Environmental Assessment

Société de Fabrication de Produits Chimiques (ALKI)

Tunis, Tunisia

by

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I. EXECUTIVE SUMMARY

An environmental assessment of the Société de Fabrication de Produits Chimiques ALKI plant in Tunis, Tunisia, was conducted under the sponsorship of the World Environment Center (WEC) and the United States Agency for International Development (USAID) in June 1992. This project supported USAID's Project in Development and the Environment (PRIDE).

Granular laundry detergent and shampoo are made at ALKI. The study was performed by Mr. Gerald N. McDermott, a licensed professional engineer with over forty years of experience in the detergent industry and working with governmental agencies.

The major environmental problem at this plant is wastewater disposal. Presently, the wastewaters from industrial processes and sanitary facilities are being hauled to disposal sites. There is no available system of publicly-owned sewers for either sanitary or process wastewaters. Service has not been provided to the site because regulations prohibit the discharge of wastewater containing concentrations of the detergent, linearalkylbenzene sulphonate (LAS), greater than the average found in residential sewage. The process wastewaters of the ALKI plant contain concentrations 10 to 100 times the sewage concentration. The concentrations are particularly high because the plant minimizes water use. (Even with its high concentration, this small volume of process wastewaters is less than the quantity reaching the public sewers from the laundry detergent and shampoo used in the home.)

The hauling of ALKI's wastewaters for disposal is not an economic solution, nor does it provide the degree of environmental control that can be achieved by other means. Monitoring hauling is difficult and probably will not prevent haulers from discharging the material where it could potentially damage groundwater quality.

This report describes the wastewater control improvements that could possibly reduce the volume of wastewater and the quantity of pollutants. These measures should be evaluated by ALKI to determine their appropriateness. The following is an abbreviated version of recommendations which are described fully in Section IV of this report:

- Use a process whereby SO_2 is oxidized, or otherwise rendered harmless, in order to eliminate the possibility that some reaction product of SO_2 and caustic (in the spent stream of caustic from the SO_3 scrubbers which is used to make detergent paste as replacement for fresh water) will be present in and affect the quality of the product. The addition of ozone or hydrogen peroxide might be effective in such a process.

- Employ dry cleanup and housekeeping practices to the maximum extent possible in order to reduce wastewater.

- Use steam to clean shipping drums to minimize water losses from drum washing. If more reliable cleaning is required, use a high pressure nozzle wash and rinse system after steam-cleaning drums.

- Use a pressure control and recirculation system for bearing cooling water in order minimize wastewater while preventing bearing erosion and product loss through leakage past the bearings.

- Use shallow, moveable pans made of stainless steel sheet metal in order to catch water from discharge valves of tank trucks, pipe joints prior to their being opened, and at drum filling stations.

- If a land treatment system looks feasible for ALKI's wastewater, test the practical application rates and effectiveness by a pilot operation. This pilot could be conducted on a very small scale by using a barrel-size plot of the candidate soil.

The treatment of the process wastewaters to meet severe LAS limitations before discharge to the public system is not a practical solution. Physical/chemical treatment is not considered a successful method. Biological treatment degrades the LAS, and is considered the process-of-choice for domestic sewage treatment. The most practical disposal method is to discharge wastewaters to community systems for biological treatment in combination with large volumes of domestic sewage.

Air emissions are minimized by ALKI by using the most effective practicable measures available. Treatment consists of cyclones and fabric filters for some emissions, and packed bed scrubbers and electrostatic precipitators for other emissions.

No serious worker health threat appears to exist. Posting of caution signs and safety training is recommended relative to two of the chemicals used: sodium hydroxide and sodium silicate solution. Particulate matter in the air in the packing room should be checked and dust collection instituted, if warranted.

While the volume of wastewaters and quantities of pollutants may be significantly reduced by the means suggested, the best method would be based on the recognition that the wastewater needs of all members of the community should be met through joint treatment of residential, commercial and industrial wastewaters. With such a system, permits would be granted to industry for discharge of wastewaters without unwarranted restrictions on the contribution or quantity of compatible wastewater constituents. (Compatible means appropriate for transport without difficulty and for an adequate treatment using normal processes.) This approach, if accompanied by a service charge program requiring all users and beneficiaries to share the costs fairly, would be the most economic wastewater treatment method for all users. Of course, sewer use regulations should adequately limit toxic and otherwise incompatible constituents as present Tunisian regulations do. Through this joint treatment scheme, the ALKI plant wastewaters could be discharged to the public sewer. The discharge of wastewater from detergent manufacturers to public sewers is a common practice in many other nations.

