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INDUSTRIAL WASTE DISPOSAL

and Bibliography on Chemical Wastes

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1. This pamphlet outlines briefly the hazards and problems of the complex processes of safe disposal of industrial waste. It contains some suggestions for the elimination of such hazards, but answers to many questions regarding safe and proper methods are not yet available.

2. Inasmuch as kind of waste, amount, existing facilities, and plant location differ so widely, the pamphlet makes no attempt to provide detailed answers to specific problems. The bibliography gives an index to more detailed discussions of some of the problems. However, each problem has to be solved by itself and should be handled by an expert.

3. Interest in the subject of industrial waste disposal is increasing rapidly and will probably continue to increase as more is known about the protection of public water supplies and wild life and as industries become more concerned with providing pleasant communities where living conditions are good.

4. The problem is important to safety men because improper methods of disposal have caused injury and disease among plant personnel and members of the general public, as well as damage to property. Improper practices have created nuisances such as deterioration of the recreational value of lakes and streams and increased load on water treatment facilities. Such occurrences can be considered valid reasons for some of the ill will which has been directed toward certain industries.

5. Sometimes municipal or district sewage disposal departments will not accept industrial waste which interferes with efficient operation of their disposal processes. Some liquid wastes and chemicals have properties that do strongly interfere and may cause serious overloading of the disposal facilities.

This pamphlet is one of more than 150 Safe Practices and Health Practices Pamphlets. It is a compilation of experience in accident prevention from many sources. It should not be assumed, however, that it includes every acceptable procedure in the field covered. It must not be confused with American Standard safety codes; federal laws; insurance requirements; state laws, rules and regulations; and municipal ordinances. *Additional copies of this pamphlet are available. Member price, 40 cents each. Quantity and non-member prices on request.*

6. To meet increasing demands for proper waste disposal, the following information must be secured: amounts and kinds of wastes being made, properties and characteristics of these materials, and methods of disposal for each kind. Present disposal practices should be examined for possible sources of personal injury (either in the plant or outside), property damage, or nuisance.

7. The investigator should find out whether local, state or district ordinances or regulations on air or stream pollution are being violated by his plant. These regulations or ordinances may be published by departments of health, by departments of waterways or conservation, or by fish and game commissions. Such regulations may be particularly important in the selection of a site for a new plant.

8. Manufacturing concerns in the same type of business do not necessarily have the same kind of waste disposal problems. Much depends upon the location of the plant - whether it is in a manufacturing, residential, or farming district - as well as upon variations in the processes used. A solution applicable at one plant may not be at all satisfactory at another plant employing a similar process. One of the most important factors which determine the suitability of a solution is the ability of receiving streams to assimilate the waste without damage.

9. The following list of industries or processes which sometimes produce nuisance or hazardous wastes is by no means complete, but it may serve as a guide:

- Chemical pulp and paper manufacturing
- Vegetable canning and packing
- Ore smelting
- Milk depots (butter, cheese, and by-products)
- Beet sugar manufacturing
- Sawmilling
- Wool scouring
- Distilleries
- Oil refineries
- Fertilizer plants
- Gas plants
- Viscose rayon plants
- Yeast manufacturing
- Oil production and refining
- Ore flotation (tailing piles)
- Fish and meat packing and canning
- Textile finishing and bleaching
- Tanning
- Steel plants (pickling)
- Laundries
- Millboard manufacture
- Breweries
- Acid plants
- Chemical manufacturing
- Coal manufacturing
- Coke plants
- Explosives manufacturing
- Coal mining and washing
- Machine shops (waste cutting oil)
- Metal mining

10. When a survey of wastes is being made, they can sometimes be listed according to the following classification:

a. Waste disposed of by release into the air
b. Waste disposed of in streams (or other bodies of water)
c. Waste disposed of in dumps or on the land
d. Waste disposed of by evaporation

Air Contaminants

11. In the group of possible air contaminants are:

Smoke and fly ash from power plants
Sulfur dioxide* from smelters
Dust from foundries, cement mills, etc.
Hydrogen sulfide and carbon disulfide from viscose rayon plants
Oxides of nitrogen from nitration processes
Fluorides from metal reduction plants and fertilizer works
Acid gases from chemical operations and pickling and plating
Toxic gases (carbon monoxide, chlorine, hydrogen cyanide, and many others) from chemical and metallurgical operations
Objectionable odors
Organic solvent vapors

12. Smoke and some objectionable gases can be safely discharged through stacks ranging from 150 to 300 or more feet in height. The lower stacks are relatively inexpensive. The important factors to be considered in the use of this method are the nature of the surrounding territory, the direction of the prevailing wind, the toxicity or nuisance value of the particular contaminant, and its reasonable allowable limits.

13. Acid gases may be condensed in raindrops and, even though discharged from high stacks, may descend to damage materials or crops. In some instances processes must be discontinued during certain weather conditions such as rain or particular wind directions.

*Sulfur dioxide is one particularly harmful air contaminant because, in concentrations not perceptible to the senses of human beings, it has a serious effect on vegetation. Fluorides are also especially harmful. Deposited upon the vegetation eaten by farm animals, they have caused illness among the animals.

