeder during periods when the furnace is maintained at high temperatures for long periods of time without feeding in any wastes.

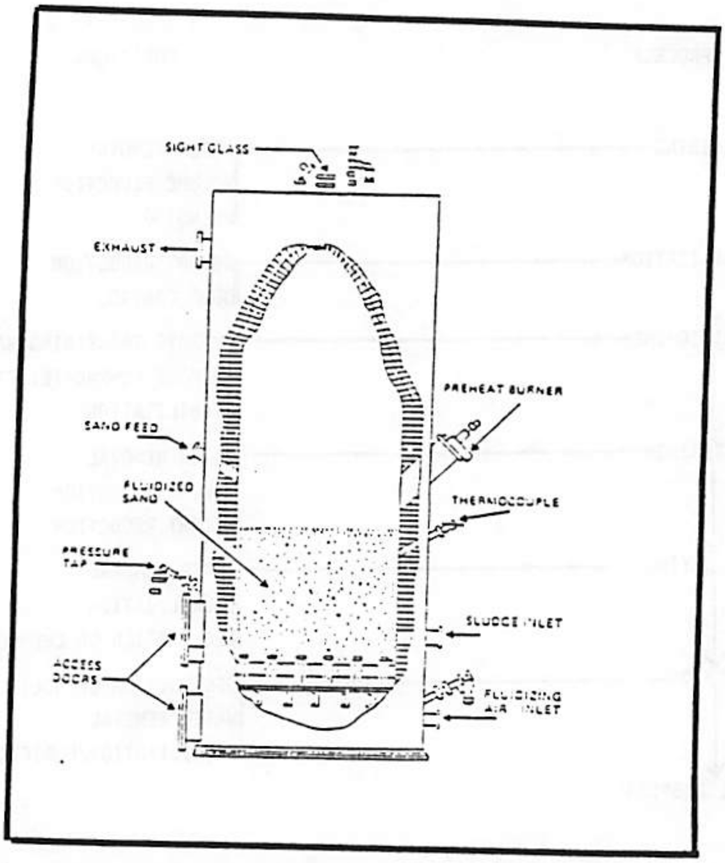

Figure 2. Cross Section of the Fluid Bed Incinerator.
Source: Brunner, 1980.

The Fluid Bed Furnace has one major item of air-moving equipment: the forced draft fan. The fan is sized to blow the flue gas through the gas scrubbing systems, which necessitates that the reactor is pressurized and tight, to prevent leakage of flue gas.

Given its simplicity in design and practicality in use, the Fluid Bed Furnace is the best incineration system available for the incineration of liquid wastes (Brunner, 1980). Those wastes, once purified and sterilized, are easily reclaimed from the furnace for use as raw materials in the production of other chemicals.

<u>Conclusion</u>

At Dow Chemical's Pittsburg plant, approximately 3,000 tons of "wet hazardous wastes" are generated per month. Dow disposes of 98% of those wastes at its plant by recycling, through incineration or treatment in specially constructed solar evaporation ponds.

On the other hand, small generators of hazardous wastes do not generate nearly as much in hazardous "wet wastes" per month as Dow Chemical does. These small generators also do not have the method of safe disposal and recycling available to them as Dow does.

When these parameters are taken into consideration, it is evident that a system of hazardous solvent recycling and disposal modelled after large generators would not be cost-effective for small generators.

The burden of setting the right example of conservation, recycling, and efficient disposal of hazardous wastes, rests heavily on large generators of those hazardous wastes. This, coupled with the continued emphasis on enforcing environmental legislation, will reduce the threat posed by toxic substances. Thus, a rigid system of monitoring the environmental practices of large generators of hazardous wastes will make the public more keenly aware of the magnitude of the efforts which these large generators are making. This practice, coupled with an intensive education program for the public on environmental issues will permit us to enjoy an environment which will become cleaner and more healthful.

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