II. INTRODUCTION

The World Environmental Center (WEC) contributes to sustainable development worldwide by strengthening industrial and urban environmental, health and safety policy and practices. In June 1992, WEC furnished the services of Mr. Gerald N. McDermott, an environmental engineer, to investigate the environmental control program of Société de Fabrication de Produits Chimiques (ALKI), of Tunis, Tunisia, to assess its soundness and areas for improvement. This document records that assessment and gives an account of ALKI's manufacturing activities and facilities pertinent to environmental control. This account includes manufacturing process descriptions with emphasis on wastewater, gas emission, and discarded material sources. Some assessment of hazards to workers' health or to the environs of the plant is included. The information was gathered by the author during site visits.

In making this assessment, the author made use of his experience in dealing with environmental problems at one of the largest producers of soap, detergents and food oils in the United States and the world. The author is retired and independent of the company currently.

In general, the detergent industry throughout the world accomplishes wastewater treatment in combination with community wastewaters in community-owned treatment facilities. The wastewaters are accepted in the community systems without regard to the concentration of compatible constituents. In the United States, only one plant in approximately one hundred provides sufficient treatment for discharge of its wastewaters directly to a stream or lake. A different system of control is being established in Tunisia.

The Tunisian system, apparently, limits industrial wastewater characteristics to the concentrations found in residential sewage. Such a system requires a complicated pretreatment processes. This assessment judged the appropriateness of those pretreatment facilities in service, or being planned, and provided suggestions for improvements to such facilities.

This report will be useful in the future and should be updated periodically. It will be of assistance in a number of applications:

- management use in review and direction of the program
- training of supervisory and operating personnel
- promoting understanding of the program by community and neighbors
- review of environmental matters with control agencies.

The cooperation of the ALKI company was flawless and the assistance of managers and engineers was enthusiastic and complete. The author is appreciative and grateful to them for this help.

III. FINDINGS

I. Manufacturing Processes: Wastewater and Emission Sources

A. Granular Laundry Products

1. Materials

Linear alkylbenzene
Sulfur
Perfume
Sodium sulfate
Tripolyphosphate
Sodium silicate
Water
Optical brightener

2. Equipment

Sulfur furnace
Sulfation unit, mixed reactor type
Gas washing columns, two
Weigh tanks
Mixing tanks
Drying and granulation tower
Drying furnace
Fabric filters for drying tower gases
Fabric filters for product dust control
Air blowers
Cyclone separators
Belt conveyors
Packaging machines
Auxiliary pumps, etc.

3. Products and Production Rates

Granular laundry detergents

3,000 to 5,000 kilograms per hour

4. Employees

300 (total plant)

5. Process Description: Wastewater and Gas Emissions

The production of sulfonated LAS from linear alkylbenzene and sulfur is the onc basic chemical synthesis process in this operaion. An important subprocess is the production by combustion of sulfur trioxide gas (SO_3) from sulfur and oxygen. The SO_3 is used for the sulfation of the alkylbenzene. The product of this reaction is linear alkylbenzene sulfonate (LAS). At many other detergent plants, LAS is purchased from a chemical company. Other major processes at ALKI are the mixing of LAS with the other constituents that make up the laundry product and with water, and then the removal of the water in a drying tower to form a light fluffy granular product.

Sulfur for the manufacture of SO_3 is received and stored in bulk. The sulfur is melted and burned in a stream of air to produce a gas containing 8 to 12% sulfur dioxide. The hot gases (SO_2, N, O_2, etc.) are passed through a converter containing surfaces of vanadium pentoxide, a catalyst, that accomplishes oxidation of SO_2 to SO_3. The conversion of SO_2 to SO_3 is usually not complete; up to 5% of the SO_2 may remain in the product gases depending on the construction and operation of the conversion system. The gas stream from the converter contains about 10% SO_3, a low level of SO_2, nitrogen and the other trace gases in air. These gases are conducted to the sulfation reactor in which they contact the alkylbenzene to produce LAS.

There is no storage of SO_3 gas between its production and use in the above arrangement. The absence of storage is important because it eliminates the possibility of accidental release of a large amount of SO_3. Users of SO_3 have the choice of purchasing it as made by chemical companies in the form of liquified gas in a pressure vessel, or making the SO_3 on site as is done at ALKI. The latter is much preferred from an environmental and safety standpoint since there is a certain danger involved in SO_3's transport and use. The use of SO_3 as it is generated reduces this danger.

