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ENVIRONMENTAL ENHANCEMENT AT AIRPORTS - INDUSTRIAL WASTE TREATMENT

DEPARTMENT OF TRANSPORTATION
FEDERAL AVIATION ADMINISTRATION

Initiated by: AAS-560

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FEDERAL AVIATION ADMINISTRATION

SUBJECT: ENVIRONMENTAL ENHANCEMENT AT AIRPORTS - INDUSTRIAL WASTE TREATMENT

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1. PURPOSE. This circular provides basic information on the nature and treatment of industrial wastes produced at airports.

2. REFERENCES. The publications listed in Appendix 1 provide further guidance and detailed information.

3. APPLICATION. This publication is a basic tool for use by airport authorities in evaluating industrial waste treatment needs at airports.

4. HOW TO GET THIS PUBLICATION. Additional copies of this advisory circular may be obtained without charge from the Department of Transportation, Distribution Unit, TAD-484.3 Washington, D.C. 20590.

Clyde W. Pace Jr.

CLYDE W. PACE, JR.
Director, Airports Service

Initiated by: AAS-560

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CHAPTER 1. INTRODUCTION

1. BACKGROUND. The Department of Transportation Act of 1966, the National Environmental Policy Act of 1969, and the Airport and Airway Development Act of 1970 require the protection and enhancement of the environment surrounding the nation's airports. An important environmental consideration is the effect of airport produced industrial wastes on municipal sewage systems and adjacent natural bodies of water.

2. AIRPORT INDUSTRIAL WASTES. Although airports are not usually considered as industrial complexes, daily activities, such as aircraft maintenance and repair work (including painting and metalwork), aircraft and motor vehicle washing, engine test cell operations, and fueling operations, are all sources of industrial waste. Because of their variable characteristics, industrial wastes are more difficult to treat than sanitary (domestic) sewage and present a significant potential stream pollution hazard.

3. WATER QUALITY STANDARDS. All states have water quality standards which have been approved by the U.S. Environmental Protection Agency (EPA). These standards are based on the effects of various effluents on natural bodies of water. Application of guidance in this advisory circular will assist airports to conform to the various state standards.

4. STORM WATER AND RANDOM OCCURRING WASTES. The specialized treatment of storm water and random occurring wastes has not been standard municipal practice. The reasoning behind this has been that the high dilution of storm water wastes and infrequent occurrence of wastes from snow removal and street cleaning operations would not significantly affect receiving bodies of water. This has also been the case with airports (e.g., use of calcium chloride, rubber removal, and minor fuel spillage). However, the EPA will be initiating research on the nature and effects of urban runoff, and it is conceivable that regulations may be issued in the near future requiring the treatment of these wastes as well. To estimate the extent of treatment which may then be required is beyond the scope of this publication. It would seem prudent, however, in the planning of airport expansion or the construction of new airports, that airfield drainage systems have the capability, when required, of channeling certain portions of all airport runoff to one location for waste treatment processing.

CHAPTER 2. INDUSTRIAL WASTE HAZARDS AND NUISANCES

5. FIRE AND EXPLOSION. Highly flammable compounds and vapors contained in some industrial wastes are fire and explosion hazards, particularly when discharged freely into sewers, natural bodies of water, or into the ground. Vapors from volatile solvents, fuels, and oils may travel considerable distances in certain soils and form explosive concentrates in low, enclosed places. Wastes with a high solids content may cause deposits that form explosive gas during decomposition.

6. TOXICITY. Certain industrial wastes can be poisonous to human beings, livestock, and aquatic life, either by direct contact or through the contamination of water supplies. Metal finishing wastes, such as cyanide and chromium, and certain organic compounds, are highly toxic in minute concentrations if discharged to receiving streams or ground water strata. Mixed solutions of metal wastes can be much more toxic than simple solutions of corresponding or greater concentration. The formation of sludge deposits by certain industrial wastes can create a potential health hazard to prospective users of the stream, as well as restrict or make impossible its use for recreational or agricultural purposes.

7. INTERFERENCE WITH STREAM PURIFICATION. The self-purification of streams depends largely on a sufficient supply of oxygen to support the life and activity of fish and other aquatic organisms. Oils and greases form mats and slicks that hinder reoxygenation of streams. Wastes with heavy organic loads utilize available oxygen and form sludge deposits that interfere with stream self-purification processes.

CHAPTER 3. TYPES OF INDUSTRIAL WASTE

8. GENERAL. The industrial wastes generated at airports are primarily products of metal plating, aircraft and vehicle washing and cleaning, and repair of engine parts.

9. CYANIDES. Cyanides are produced in metal plating, steel hardening, rust prevention, and stain removal operations. They are a source of danger to potable water supplies and, in concentration above 0.2 parts per million (p.p.m.), capable of destroying aquatic life.

10. CHROMIUM COMPOUNDS AND OTHER TOXIC METALS. Chromium compounds originate from chromic plating, bright dipping, copper stripping, and anodizing operations. Other toxic metal wastes, such as copper, lead, and zinc, are produced in metal plating operations.

a. Discharge of these wastes above certain concentrations into sanitary sewer systems causes a toxic reaction in the anaerobic sludge treatment plant. The hexavalent chromium compounds resulting from plating and anodizing operations are toxic in small concentrations to aerobic sewage treatment processes. Chromium in the trivalent form has been found to be detrimental to sludge digestion.

b. The toxicity of chromium salts, both trivalent and hexavalent, is less pronounced for fish life than for supporting aquatic organisms and varies widely with pH (acidity/aklainity), temperature, and hardness of the receiving stream. Drinking water standards of the U.S. Public Health Service limit hexavalent chromium to 0.05 p.p.m., with other maximum concentrations listed as lead, 0.05 p.p.m.; copper, 1.0 p.p.m; and zinc, 5 p.p.m

11. ACIDS AND ALKALIES. The acids and alkalies produced in pickling and cleaning operations corrode metal and concrete sewer pipes. Acid wastes interfere with sludge digestion and biological action in treatment processes and are toxic to fish. The pH of the industrial wastes to be carried through sanitary sewers should be between 6.0 and 9.0. Where both acid and alkali wastes are involved, mixing of the two may provide the required pH rating.

12. ORGANIC SOLVENTS AND PHENOLS. These wastes, produced in paint removal and the cleaning of aircraft and powered ground equipment, create explosion and toxicity hazards, interfere with sewage treatment, and pollute potable water. The average pH values of cleaning compounds range from 7.0 to 9.0, and the solvents contained interfere with the bacterial activity in sludge digestion. Solvents and phenol in particular produce objectionable tastes and odors in water supplies. U.S. Public Health drinking water standards specify a maximum phenolic content of 0.001 p.p.m.

13. GREASES, OIL EMULSIONS, AND DETERGENTS. These wastes result from cleaning of aircraft and powered ground equipment and vehicle maintenance shop operations. Grease and oil wastes should be segregated to avoid coating carrier systems and increasing the Biochemical Oxygen Demand (BOD). Grease-oil coatings will also interfere with the efficiency of the precipitants used for the sedimentation of industrial wastes. The mixing of dirt with cleaning wastes increases emulsions and clogs small openings in treatment units unless screened out. Detergent wastes, which usually carry pH values ranging from 9.0 to 10.8, cause partial sludge flotation through release of carbon dioxide.

CHAPTER 4. INDUSTRIAL WASTE SURVEYS

14. OBJECTIVES. The general objective of industrial waste surveys is the determination of the sources, characteristics, flow patterns, and volumes of liquid wastes discharged to natural drainage. The specific aim is to establish a sound basis for the treatment of these wastes, including the utilization of waste treatment by-products, and the reduction or elimination of wastes by process modification.

15. REQUIREMENTS OF WASTE SURVEY PLANNING. Requirements of waste survey planning include familiarity with the industrial processes used, operating schedules, sources of individual wastes, and the airport industrial sewer system. In order for the survey results to be of maximum value, it is necessary that the data be correlated with the records of airport industrial operations for the survey period. The length of the survey is determined by the period required to register the effects of all waste-producing operations.

16. FLOW MEASUREMENT. Flow of both specific and combined wastes should be measured at representative points and expressed in such standard units as gallons per minute (g.p.m), gallons per hour (g.p.h.), or gallons per day (g.p.d.). The method used to determine the volume of wastes will depend on the size of flow. Common metering devices include weirs, nozzles, flumes, and flow-meters.