14. Direct heating of stack gases by a coal-fired Dutch oven or a gas burner will expedite atmospheric dissemination, sometimes more economically than excessive stack height, particularly when peak loads of short duration are being handled.

15. Some gases can be partially burnt before being put into the stack provided that they will support combustion or can be economically enriched. This method destroys many objectionable odors, such as those produced in the tanning and fertilizer industries.

16. Solids can be removed from suspension in the air (and recovered if desired) by dry filters, wet collectors, cyclones, electrostatic precipitators, or combinations of these kinds of equipment. Here the important factors are the amount of the recovered solid, its value, if any, and the physical and chemical characteristics of the material.

17. Wet or soluble gases and dusts can be absorbed in spray towers, which are rather simple and inexpensive. The amount of the gas, its chemical properties, its reasonable allowable limits, and disposal of the waste solution - often a serious problem - are important considerations. Sulfur dioxide and many of the acid gases are in this class.

18. Many organic solvent vapors and gases can be absorbed or adsorbed. Commercial systems and units designed for this purpose are available. One advantage of absorption or adsorption methods is that useful volatile chemicals and solvents can be recovered by means of them. One objection to general use of these methods is the relatively high initial cost, but in a number of instances the systems have more than paid for themselves in the value of the recovered chemicals.

Stream Contaminants

19. Some of the industrial wastes which may under some circumstances become objectionable stream contaminants are listed below:

Waste pickle liquor and rinse waters from pickling
Spent acids
Sulfide liquor (and other chemical pulp wastes)
Spent plating solutions and rinse water from electroplating operations
Spent viscose spinning bath solutions
Spent tanning baths
Used cleaning solutions
Spent dye baths - soap solutions
Chemical wastes of all kinds and particularly those producing tastes or odors or both
A large number of animal and vegetable wastes in solution or suspension, by-products of food or beverage manufacturing*
Waste oils of all kinds
Wool scouring wastes
Phenolic chemicals
Paper mill machine water
Beater wastes
Acid waters from mining operations

20. Before waste disposal plans are made for such stream-polluting materials, each waste-producing process should be studied to determine if such wastes or such volumes are absolutely necessary. Many solutions now wasted, such as plating solutions, viscose spinning baths, and spent acids, can be used almost indefinitely by filtration, clarification, and refortification. In some chemical processes wash waters and rinses can be used as make-up water for the next batch.

21. A usable or salable product can sometimes be recovered at a profit. Usually, however, systems for recovery require additional equipment or buildings, and recovery costs more than the product is worth.

22. Recovery is always worth consideration - particularly if the waste disposal problem is acute. It is often cheaper to recover a material from waste than to destroy the waste and buy the material. An outstanding example of recovery from waste materials is the feed recovery process employed in whisky distilleries.

23. Reduction of the volume or concentration of waste waters may increase economy of operations in some industrial processes. For example, re-use of the white water in paper manufacture has prevented

*These materials are innocuous in themselves, but serious nuisances because of their tendency to putrefy.

the loss of valuable fiber as well as heat and chemicals, in addition to reducing the waste disposal problem.

24. Other outstanding examples, although somewhat limited in application, are the recovery of alcohol or vanillin from waste sulfite liquor and the recovery of copperas or pigment grade iron oxide from waste pickle acid.

25. The investigator should get some measure of the volume, as well as the chemical strength, of the liquid wastes in his plant. If an organic waste is being produced, the biological characteristics may be more important than the chemical strength. A complete study of liquid waste which is being discharged into a stream will provide information on the flow of the stream and its capacity to absorb such waste without damage. Calculation of minimum stream flow during dry periods is essential.

26. Information should also be secured on all uses of the stream below the point of waste discharge. The requirements for water purity of a stream will vary widely depending on whether the water is a source for municipal supply, for industrial use, for recreation, for commercial fishing, or possibly for general farm uses.

27. Some liquid wastes can be treated or neutralized chemically. This method is feasible when the products of the chemical treatment are less objectionable than the original waste or when they present an easier disposal problem. Many acidic and basic wastes are in this class and can be neutralized, then filtered or settled and decanted.

28. Objectionable solids in suspension can be settled with or without coagulants or by filtration. Occasionally filter aids facilitate the process. Some exceedingly fine materials in suspension (colloids) can be settled satisfactorily, and the clear effluent can be decanted if such flocculating agents as alum or soluble iron salts or such aids to flocculation as lime are first added.

29. The lagoon or settling pond is useful in this type of process. In fact, lagooning of many liquid wastes so improves the effluent that further treatment is not necessary. This process of natural purification is particularly important where operations are seasonal and do not warrant a large expenditure for waste disposal facilities. Vegetable canning plants have made considerable use of lagoons for natural purification.

30. Liquid wastes produced intermittently can sometimes be held in storage and released either at a slow, controlled rate or at times of high water flow. The storage method minimizes the probability of damage which might occur if the wastes were released in large batches, as produced, and sometimes eliminates the need for further treatment. It almost always facilitates the application and control of treatment.