The materials for making the laundry product (alkylbenzene, tripolyphosphate, sodium sulfate, etc.) are mixed in a vessel with sufficient water to form a viscous material. This mixture is pumped to the sulfation reactor where it is mixed with the SO_3 gas stream. In the reactor, the SO_3 reacts with the benzene of the alkylbenzene to create the sulfonated material, LAS.

The gases remaining after the sulfation reaction, namely SO_3 in excess of that reacting with the benzene, SO_2 and nitrogen from the air, are conveyed in a duct to the bottom of the washing column. The column contains layers of solid particles which are continuously wetted with a stream of dilute sodium hydroxide (NaOH) which is pumped to a distributor at the top of the column. Practically all the SO_3 reacts with the water and the caustic in this gas washing process to form sodium sulfate. The sulfur dioxide also reacts with the water and caustic in the washing column and the product is a component of the liquid stream flowing from the bottom of the reactor. Sulfur dioxide is so soluble in water that its removal is essentially complete. Its reaction with the sodium hydroxide is rapid and substantially irreversible. The SO_3 and SO_2 in the gases leaving the washing column are believed to be at trace level, although no data are available.

The engineers of the plant have conceived and are experimenting with a use for the caustic liquid stream from the washing column. This stream is used in the mix tank to make up a paste of the various ingredients of the detergent product. The stream contains sodium sulfate and unreacted sodium hydroxide and of course water, in addition to the product of the SO_2 and NaOH reaction. Thus, the stream supplies part of the water needed to form the paste in addition to two materials which are normal constituents of the paste (or used in the process) which are thereby conserved by return to the product stream.

This liquid stream, however, also contains the product of the reaction of SO_2 and NaOH. ALKI management is concerned that the inclusion of a trace of the SO_2 reaction product will have an undesirable effect on the laundry product performance. The plant is seeking help in the analytical and risk assessment parts of this matter. The reuse of this washing column stream is an important control measure, so the concern with the SO_2 content (if there is one) is noteworthy.

The non-reacted gases from the washing column are discharged to the atmosphere through a stack which terminates slightly above the roof of the main plant. Sulfur trioxide rapidly combines with water in the air to form sulfuric acid which has a low condensing temperature. An aerosol or mist is formed. Sulfur dioxide is a colorless gas with a pungent, irritating odor and should be virtually absent from the gases after the scrubbing operation described above.

ALKI engineers state that, ordinarily, the sulfur trioxide concentration is low enough that there is no irritating amount in the atmosphere, even within the confines of the plant property. On the days the author visited the plant, the sulfonation process was not being operated. The plant wishes to obtain data on the oxidized sulfur compounds in the gas emissions but there is no commercial firm which makes such measurements in Tunisia. Information is being sought so that ALKI engineers can perform this analysis. Information on analytical methods for SO_3 in use in the United States and approved by the EPA has been supplied to the plant manager in a separate communication.

ALKI management is particularly concerned with the SO_3 emissions when the amount of SO_3 in the gases leaving the reactor are greater than normal or when the reactions which remove the compound from the gas emissions are more stressed. These conditions are thought to occur occasionally at start-up or when a process malfunction occurs.

The process of making the laundry product from the LAS and other constituents consists of mixing the various materials with the LAS in a vessel. Sufficient water is added to form a viscous material. The other materials are tripolyphosphate, sodium sulfate, etc. This mixture is pumped to the drying tower by means of high pressure pumps. The process of creating the granules or flakes of detergent consists of spraying the mix of constituents including the LAS into the upper levels of a drying column via spray nozzles. Heated air for the drying is created in a furnace which burns gas oil; the combustion gases are used in the drying tower. The products of combustion of the gas oil and air are pulled by a fan upward through the drying tower. The paste form of the mix is pumped at high pressure through nozzles located in the upper section of the drying tower. The spray nozzles deliver the paste in fine drops into the hot stream of combustion gases. As the water evaporates from the particles, the drops are transformed into snowflake-like material. The water evaporates from the droplets to a water content sufficiently low that the particles will not stick together to any extent. The detergent flakes settle to the conical bottom of the drying column in the form of granules of 1 mm diameter or less. The detergent granules fall from the cone to a belt conveyor. Larger particles are screened from the powder. Some larger agglomerates may form or pieces of agglomerated detergents may loosen from the walls of the drier and be present in the material leaving the drier cone. The agglomerates removed by the screening process are returned to the mixer where the paste is produced.