17. SAMPLING. Accurate sampling, a necessity for correct analysis of industrial wastes, is one of the most difficult aspects of industrial waste survey work. Industrial wastes are seldom homogeneous and their composition may vary widely in the space of minutes. They frequently contain material in suspension as well as solution. Either grab or composite samples, as required, should be taken in direct proportion to the flow and be properly preserved before analysis. The sampling operation should be as frequent as available manpower permits. Only by frequent sampling can an accurate determination of average waste concentration be made. A recommended sampling interval is 10 to 15 minutes, with a maximum of 1 hour.

18. ANALYSIS. State water pollution control authorities establish limits for BOD, pH, dissolved oxygen (DO), total solids (suspended and dissolved), effluent temperature, color, turbidity, oil, and grease. The recommended reference work on analytical procedures is Standard Methods for the Examination of Water, Sewage, and Industrial Wastes published by the American Public Health Association.

CHAPTER 5. COLLECTION

19. COLLECTION SYSTEMS. Industrial wastes containing an appreciable amount of solvents, sludges,oils, greases, acids, or alkalies must be segregated and treated prior to discharge into sanitary sewers or receiving water. Several types of collection systems are used.

a. Open. Open ditches and canals, although not suitable for the collection of industrial wastes involving fire or explosion hazards or odor nuisance, may be used to carry other industrial wastes if concrete linings are provided to minimize the percolation of waste liquids into the soil and potential contamination of ground water. In general, open collection systems are not desirable because of unsightly appearance and hazard to the public.

b. Closed. Closed systems are commonly used for industrial wastes and sanitary sewage. Separate sewers are sometimes required because of the nature of industrial wastes and their adverse effect on the treatment of sanitary sewage. If industrial wastes are to be carried in sanitary sewers, they should be pretreated to avoid harmful effects.

c. Special. Special provisions, such as the use of holding tanks, must be made for some noncompatibile wastes which cannot be discharged into sewers without danger of fire, explosion, or damage to the material of the sewer.

20. SEWER MATERIALS. In most cases, the same materials are used for industrial wastes and sanitary sewage. These materials include vitrified clay and asbestos cement. Acid wastes are particularly corrosive to cement and concrete. Wastes with temperatures above 150°F. may damage sewer joints and should be cooled before being discharged into the sewers. In the selection of piping and pumps, consideration should be given to the corrosive and other damaging effects of many industrial wastes on concrete and metal.

21. DRAINAGE AND STORM FLOW. The combination of storm flow and runoff with industrial wastes should be avoided. Such a combination may lead to eventual sewer destruction during periods of drought and to health and property hazards. If storm water is received in the same sewer for the purpose of diluting untreated industrial wastes, the carrier's capacity should be increased and other factors, such as sand and grit, considered.

CHAPTER 6. GENERAL TREATMENT METHODS

22. WASTE CONCENTRATION REDUCTION. Proper handling of waste materials and the observance of good housekeeping practices can reduce the amount and concentration of industrial wastes.

a. Waste materials can be properly segregated according to groups in holding tanks and treated in concentrated form when the quantities involved are large enough to cause operational difficulties if included in the general waste flow. These materials include: concentrated acids, concentrated alkaline solutions, cleaners, solvents, plating solutions, stripping solutions, cyanide wastes, and phenol compounds.

b. Separated wastes can be periodically transported to an industrial waste plant for disposition at times and rates most favorable to plant operations. The batch treatment of certain wastes will be required in many cases. The collection and transportation of individual wastes will depend on such variable factors as size of plant, amount of wastes involved, type of waste dilution factors, and stream standards.

23. COMBINING WASTES. The most desirable and economical method of treating industrial wastes is by combination with sanitary sewage for treatment in the same plant. Pretreatment, however, is generally necessary to prevent the damaging effect of acids, alkalies, oils, and greases on treatment units and interference with biological treatment methods. Consideration should always be given to grouping industrial wastes because of the operating economies involved (e.g. acid wastes with alkaline wastes, small volume of high BOD wastes with a large volume of low BOD wastes). By such combinations, industrial wastes may be brought into the range of the biological treatment used in treating sanitary sewage, thereby permitting combined treatment.

24. TYPES OF TREATMENT. The treatment of industrial wastes can be grouped into three general categories: physical, biological, and chemical. There is no standard method for treating industrial wastes, as each industrial plant effluent presents a special treatment problem. Laboratory and pilot-plant studies may be required to determine the type of treatment required for a particular waste. Depending on waste characteristics, combinations of these basic procedures may be utilized to provide the required degree of treatment.

25. PHYSICAL TREATMENT. Physical methods of treating industrial wastes sometimes use the equipment and processes of chemical engineering, particularly for recovery of materials. Generally, they are the same as those for sanitary sewage. Such treatment is often necessary due to the nature of industrial wastes or as a preliminary to other types of treatment.

a. Racks and Screens. Bar racks (also called bar screens) with relatively wide spacing of 1 to 1.5 inches are often used at treatment plants for protecting pumps and treatment units from damage and clogging by large solids, rags, and other debris carried by sewage. Revolving drum or disk screens with 1/16-inch to 1/4-inch openings may be suited to preliminary treatment of wastes containing coarse solids.

b. Grit Removal. Wastes from maintenance and repair operations are likely to contain considerable grit as well as dirt and grease. Washing and steam cleaning are major sources for these waste components. Grit is objectionable because of its tendency to clog sewers and cause rapid wear on pumps and sludge removal mechanisms. It is also harmful to plants employing sludge digestion by its accumulation in the digester and clogging of drawoff piping. Wastes containing an excessive amount of grit should be segregated and subjected to grit removal and treatment by means of a grit-chamber prior to discharge to sewer systems, pumping stations, or waste treatment units. A grit chamber is an enlarged channel or long tank placed at the influent end of the treatment plant. Its cross section is designed to retard the flow velocity just enough to cause the settling out of heavier solids for removal.

c. Sedimentation. Either plain or chemically assisted sedimentation is useful in connection with the treatment of most industrial wastes since it produces a substantial reduction in the suspended-solids content. Sedimentation basins similar to those used for sanitary sewage treatment are used for treatment of industrial wastes. Normally, mechanical sludge and scum removal equipment is utilized during the process.

d. Flotation. Suspended material, such as oil, grease, and other substances with a specific gravity less than that of water, tends to separate by floating. Fine particles and some flocculent material with a specific gravity greater than that of water settle, but at a very slow rate. Flotation may be accomplished in simple gravity separators or by the use of dissolved air flotation devices.

(1) Gravity Separators. Gravity type oil separators should be installed for activities producing large amounts of oily wastes. The "API Separator" (Figure 6-1, below), developed by the American Petroleum Institute, is an example of a gravity separator of proven usefulness in oil removal. It consists of a long, narrow, relatively shallow, baffled basin equipped with a continuous skimming and scraping mechanism. Free floating oil is readily separable in a basin of this type. Dispersed oil which will coalesce rapidly is also removable. However, emulsified oil, which coalesces slowly is not reduced appreciably and must be chemically treated to break the emulsion.