31. Many liquid wastes, mainly those from the food processing industry, contain organic substances in solution or in suspension. These substances are not poisonous in themselves, but they do putrefy and change into highly offensive solid and gaseous by-products. A stream contaminant may thus become an odorous air contaminant even at some distance from the source.

32. The greater hazard, however, is that in the process of putrefaction the dissolved oxygen is removed from the lake or stream or so depleted that the water cannot be used for its normal purposes. Unless the plant producing this type of waste has access to suitable waste disposal systems, trouble may be expected sooner or later.

33. Proper disposal of these organic wastes is a job for experts. However, it can be pointed out here that the problem should first be approached with the object of recovering a usable product. Reduction or re-utilization of the waste or treatment of the waste can then be considered.

34. After the extent of the problem has been determined, the possibility of a recovery process which will either operate at a profit or pay a portion of the operating cost should be exploited to the fullest. This recovery may require additional processing and equipment.

35. If by-products cannot be recovered, the possibility of re-utilization of the waste water in the process, or reduction of the volume or concentration of the waste, or both, should be investigated. Frequently re-utilization will solve the problem. Treatment should be resorted to only when the other two possible courses have been exhausted.

36. Where recovery is not practicable, or where the waste liquids have objectionable properties after recovery, treatment is necessary. This treatment is usually the kind of processing employed in municipal waste disposal plants, modified according to the characteristics of the waste. Often treatment at the source is more practical than treating the entire plant effluent. In any case, treatment is emphatically a job for experts.

37. Waste waters may be safely skimmed and discharged if insoluble oils which can be removed by the skimming process are the only contaminant. Some emulsified oils can be separated from the water by the process of "salting out" or by flotation. Change in the pH of the mixture, electrical precipitation, or centrifuging are also useful methods for breaking some kinds of oil emulsions.

Disposal of Solid Materials

38. Waste solid materials usually can be safely disposed of on dumps. It is necessary to know the properties of the wastes being dumped, and it is recommended that a plan of the plant premises be made, showing areas used for dumping and precisely what has been dumped in each area. This information may become important in the location of future buildings.

39. Some solid waste may be dispersed over large ground areas rather than collected in dumps. This method is particularly advantageous in the disposal of small quantities of hazardous material or in instances in which water dilution is not possible.

40. Whatever method of dumping is used, it is important that the dumps be fenced off or otherwise guarded and that the housekeeping

be excellent so that the dumps will not be hazardous to plant personnel and to possible trespassers, particularly children.

41. If the wastes contain water soluble materials, the natural drainage of the dump area and the permeability of the soil have to be considered. Soluble chemical substances placed on dumps have been leached out by rains and have contaminated neighboring streams or damaged crops in nearby fields. Soluble chemicals and oils in waste materials have also seeped for considerable distances through porous formations under dumps and have reappeared in wells used as sources of drinking water.

42. Combustible waste material has become ignited on dumps and has caused serious burns. Magnesium chips and filings may be spontaneously flammable. Certain chemicals such as sodium react violently with water, and under certain circumstances the reaction may serve as a source of ignition for other combustibles. Other chemicals such as the sulfides, cyanides, or phosphides may react with water or with weakly acid solutions to produce poisonous gases.

43. Corrosive and poisonous chemicals, explosives, and unstable compounds dumped in bulk or not completely removed from discarded containers have also caused serious injuries.

44. It is a safe rule that every combustible waste material placed on a dump should be burned under controlled conditions. However, some solid materials which are only moderately combustible can be covered with sanitary earth fill instead.

45. Containers should be discarded only after their contents have been completely removed. Strong acids and caustics should be neutralized before they are dumped. Explosive materials, unstable chemicals, or poisonous mixtures should be rendered harmless. Containers under pressure or those which might generate pressure should be permanently vented before being discarded.

46. Waste wood, scrap paper, and such combustibles should be burned as they accumulate unless they can be baled or briquetted and some of their value recovered. Incinerators can be built to burn this kind of material safely. Their proper use improves the appearance of what otherwise might be an unsightly area.

47. Oils (after rough separation from water), waste solvents, and other flammable liquids can be flowed into a shallow trench (the size of which will be determined by the volume of material to be disposed of) and ignited from a safe distance by means of a fuse. This arrangement will safely burn a number of sludges and mixtures, even greases and waxes.

48. If a waste mixture is not flammable enough to burn alone, flammable solvents, which may themselves be wastes, can be added. Care should be taken that the smoke and gases given off by such burning wastes do not become an air pollution problem.

49. If the heat value of waste solvents or oils is high enough, they may be piped to a special tank and burned under the plant boilers. The effect of possible contaminants on furnace linings and tubes should be considered before this method is attempted. Also, no attempt should be made to recover heat from oils or solvents with flash points too low for them to pass safely through the burners.

50. The problem of disposal of radioactive wastes will become increasingly important as atomic power and radioactive isotopes find applications in industry. The problem will ultimately have to be solved on a national basis.

51. It is obvious that no radioactive substances should be discarded until the amount of radioactivity has been monitored. Waste containing excessive amounts should be stored in protected, guarded areas which are monitored periodically. Such waste should be held until a national policy for the handling of it is formulated.

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