The screened powder is conveyed in an air stream to a cyclone separator used for separating the conveying air from the powder. The air enters the cyclone at the circumference of the cylindrical main body and moves in circles around the walls. The inertial force carries the particles to the walls. The particles slide down the walls to a conical bottom and are discharged into storage bins. The air from the cyclone is directed from the cyclone to a fabric filter. At every place in the process where powder is conveyed by air, the air is filtered by fabric filters before discharge to the atmosphere.

The drying gases are carried from the top of the drier in large ducts. These gases contain particles of detergent which have not settled against the drying gases. The gases are conducted to cyclone separators like those described in the previous paragraph and then through fabric filters in order to capture the detergent and to prevent emission of the dust to the environment. The final fabric filter is constructed of duplicate units. When one unit is out of service for cleaning or changing the fabric, the other unit is placed in service. The filtered gases are discharged through a short stack to the atmosphere.

This cyclone/fabric filter system provides emission quality equal or superior to that which constitutes the best available control practice in the United States. Removal by this series could be greater than 99%. The alternative of using wet scrubbers is not as effective and produces a large wastewater flow. A small percent of fine dust particles, however, may remain in the emissions from the cyclone/fabric filter system. Also, where volatile materials are used in the formulation, some of such material will be found in the emissions. The materials presently used at ALKI, however, are not expected to contribute significant volatile materials to the emissions.

The drying gases are produced from burning fuel oil. Therefore, the usual components of fuel oil boiler emissions would be expected. These would include sulfur dioxide and perhaps other reduced sulfur compounds depending on the sulfur content of the fuel oil. They would also have some content of oxidized nitrogen. The quantities involved at ALKI are very small compared to power plants and the like and would not be included in a local control program for sulfur or nitrogen gases. The temperatures of the flame and gases are not high so that the nitrogen compounds should be low or at trace levels.

The equipment for the sulfation, mixing, and drying operations is all housed. This enhances wastewater control because rainfall runoff from the processing area does not occur. However, these surfaces are subject to wastewater generation if washups with water are carried out. When observed, a major amount of product material was present as a dust layer on the floors and surfaces. This subject is discussed subsequently under the heading of "Housekeeping Wastewaters".

The final processing step is the packaging of the granular detergent. The plant has a separate packing area and warehouse facility. Three modern automatic packaging machines are used to fill the bags and packages. These machines are equipped with duct systems and intakes around the periphery of the machine near the positions of the packages as they are filled. Normally the displacement of air from the package as the granular material flows into this space caused a puff of fine detergent dust to rise from the package. The collecting intakes were intended to pick up this dust and convey it to a fabric filter or other device for removal of the particulate matter. On the day of visitation to the area, a filling line was running and there did not appear to be much dust.

The preceding description does not reveal any routine process wastewater sources, at least that are not reused and thus eliminated. The latter refers to the stream from the sulfation off-gas scrubbers. The use of this stream in product making has been described. The scheme is a clever arrangement and ALKI is to be complemented for the waste-minimization attitude displayed.

There are typically some miscellaneous wastewaters in a detergent making plant such as this one. This plant was not in operation when visited and thus, such wastewater may have been evident if the plant was observed in operation. For the purposes of this report, the assumption is made that certain typical wastewaters are produced at ALKI even though not confirmed. ALKI engineers will be able to disregard or apply whatever information is helpful to them.

Pump bearing cooling water

The bearings of pumps, especially those handling hot materials, are likely to be subject to damage by erosion if the pumps are handling fine, gritty material. The erosion of these bearings is minimized by keeping them at low temperatures. Typically, such bearings are cooled by surrounding them with cold water which flow in a metal jacket covering the bearing. Otherwise, the water can simply flow slowly from a pipe onto the bearing and then onto the floor. The drive shaft connecting the motor to the pump passes through the cooling water chamber. The material being pumped may pass through the opening around the shaft and enter the cooling water. The amount entering the cooling system will depend on the clearance between the shaft and the bearing or any mechanical seal or gland that may be used.

The pumps that move the paste to the sprays in the drying tower are under high pressure and are, thus, particularly likely to leak. There may be other pumps, or a homogenizer for the paste, which would also use water to cool bearings but, no observations were made of these cooling water sources of wastewater since the plant was not operating. It may be that the temperature of the paste in this plant is tolerated by the pumps or special pumps may be available which do not need cooling. However, typically there is use of cooling water on pumps and when leaks occur this can be a significant loss of material to wastewaters. Probably at ALKI this cooling water is recirculated. Thus, the water would flow from the pumps to a hot water sump from which it would be pumped over a cooling tower. The cooled water would then be pumped through the bearing cooling system.