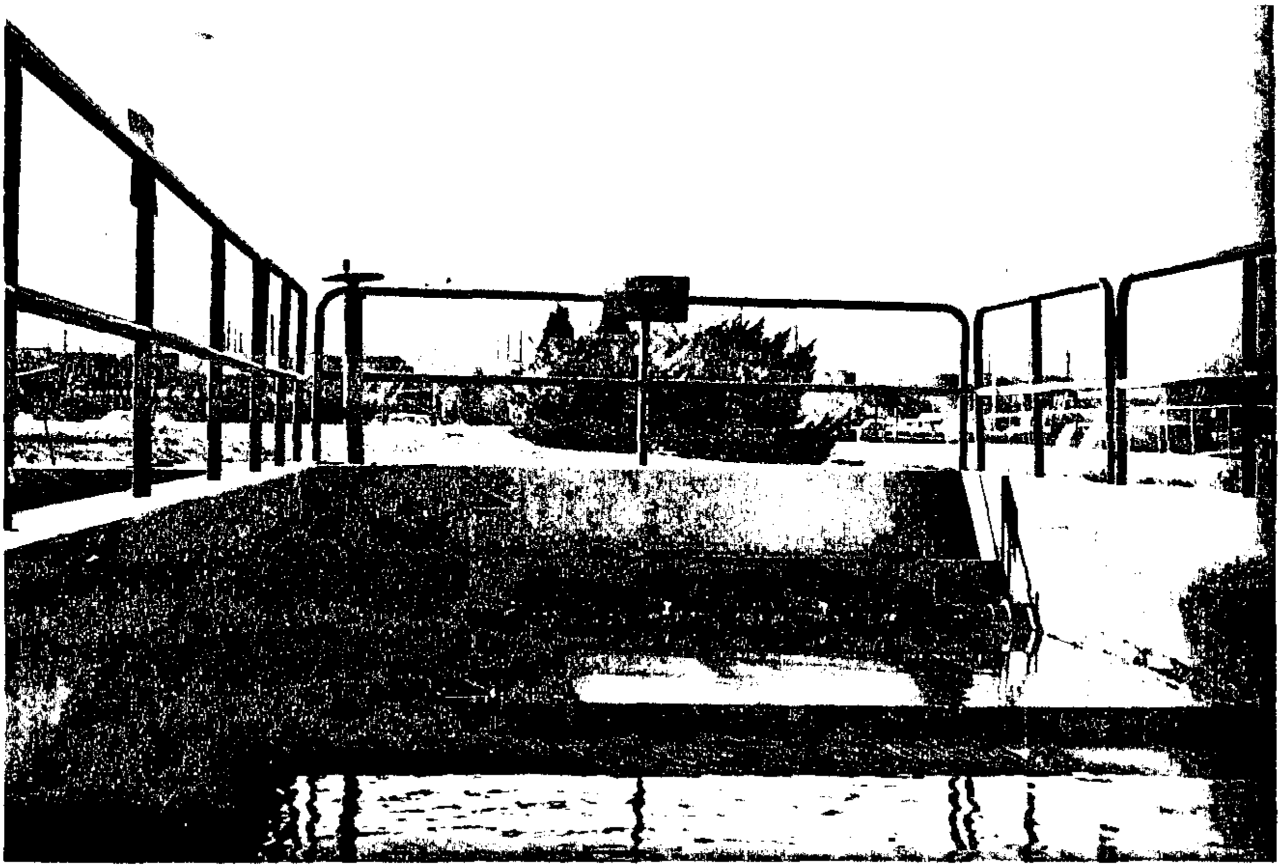

FIGURE 6-1. API SEPARATOR

(2) Dissolved-air Flotation. This method is used to remove oil, fat, and grease from industrial wastes and involves the production of many small air bubbles within the waste. These attach themselves to the suspended particles, causing them to float to the surface and be skimmed by mechanical means. The clarified liquid is removed from the flotation tank through submerged outlets. The efficiency of the process may be improved by the addition of flocculating chemicals, such as alum and activated silica. Clarification in air-flotation units is quite rapid, permitting a fairly tight operating rate and an economy in space requirements.

26. BIOLOGICAL TREATMENT. The destruction of the organic component of many industrial wastes may be accomplished by biological oxidation. Wastes which exhibit a biochemical oxygen demand are amenable to biological oxidation. Biological processes are customarily preceded by treatment for the removal of a substantial proportion of suspended matter.

a. Trickling Filters. Trickling filters, similar to those employed for domestic sewage, provide effective treatment of those organic industrial wastes exhibiting a normal biochemical oxygen demand. Both standard and high-rate trickling filters with recirculation are used. Trickling filters are reliable treatment devices which are relatively easy and inexpensive to operate and, in general, provide the best type of biological treatment for industrial wastes or for combined sanitary and industrial wastes.

b. Activated Sludge. The activated sludge process is useful for treating industrial wastes where the organic loading is relatively uniform. The method is sensitive to shock loads and toxic substances and requires careful operating controls.

27. CHEMICAL TREATMENT. The addition of chemicals to industrial wastes is designed to coagulate suspended or colloidal solids, break grease and oil emulsions, and neutralize strongly acidic and alkaline wastes. The combination of chemical and biological treatments requires that consideration be given to the fact that strong acids and alkalies inhibit or interfere with bacterial action. Specific chemicals are required for various wastes, such as lime-sulfur or chlorine compounds for cyanides and several sulfur compounds for metal wastes. Chemicals can be fed either dry or in solution.

28. ION EXCHANGE. In the ion exchange process, the influent reacts chemically with the ion-exchange materials to produce an effluent in which certain elements have been exchanged for others. The resins themselves are not altered chemically and can readily be regenerated, depending on the resin, by the use of a salt, base, or acid. This method is used in removing cyanides and chromates from rinse water, removing impurities from chromic acid plating and anodizing solutions, and producing demineralized water from raw water.

29. NEUTRALIZATION OF ACID AND ALKALINE WASTES. Concentrated acidic or alkaline wastes normally require neutralization by chemical means before final disposal. Where both types of wastes are available, mixture of the two is advantageous, since only the excess acid or alkali requires further neutralization.

a. Acid wastes from metal pickling and finishing operations usually present the greatest problems. The various acids used in the pickling process are sulfuric, nitric, hydrochloric and phosphoric with sulfuric acid the most commonly used. Quick lime or hydrated lime is the neutralizing agent most commonly used.

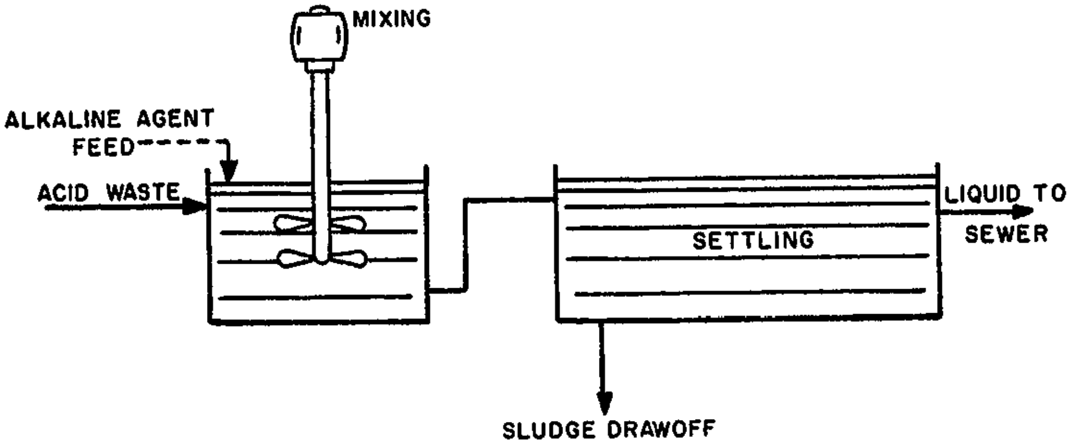

FIGURE 6-2. NEUTRALIZATION (CONTINUOUS METHOD)

b. Neutralization may be accomplished by either continuous or batch treatment methods (see Figures 6-2 and 6-3 on pages 15 and 16). Neutralization is carried out by feeding lime slurry to the spent pickle liquor contained in a tank equipped with an agitator. Lime requirements are obtained from the "acid value" of the pickle liquor and the "alkaline value" of the lime as determined by chemical analysis. The sludge formed in the process is usually disposed of by lagooning (see Figure 6-4 on page 17).

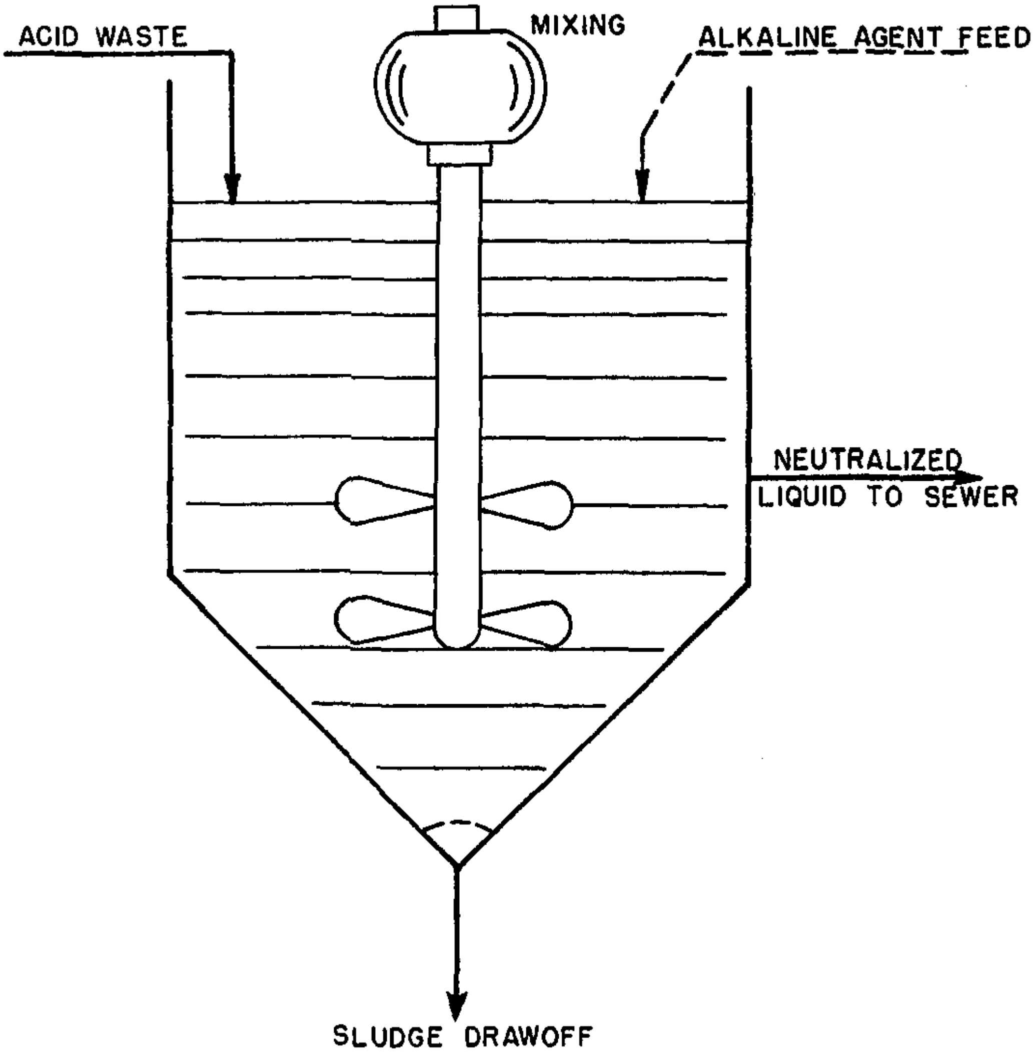

FIGURE 6-3. NEUTRALIZATION (BATCH METHOD)

30. SLUDGE HANDLING. Sludge resulting from industrial waste treatment is dried and disposed of in the same manner as sanitary sewage sludge. Organic sludge may be handled by the digestion methods used in sanitary sewage plants. Drying may be accomplished on open beds or vacuum filters. Industrial wastes containing heavy doses of chemical coagulants produce a large volume of sludge that ordinarily does not dry as rapidly as sanitary sewage sludge. Sludge resulting from the treatment of fuels, solvents, oils, and greases may contaminate ground water supplies by seepage when applied to the ground. Care must be taken that sludge drainage or disposal does not create a new pollution problem.

FIGURE 6-4. SLUDGE LAGOON

CHAPTER 7. AIRCRAFT WASH WASTES AND SIMILAR WASTES

31. GENERAL. Discussion in this chapter involves the collection and treatment of wastes from aircraft washracks, motor vehicle service areas, engine tests cells, engine repair shops, and other activities contributing large quantities of oil, grease, and emulsified wastes.

32. WASTE CONTRIBUTORS.

a. Aircraft Washing. In general, aircraft washing involves the following: pressure spraying entire aircraft surfaces with cleaning agents to loosen accumulated oil film, dirt, and oxides; brushing of surfaces with an alkaline water base type cleaner to help loosen foreign matter; and hosing down with hot or cold water for thorough removal of emulsified oil, grease, and dirt from the aircraft.

b. Vehicle Service Areas. Vehicle maintenance wastes result from washing operations and the disposal of used grease and oil.

c. Engine Repair. Engine repair shop wastes result from cleaning engines and parts with oakite or other base chemicals.

d. Engine Test. Engine test cell wastes result from engine and floor cleaning operations and generally contain oil, grease, and emulsified materials.

33. AIRCRAFT WASH WASTES TREATMENT. When large quantities of oil, grease, and emulsified wastes are being discharged, it may be necessary to use specifically designed treatment plants. A typical treatment plant consisting of a holding tank, and air compression, chemical induction and flotation units is shown in a flow diagram (Figure 7-1 on page 20). and described as follows:

a. Primary Treatment. Raw industrial wastes are piped to a combination holding tank and grit chamber. The purpose of the holding tank is to level out peak rates of flow and equalize waste concentrations by mixing them throughout the tank. The tank is provided with devices for the removal of grit, free oil, and free kerosene. Usually suitable stirring and mixing devices are installed to keep wastes from stratifying.

b. Secondary Treatment. The secondary treatment system consists of a continuous operation of flocculation and flotation by air under compression. The components of the system are: inflow pumps, chemical mixing tank, and mechanical sludge collector equipment for removing flotated sludge from the liquid surface in the flotation tank to the sludge trough or hopper. Automatic controls are required for starting and stopping the operation of the inflow pumps at preset liquid levels in the surge tank.

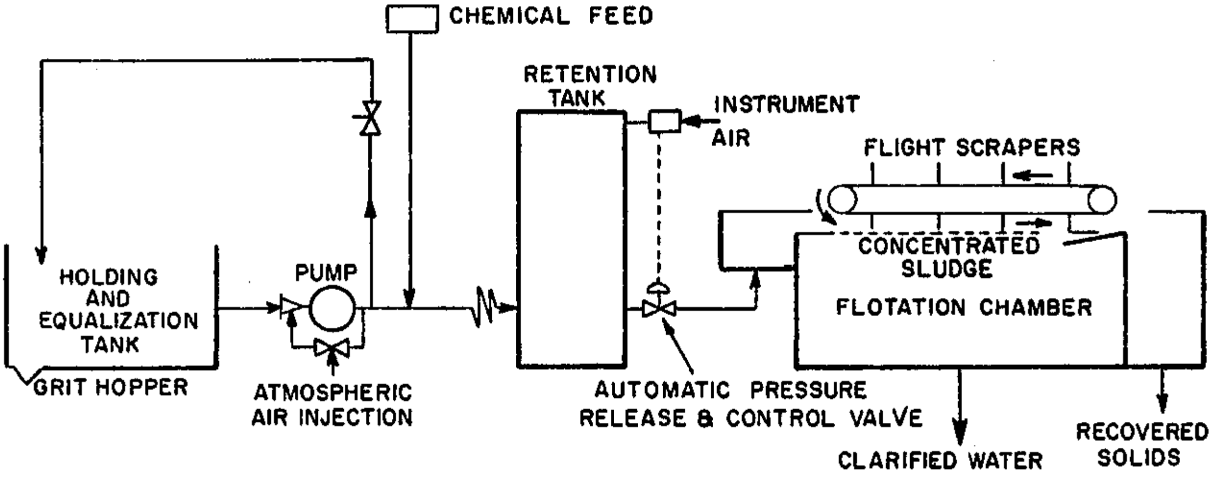

FIGURE 7-1. AIR FLOTATION PLANT

34. SLUDGE DISPOSAL. Usually the sludge volume is approximately 10 percent of the total flow when motor vehicle maintenance, engine test cell, and other wastes are included. Wet sludge is transferred to a storage basin where a three phase separation occurs; the heavier sludge settles to the bottom, the lighter floating material forms a scum layer on the surface, and relatively clear water exists between the two layers. Sluice valves placed at various levels in the basin outlet structures may be selectively opened to draw off the clearest water for recirculation through the system. The accumulated sludge is periodically trucked away.

CHAPTER 8. MAINTENANCE BASE WASTES

35. GENERAL. The operations conducted at aircraft maintenance bases include cleaning, reconditioning, and overhauling. The principal wastes produced, in addition to those discussed under "Aircraft Wash Wastes ...," are metal cleaning, treating, and plating solutions. This chapter describes treatment facilities for these major industrial wastes including systems for the treatment of chromates, phenols, and cyanides.