Cooling water for paste cooling

The mixing of the constituents of the detergent and the neutralization of the acids with caustic will produce some heat of reaction. This heat is typically removed by indirect heat exchange using a flow of water in an exchanger. This cooling water is usually recirculated through an evaporative cooling system such as described above for the pump cooling water. Some water must be drained from such a system to control the buildup of dissolved minerals. The cooling water system for this and the pumps may be one and the same so that any product leaks into this stream would produce a polluted wastewater stream.

Paste filter cleaning water

The paste must be free of larger particles of material to prevent clogging of the spray nozzles in the drier. To avoid these occurrences the paste is usually passed through an in-line filter. These must be isolated from the flow and cleaned periodically, usually at down times. The filter is opened and the accumulated solid material and accompanying paste is flushed to the wastewater system.

Drying tower washout wastewater

The characteristics of the detergent product are such that a certain amount of the product will cling to the walls of the drying tower. At a certain moisture content the particles are a bit sticky. An accumulation will build up on the walls of the drying tower, especially in the cone at the bottom. The accumulation can be so severe as to restrict the movement of the dry powder from the drier and to increase the air flow velocity. When allowed to accumulate to thick layers, the cake will occasionally slough off in pieces and block the outlet or cause trouble in the conveying system. To avoid or minimize these occurrences, the tower is taken out of production and cleaned periodically.

The cleaning consists of running a powered revolving brush up and down the walls. The brush spins against the wall and loosens the accumulation of much of the material. This dry material is removed from the bottom, returned to the paste tank to be made into paste again, and thus recovered as product.

The dry cleaning with a powered brush as described is seldom so effective as to attain clean tower walls. The final cleaning is done with water. Special high pressure nozzles may be used. The water spray may be supplemented by hand scraping, especially in the conical bottom of the drier. A significant volume of wastewater is created, perhaps up to five cubic meters or more. This may contain a thousand kilograms or more of product.

Housekeeping wastewaters

ALKI engineers believe that losses to surfaces around areas where equipment is taken apart for repair or maintenance is the largest source of wastewaters and pollutants in this plant. When a pump or filter or other piece of equipment has to be taken apart, there is frequently much material in connecting pipes that is drained to waste.

An appreciable amount of fine product powder and spilled product reaches the surfaces in the areas surrounding the drier and auxiliary equipment.

B. Liquid Detergent and Shampoo Manufacture

1. Materials

Ethoxylated alcohol
Sulfur
Formaldehyde

2. Equipment

Sulfur furnace
Sulfation Unit, film type
Pumps and auxiliary equipment
Barrel filling station

Barrel washing vats

3. Products and Production Rate

   Liquid detergent (shampoo)
   (Rate not recorded).

4. Employees

   Included with process A

5. Process Description: Wastewater and Gas Emissions

The synthesis process consists of reacting alcohol with SO_3 to form an ethoxylated alcohol sulfate. This is accomplished in a reactor in which the ethoxylated alcohol is caused to flow as a thin film on a tank wall in the presence of an atmosphere containing a high concentration of SO_3.

The SO_3 is produced at this plant by the combustion of sulfur as described in part A of this report.

The liquid product is pumped from the bottom of the reactor.

The gases from the sulfur furnace consist of SO_3 and nitrogen of the combustion air, unreacted oxygen, and perhaps traces of SO_2. These gases are piped to the bottom of a gas washing column. In this case, an electrostatic precipitator is used for SO_3 removal. The equipment consists of a group of wires closely spaced and fixed in a vertical position parallel to the walls of the cylinder. The wires are connected to a terminal in which a selected voltage of electricity is maintained. The charged wires attract the SO_3 from the gas stream.

The wires are wetted with a flow of a dilute caustic. The used caustic flows continuously from the bottom of the washing column. The caustic solution containing the SO_3 is stored and used in making the laundry detergent as previously described.

As in the manufacturing process for granular laundry detergent as previously described, the non-reacted gases from the washing column are discharged to the atmosphere through a stack which terminates slightly above the roof of the main plant building. Once again, ALKI engineers state that ordinarily, the sulfur oxides are at low enough concentrations in these gases that there is no irritating amount in the atmosphere even within the confines of the plant property. On the days the author visited the plant, the sulfation process was not being operated.