36. PLATING WASTES. Plating wastes, which are mainly inorganic, consist of acids, cyanides, and such metals as zinc, copper, lead, and chromium.

37. PLATING ROOM PROCESSES. The chief plating room operations contributing to the generation of wastes are:

a. Stripping. The use of acidic or alkaline baths to remove undesirable films or coating on the metal to be plated.

b. Cleaning. The removal of oil, grease, dirt, and corrosion through the use of acidic and alkaline pickling cleaners.

c. Plating. The process of depositing metal on the material being plated, producing metal and cyanide concentrations.

38. SOURCES OF WASTES. The chief sources of wastes in plating room operations are: drag-out losses (solutions carried out of the bath and into overflow rinses on the part being plated); spray losses (chiefly in chrome plating where the gas produced causes a fine spray); and the dumping of spent or useless solutions.

39. REDUCTION OF WASTES. Drag-out losses may be reduced by providing adequate drainage of the metal being plated and the use of a rinse save tank. Spray losses may be decreased by the installation of an exhaust system to recover finely divided spray for return to the solution tank. The use of series rather than parallel rinses reduces water consumption. Finally, good housekeeping and supervision decrease wastes, prevent improper dumping, and improve the segregation and collection of waste.

40. STRENGTH AND CHARACTER OF WASTES. The strength and character of plating wastes vary considerably. They may be either acidic or alkaline, depending on the baths used. Chromate baths produce highly acidic wastes while alkaline cleaning baths and cyanides produce alkaline wastes. In general, plating wastes are highly toxic and corrosive and should be dumped directly into a treatment tank or a protected lagoon.

41. CHROMIC ACID RECOVERY. Chromates are generally treated separately to aid in recovery of this critical item. The treatment is primarily designed to remove contaminating metals from chrome plating and anodizing solutions. The contaminants are iron, trivalent chromium, and copper in plating solutions, and aluminum in anodizing solutions. A flow diagram of a chromic acid recovery system is shown in Figure 8-1 on page 25.

a. Waste Storage Tank. Spent chrome plating solutions from process tanks are collected in a storage or holding tank for dilution to a suitable chromic acid content. Anodizing solutions may be sufficiently low in chromic acid concentration and require no dilution. Dilution of plating solutions is necessary to avoid damage to the equipment used in the next step, ion exchange.

b. Ion Exchange Equipment. The sulfonic cation exchange resin bed in the hydrogen form exchanges the contaminating metals in the solution with hydrogen ions. The purified solutions are then passed on to an evaporator. When the accumulated impurities from the plating solutions exhaust the ability of the resin in the exchanger to continue purification, the exchanger is removed from service and the resin regenerated with sulfuric acid. In the regeneration process, the sulfuric acid removes the contaminating metal ions and restores the exchanger resin to the hydrogen form. The sulfuric acid regenerate waste may either be passed on to the waste acid treatment tank in the industrial waste plant or used for neutralizing alkaline wastes.

c. Evaporator. The chrome plating solutions, which are diluted before passing through the cation exchanger to avoid excessive decomposition of the exchanger resin, are brought back to original concentrations by evaporation before return to the plating process tanks.

d. Chromic Acid Storage Tank. The purified and concentrated chromic acid is stored for return to the plating process tanks as required.

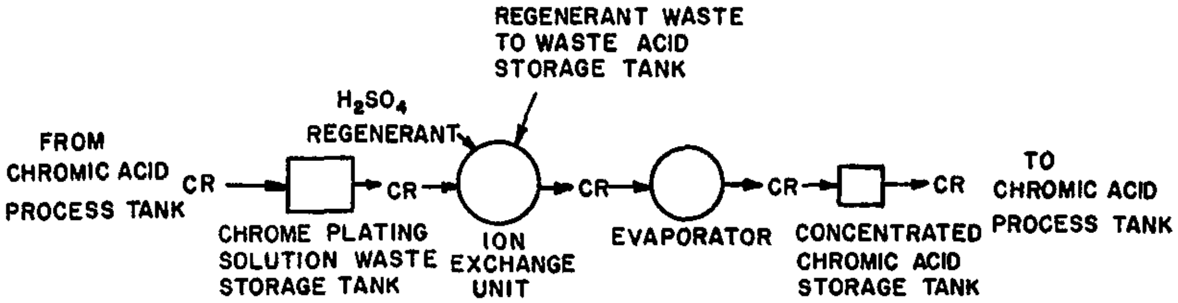

FIGURE 8-1. CHROMIC ACID RECOVERY

42. REDUCTION PROCESS. Another method of treating chromate wastes is by the reduction of the chromate ion through addition of ferrous sulfate, followed by neutralization with lime to precipitate the heavy metals (see Figure 8-2, page 26). Normally, batch equipment is used. The waste is discharged to acid-resistant tanks equipped with mixing devices, skimmers, baffled decanting outlets, and sludge withdrawals. Treatment of the waste is with about twice the theoretical amount of ferrous
* sulfate (either sulfur dioxide or barium sulfide may also be used) and *
thorough mixing. After a standing period of about an hour, oil and grease are skimmed from the top. Milk of lime is then added until the mixture has a pH of about 8.0. This mixture is then agitated and allowed to settle for a period of about 12 hours. The supernatant liquor is then decanted and the sludge removed.