The shampoo is shipped in drums to bottling plants at other locations. The barrels are returned from the bottling plant and maintained in this service repeatedly.

Before reuse, the barrels are washed at this plant by hand washing in a vat. The barrel washing operation continuously produces a waste of rinse water and the vats of used water are dumped periodically.

The growth of bacteria in the pipes, equipment, and barrels has been a problem. Formaldehyde is added to the product and used in cleaning the pipes, equipment, and drums.

ALKI is seeking a better and more effective system for equipment cleaning and product protection.

The pipes and equipment are periodically drained and flushed with water and formaldehyde solution in order to control bacterial contamination and growth. A significant quantity of detergent shampoo, is probably lost in this operation.

The floors and surfaces in the material storage and handling areas, in the barrel washing room, and around storage tanks are provided with trench drains or buried pipe sewers which drain to a central collection basin. This basin serves the entire property for receipt of wastewaters from all processes and, in addition, some roof and surface drainage.

Some water is softened for process use such as the water used as part of the product. Softening is the process which removes calcium and magnesium from the water. The removal is accomplished by ion exchange where the calcium and magnesium replace sodium on the solid exchange material and are thus removed. The exchange material is regenerated using a solution of sodium chloride which, in high concentration, displaces the calcium and magnesium from the exchange material and replaces them with sodium. Wastewater is produced from this regeneration and consists of the unreacted sodium chloride, the calcium and magnesium, and rinse water. The mineral content is quite high.

The laboratory where the quality of raw materials and products are checked will typically generate a small amount of wastewater. These originate from the washing of glassware and sample bottles, spent chemical solutions from certain analytical procedures, solvent used in analytical separations, samples of product and raw materials, and cooling or condensing water. The manager of the ALKI laboratory has placed in effect good laboratory practices for minimal discharge of pollutants such as placing spent solvents in a separate container for disposal as a waste material, no use of merc ry containing compounds in the analyses, no use of reagents containing heavy metals that are toxic in low concentrations, and no dumping of toxic chemicals to the sewer.

In summary the wastewaters from liquid detergent (shampoo) making which are discharged to the collection basin are:

- drainage from pipes and equipment when dismantled for cleaning
- washing water and rinse water from drum washing
- rainfall runoff
- drainage of water and formaldehyde solution flushings of piping and equipment in bacterial control practices
- wastewater from water softener regeneration

As related in the section on granular detergent making, the significant process wastewater is the spent caustic from the SO_3 washing columns. This wastewater is astutely handled by being reused in the detergent making process.

C. Rainfall Runoff and Spill Protection

ALKI engineers are aware that rainfall runoff from the plant can convey significant quantities of product and raw materials.

The engineer in charge of detergent production has put in place an admirable practice of collecting in a large basin drainage from the roof area near the drying tower stack. He had noticed that rain water, particularly after a long dry period, washed the accumulation of detergent dust from the roof of the building into the roof runoff. In spite of application of the best practicable technology for removal of the dust from the drying stack gases, there will be some content of fine particles. Many of them will settle on surfaces surrounding the stack discharge. This roof drainage is used as process water for making up the paste so the material is recovered as product and the need for fresh water is reduced. ALKI has thus lessened the volume of wastewaters and the mass of materials lost in wastewaters by collecting and reusing the drainage from the one roof.

The rainfall from the plant area where the storage tanks and material storage areas are located drains via roadways and trenches to the wastewater collecting basin. The basin is constructed so that when the water level in the basin reaches a certain level, no more water enters because the entrance is submerged. When the water level in the basin reaches the top of the trench, the water overflows and runs off the property in natural channels. The collecting basin holds about 40 cubic meters. Assuming at the time of rainfall the basin is half full, the first flush, at least, of the runoff can be held in the basin. This affords some control over the quality of stormwater leaving the property since the first flush is likely to contain much of the material on the surfaces.

Outside uncovered areas of the plant such as unloading areas, transfer pump locations, and storage tanks are subject to polluting material losses from leaks, spills and overflows. There are no spill containment facilities in these areas. A massive spill would flow to the wastewater collection basin which, if not full, provides some containment capacity.

Process equipment, particularly for the granular detergent operation, is inside buildings so that rainfall runoff is not involved.

Fortunately, there are no buried storage tanks so that groundwater contamination through leaks of such tanks is not a risk.

D. Sanitary Wastewaters

Sewers serving the toilet and shower facilities lead to an underground storage vault. The contents of the vault are hauled by a contract hauler on a routine schedule.

The sanitary wastewaters from 300 employees is estimated to be about 30 liters per day each for a total of about 10 cubic meters per day.

III. Waste Water Conveyance and Disposal System and Treatment Practices

The wastewaters from both the granular laundry product area and the liquid detergent area are conveyed by a system of trench drains and pipes to a centrally located collecting basin. This concrete basin is deep in the ground so that storage of about 40 cubic meters of wastewater is possible below the entrance pipe. From this basin the accumulated wastewaters are pumped at intervals of twice daily or so to a tank truck by a pump located permanently at the side of the basin. The wastes are hauled to a disposal site and discharged from this tank truck.

The average daily volume of process wastewaters, excluding rainfall runoff, is estimated by ALKI engineers as 21 cubic meters per day. The characteristics of the wastewaters are not measured routinely. A few analyses have been made. ALKI estimates the characteristics to average about as follows:

LAS - 15,000 mg/l

Total organic matter - 20,000 mg/l

Total Mineral Matter - 10,000 mg/l

Such concentrations are very high for process wastewaters and reflect the emphasis in this plant on minimization of water use.

The plant is not served by any form of municipal sewer system for process wastewaters, sanitary wastewaters, or stormwater. The nearest public sewer is 500 meters or more from the plant.

A second sewer system serves only the toilets and washrooms. This sewer drains to a vault. The contents are hauled by a licensed hauler of septic tank cleanings and the like.

There is no wastewater treatment practiced. Some measures are taken to suppress foam in the wastewaters such as adding oil to form a surface layer. Foam prevention consists mainly of preventing the wastewaters from entraining air such as when falling into trenches and when pumped. All intakes should be below the water level so that no air is entrained and discharges, likewise, should be below the surface so that air will not be drawn in with the plume of liquid.

Two outstanding measures practiced at ALKI for the reduction of wastewater volume and load of polluting materials are the reuse of spent caustic solution for the SO_3 from the sulfation off-gas washing columns, and the collection and reuse of rainfall from the roof area where dust quantities are greatest.

IV. Air Emission Control Practice

The air emissions described in the previous discussion of processes and equipment emanate from the following:

- drying of the granular detergent product
- the air conveyance of granular detergents
- the washers for removing SO_3 from the off gases from sulfation of liquid detergents

The gases from the drier pass through the cyclones for removal of fine particles of product and then to fabric filters as previously described. This process was not in operation during the visit so that observations of the plume could not be made. No data are available on the particulate concentration or quantity in the emissions.

There are no volatile constituents in the granular laundry products so the amount of volatile organics would be expected to be below any standard for such, and no toxic materials would be expected.

The furnace for granular detergent drying uses fuel oil. The combustion gases would be expected to have an amount of oxidized sulfur reflecting the sulfur content of the fuel oil. There might also be a slight concentration of oxidized nitrogen compounds in these gases. The temperatures used are low so that the concentration is likely to be quite low. The quantity of fuel oil used would be such that this would be considered a significant source of the sulfur and nitrogen compounds only in extreme circumstances.

IV. CONCLUSIONS AND RECOMMENDATIONS

Potentially useful methods for improving ALKI environmental control system, from waste minimization to ultimate disposal, are discussed in this section. The intent is to raise these potential improvements for consideration. Investigation as to their practicality, economics, and effectiveness will be required in order to select those appropriate for application.

The following topics for investigation are suggested to ALKI and are discussed more fully in the subsequent pages:

1. Use a process whereby SO_2 is oxidized, or otherwise rendered harmless, in order to eliminate the possibility that some reaction product of SO_2 and caustic (in the spent stream of caustic from the SO_3 scrubbers which is used to make detergent paste as replacement for fresh water) will be present in and affect the quality of the product. The addition of ozone or hydrogen peroxide might be effective in such a process.

2. Employ dry cleanup and housekeeping practices to the maximum extent possible in order to reduce wastewater.

3. Begin using tank trucks rather than drums in order to eliminate wastewater from drum washing. Such a change would have to be justified by a sufficient market for sulfated alcohol and sufficient capacity in accumulating and receiving tanks.

4. Use steam to clean the shipping drums to minimize water losses from drum washing. If a more reliable cleaning method is required, use a high pressure nozzle wash and rinse system after steam-cleaning the drums.

5. Use periodic steam cleaning of piping, tanks, and pumps to help prevent infection of the product with bacteria and the growth of bacteria in equipment.