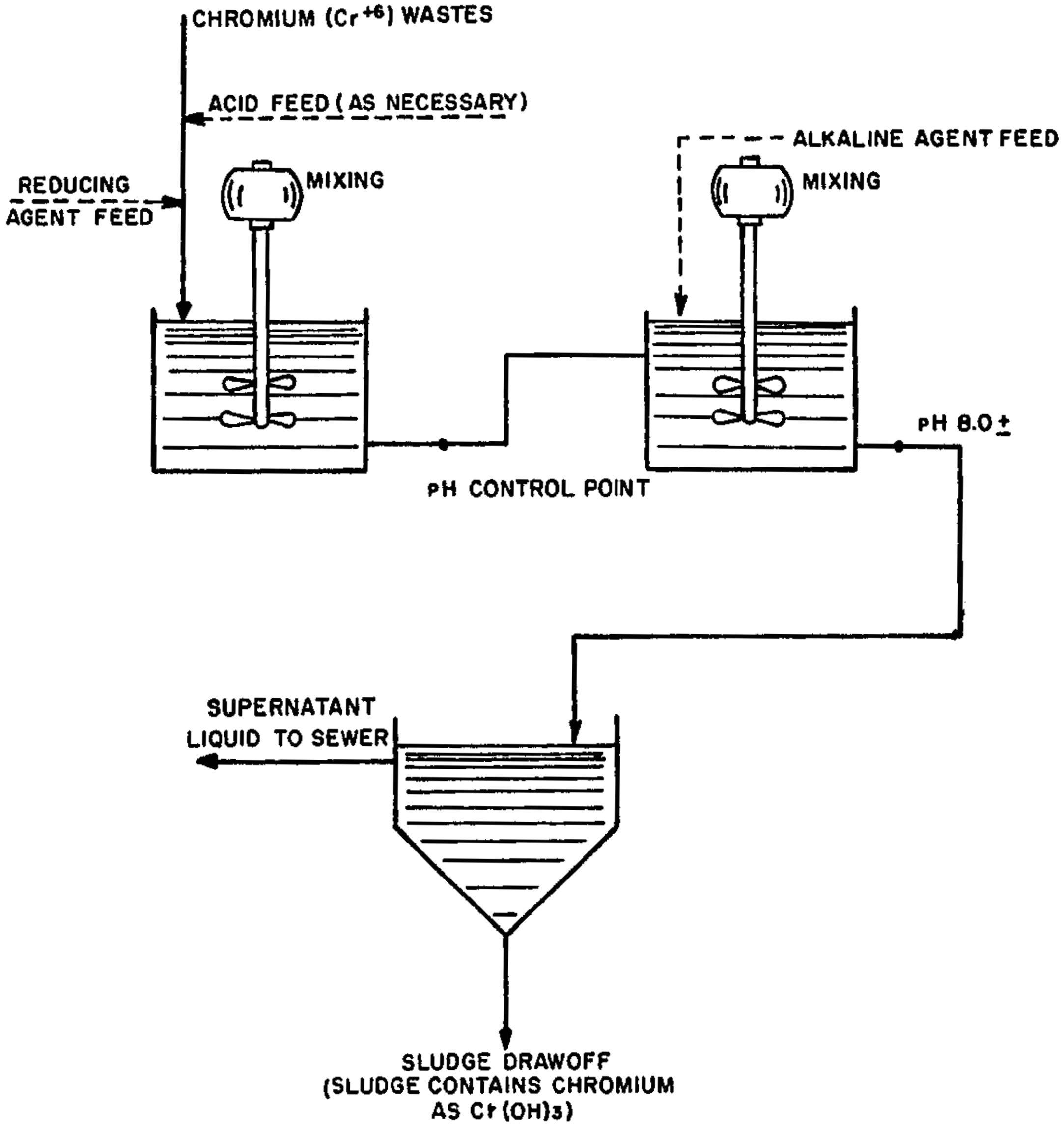

FIGURE 8-2. CHEMICAL TREATMENT OF CHROMIUM WASTES

43. PHENOLS. Biological treatment in sewage plants of wastes containing phenols and cresols has been used in some cases where the quantity of sewage is sufficient to dilute the phenols to a concentration of not more than 20 ppm. Concentrated phenol and cresol wastes result from the cleaning of aircraft parts and require separate treatment since they are extremely polluting to streams. Pretreatment of phenol wastes for oils and suspended solids removal can be accomplished by the air flotation method previously described in paragraph 25d(2).

44. CHEMICAL OXIDATION (PHENOLS). Figure 8-3 on page 28 shows a flow diagram of the chemical treatment of phenol wastes. Concentrated phenol and cresol wastes are collected in a receiving tank with a capacity sufficient to hold at least the daily flow of these wastes. The tank contents are then transferred to the phenol oxidation tank where the pH of the phenol bearing wastes is raised by addition of lime. Chemicals, such as alum or ferrous sulfate, are added to assist in coagulating the solids in the waste. The entire contents of the tank are then mixed and allowed to stand for a time to permit sludge and scum to separate out of the liquid. After separation, the scum and sludge are removed by oil skimming and sludge scraping mechanisms in the tank. Chlorine is added and the tank contents thoroughly mixed to insure complete oxidation of the phenols. The resultant wastes can be discharged to a main industrial waste treatment plant for additional treatment.

45. BIOLOGICAL OXIDATION (PHENOLS). Phenols in low concentrations (not greater than 20 p.p.m.) can be treated by biological oxidation processes such as trickling filters, the activated sludge process, or a combination of both. In this process, the wastes, after neutralization with an alkali such as lime, flow to a primary sedimentation tank. The tank effluent flows through a two stage trickling filter which removes a large part of the BOD and phenol content. The effluent from the trickling filter is passed through aeration tanks in which further reduction of phenol content takes place. The effluent flow continues through secondary sedimentation units for removal of biological floc and other suspended materials and, if necessary, to a holding pond for further retention before discharge to a stream.

46. CYANIDES (GENERAL). Cyanide wastes require separate treatment because of their toxicity. A method which has been used for the treatment of cyanide wastes is simple lagooning or detention for long periods (200 plus hours). However, lagooning entails considerable space and the alkaline chlorination method, described in paragraph 47, is considered to be the most generally satisfactory method available.

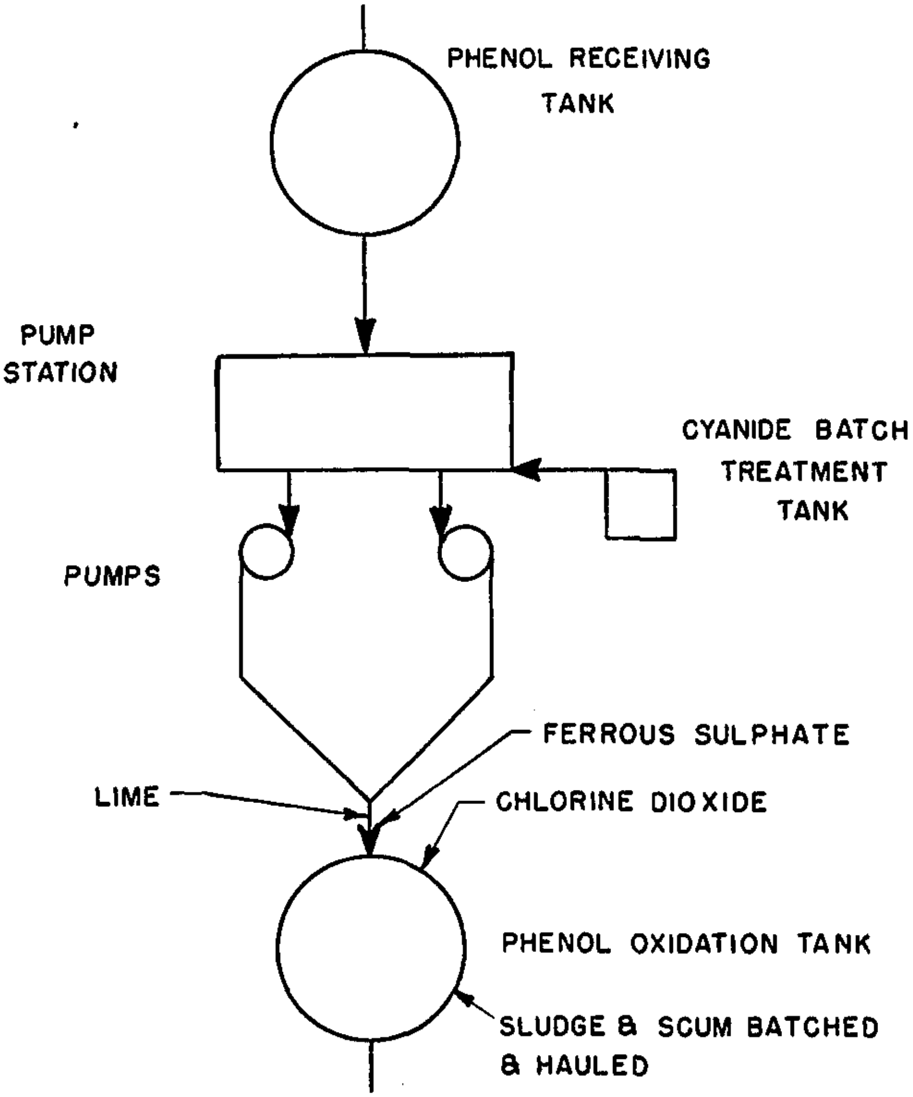

FIGURE 8-3. CHEMICAL OXIDATION OF PHENOLS

47. CYANIDE TREATMENT. While either batch or continuous treatment may be used, batch treatment facilities are best for small and medium size plants. Batch treatment offers the advantage of postive control of effluent quality, since no wastes need be discharged until analysis reveals complete cyanide destruction. Cyanide wastes are alternately collected in one of two holding tanks, each having one day's capacity of waste flow. While one tank is filling, the contents of the other are being treated (see Figure 8-4 on page 29). Lime or caustic soda

is added to raise the pH of the wastes above 8.5 and the pH is then continually maintained at this point by the addition of more lime. A minimum pH of 8.5 is required to prevent formation of the toxic gas cyanogen chloride. After a thorough, vigorous mixing, chlorine is added for cyanide destruction. For small scale operations, the chlorine is often applied in hypochlorite form. The approximate ratios, by weight of the caustic and chlorine required to treat the cyanide, are 10:1 each, with a minimum exposure period of one hour. Completion of reactions is assured by the application of a slight excess of chlorine. After destruction of the cyanide, the alkaline waste water may be mixed with other waste streams and used in neutralizing acid wastes.

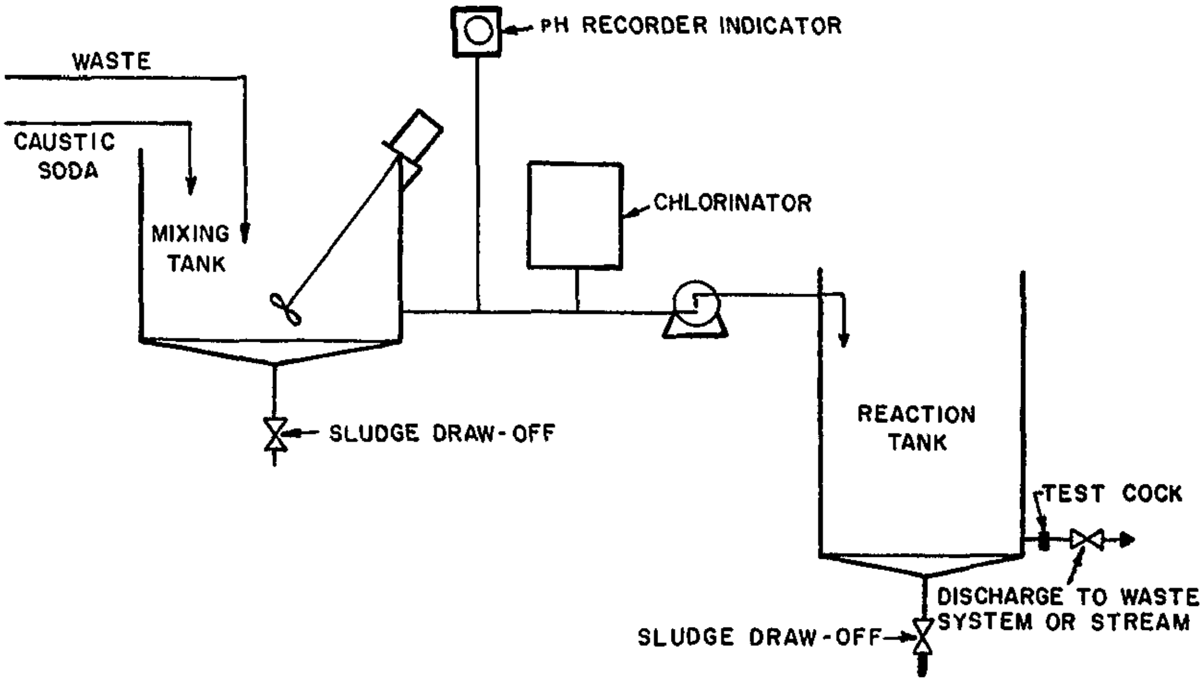

FIGURE 8-4. CYANIDE TREATMENT

CHAPTER 9. MAIN WASTE TREATMENT PLANT

48. GENERAL. Figure 9-1, page 32, shows a flow diagram for an industrial waste treatment plant handling combined wastes. All wastes, including those from the special treatment processes previsouly discussed, receive final treatment at this plant before disposal.

49. WASTE ACID STORAGE TANK. Concentrated waste acid solutions should be collected in acid-proof tanks or barrels and hauled to an acid-resistant storage tank at the industrial waste treatment plant. The acids can be neutralized by alkaline agents, such as lime or caustic waste, or used for treatment of other wastes. The neutralized wastes may then be discharged to the primary clarifier.

50. WASTE ALKALINE STORAGE TANK. Concentrated alkaline waste solutions are collected in the same general manner as waste acid solutions and are either batch treated or used in plant operation. Waste alkaline solutions are treated with neutralizing acid in a storage tank equipped for mixing, skimming, and sludge removal before discharge to the primary clarifier.

51. SCREEN CHAMBER AND WET WELL. A screen chamber with manually raked bar screen is located ahead of the raw waste wet well. Wastes received at the industrial waste treatment plant flow first through the bar screen and into the wet well. From there wastes are pumped, if necessary, to the primary clarifier.

52. PRIMARY CLARIFIER. The primary clarifier is sized for providing adequate detention of wastes to permit separation of solids and scum from the liquid. The tank is equipped for removal of scum and settled sludge daily or more often if necessary. The effluent from the primary clarifier flows to the surge tank.

53. SURGE TANK. The surge tank (or detention basin) contains an agitating mechanism for thorough mixture of wastes while the major portion of the daily flow is passing through. This eliminates the surge effects of highly concentrated wastes by their dispersal throughout the tank and permits a more uniform equalized flow to the air flotation unit.

54. FLOTATION UNIT. Coagulating chemicals (e.g., aluminum sulfate) are added to the effluent from the surge tank which is then passed to the flocculation basin where the chemicals are slowly mixed with paddles to form "floc." Air is introduced to the flow and dissolved under a pressure in excess of 25 p.s.i. The quantity of air used is limited to that which can be kept in solution while passing through a retention tank. Flotation is accomplished by the attachment of air bubbles to the floc and occurs over the entire area of the flotation tank in a uniform, nonturbulent manner. The particles of grease, oil, and lighter solids are collected by flight scrapers. Figure 9-2, page 33, shows the flotation chamber of the air flotation unit.

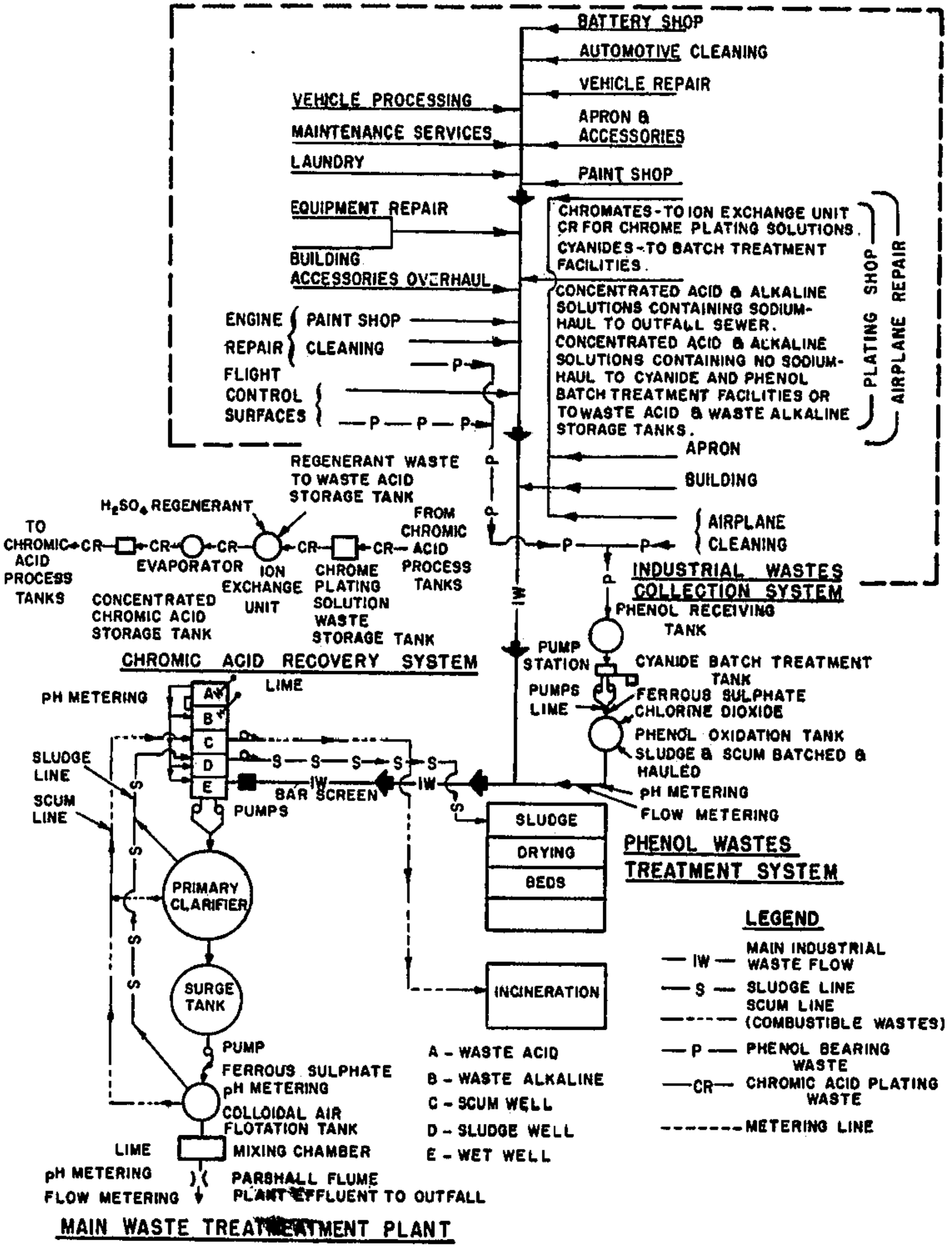

FIGURE 9-1. MAIN WASTE TREATMENT PLANT

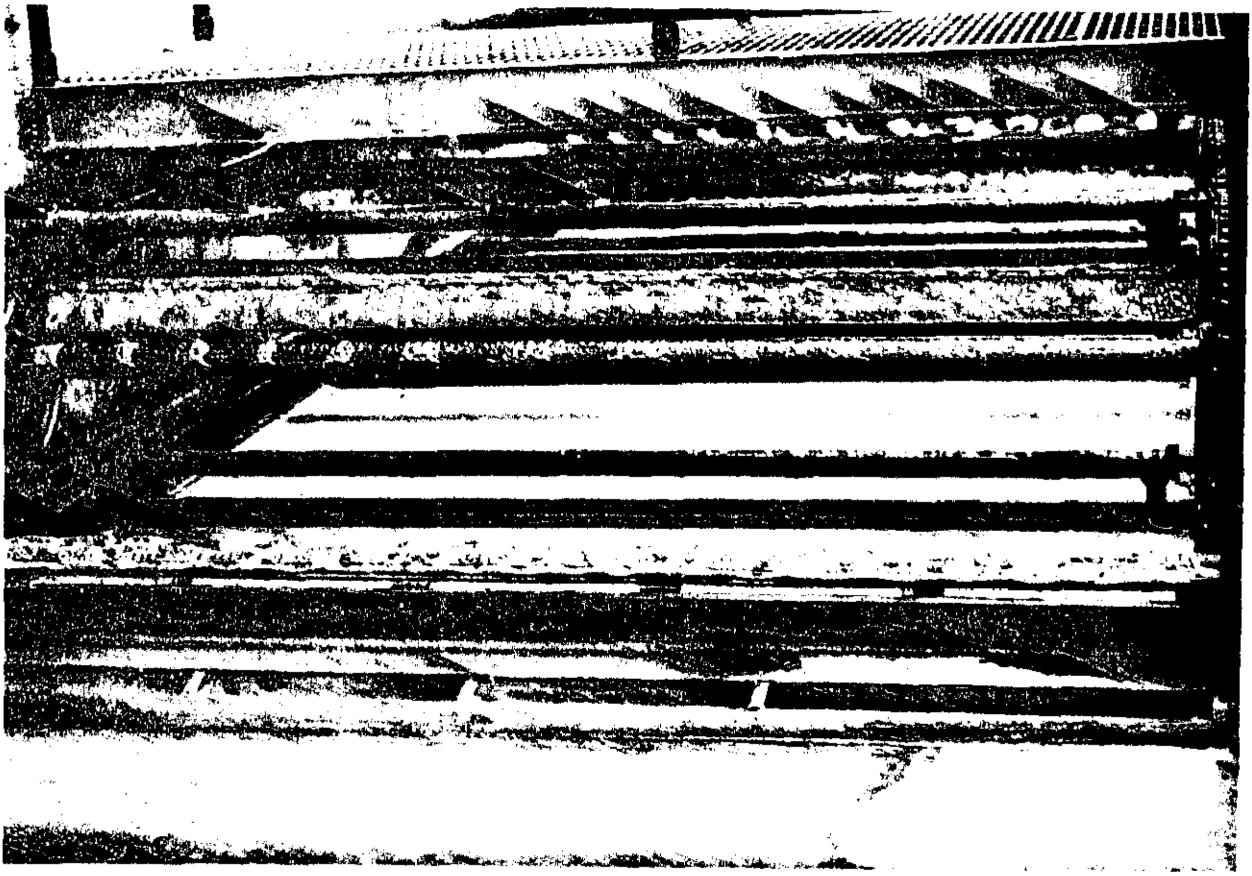

FIGURE 9-2. FLOTATION CHAMBER

55. MIXING CHAMBER. Effluent from the flotation unit flows into a mixing chamber where lime is added for pH control, and from there to the outfall at the disposal point.

56. SCUM WELL. Scum removed from the surface of the waste acid and waste alkaline storage tanks, primary clarifier, and air flotation unit is collected in the scum well. The scum may contain a high percentage of waste oils and other combustible substances. To avoid hazards, it is trucked away for disposal. Scum from the phenol treating tank may also be similarly eliminated.

57. SLUDGE WELL. Sludge from the sources mentioned in the preceding paragraph is collected in a sludge well and then discharged by gravity or pumping to beds for air drying. Any liquid from the sludge beds drains back to the raw waste well to mix with incoming raw wastes. Sludge from the phenol treatment tank may be batched and hauled either to the sludge well or to the sludge drying beds at the main treatment plant. Air-dried sludge is removed from the sludge beds for disposal by dumping or burial.

58. METERING. Metering is required for the measurement and control of industrial waste flows. The metering provided includes pH indicating and recording equipment for the phenol treatment system and for the influent and effluent of the main waste treatment plant.

59. CHEMICAL FEEDING. Chemical feeding equipment is provided for the addition of chlorine, lime, ferrous sulfate, and other coagulating chemicals at various points in the treatment proccess; for oxidation of phenols; for neutralization of waste acids and alkalies; for pH adjustment; and for coagulation of suspended matter.

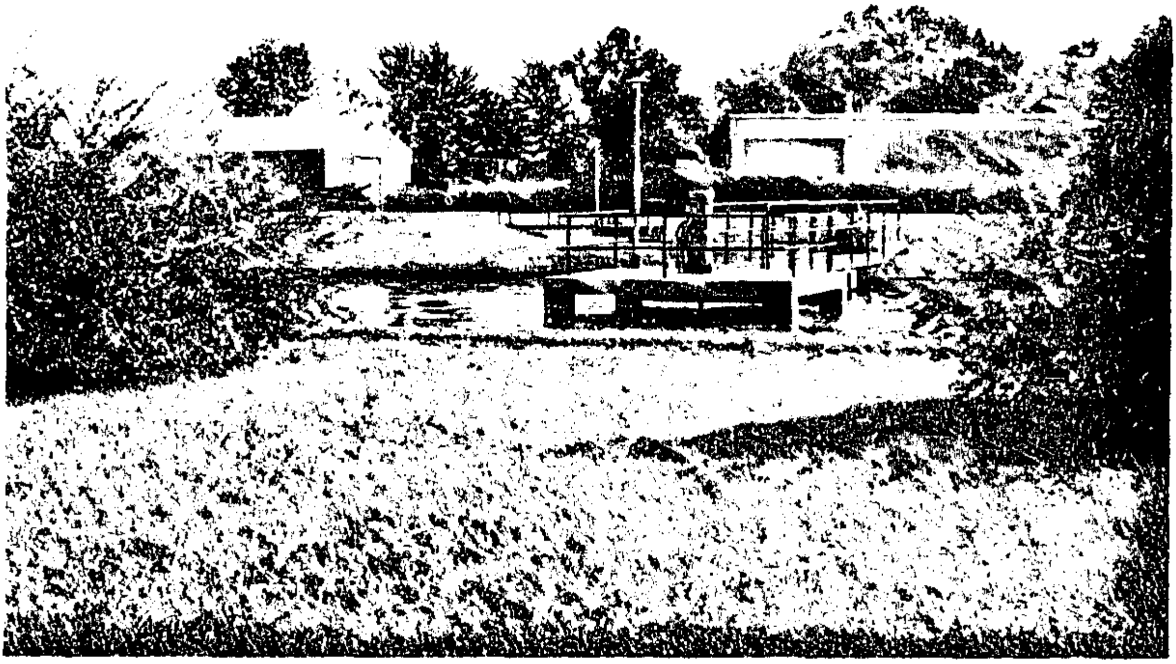

FIGURE 9-3. LANDSCAPING THE INDUSTRIAL WASTE TREATMENT SITE

60. LANDSCAPING. Landscaping of the industrial waste treatment site is a desirable element in the control of dust, erosion, and drainage. In addition, the provision of pleasing visual features assists in attaining an appearance which is an asset to the airport environment (see Figure 9-3, page 34.).

APPENDIX 1. REFERENCE LIST

1. Standard Methods for the Examination of Water, Sewage, and Industrial Wastes, American Public Health Association (latest edition), Washington, D.C.

2. Drinking Water Standards, U.S. Public Health Service (1962), Washington, D.C.

3. Water Quality Criteria, Federal Water Pollution Control Administration (1968), Washington, D.C.