6. Use a dilute caustic solution and/or steam to periodically sterilize pipes and equipment in order to control bacterial contamination.

7. Use a pressure control and recirculation system for bearing cooling water in order minimize wastewater while preventing bearing erosion and product loss through leakage past the bearings.

8. Install a system whereby the wastewater from drying tower washdowns is collected and reused in making detergent paste in place of fresh water.

9. Use shallow, moveable pans made of stainless steel sheet metal in order to catch water from discharge valves of tank trucks, pipe joints prior to their being opened, and at drum filling stations.

10. Insure that efficient fabric filters are used for removing particulate matter from the air emissions of the drier.

    Such particulates will produce drops of water with considerable detergent content during occasions of light rain or condensation of the plume.

    Car surfaces should be washed daily of these drops to prevent spots on the paint.

11. Place those workers who have particular sensitivity to SO_3 (emitted from the sulfation process for liquid detergent) in areas where their exposure is at a minimum.

12. Check the air in the packing room and, if unsatisfactory, install a duct system, fan and filter in order to collect dust at the machines.

13. Do not dispose of wastewaters under circumstances where the detergent could reach groundwater of useable quality.

14. Eliminate the vaults for collecting wastewater and sanitary sewage when alternatives are available in order to reduce the potential for groundwater contamination.

15. If a land treatment system looks feasible for ALKI's wastewater, test the practical application rates and effectiveness by a pilot operation. This pilot could be conducted on a very small scale by using a barrel-size plot of the candidate soil.

16. Institute a formal safety program to address the two hazardous materials used at ALKI, caustic and sodium silicate/caustic solution. This program should include:

- labels on tanks containing hazardous materials;

- exhibition of safety data sheets on the tanks or in the immediate area;

- records of employee training including dates and type of training;

- elimination of any overhead piping of these materials where possible; and

- provision of secondary spill containment for storage tanks and unloading areas for these materials.

17. Promote the use a more economic joint treatment system where industry wastewaters would be treated at a community facility serving residential and commercial customers, as well.

A. In-process Measures to Reduce Wastewater Flow or Pollutant Quantities.

1. Use of Spent Caustic from the SO_3 Scrubber

ALKI engineers have a scheme to use the spent stream of caustic from the SO_3 scrubbers as discussed in the preceding text. The stream is proposed to be used for making detergent paste as a replacement for fresh water. However, there appears to be concern that some reaction product of SO_2 and the caustic will be present in the product through such reuse. If such material is present, a process could be put in place to oxidize the SO_2 or otherwise render it harmless. For example, the addition of ozone or even hydrogen peroxide might be effective. The author plans to become better informed on the properties of SO_2 and will transmit information on this subject to ALKI under separate cover.

2. Dry Cleanup Practice

An effective wastewater reduction measure is the employment of dry cleanup and housekeeping practices to the maximum extent possible. In extreme cases, the policy is no use of water in cleanup. To assure no use of water, hose connections may be removed and floor drains plugged. The tools for dry cleaning include brooms, brushes, scrapers, square shovels, scoops, and pans. The recovered material is generally not useable and is disposed of with other waste materials.

3. Elimination of Barrel Washing

The market for sulfated alcohol may be sufficient to justify procurement and use of a tank truck rather than drums. This would allow transfer by pumps and thus greatly reduce the drum handling costs. A tank and pump system would reduce the air exposure of the product and thus would be expected to reduce bacterial contamination. Contamination and cleaning could be taken care of by steam flushing of the lines, pump, and tank at the time of unloading. Thus, little product would be lost from retention in the tanks and the dilution with condensed steam should be tolerable. The steam would serve to flush out the product as well as sterilize the lines and tanks. A temperature of 75°C or so should destroy the bacteria. This would require sufficient capacity in accumulating and receiving tanks and, for this reason, may not suit the customer.

4. Minimizing Losses from Drum Washing

As explained in the process and wastewater source description, some of the liquid detergent product is shipped in steel drums and the empty drums are returned for reuse. Undoubtedly, there is a considerable amount of the liquid detergent in the returned drums. It is quite viscous. These residuals are washed from the drums under current practice and become a part of the wash wastewaters.

There is a possibility that steam cleaning could be done that would allow either recovery of the product or the handling of it in the manner of a waste material rather than in the wastewaters. The best scheme would be to have the drum cleaning take place at the place of receipt of the product. The condensation of the steam would cause some addition of water to the product which is likely tolerable at the point of use, because water is probably added before packaging in consumer size containers. In addition to cleaning the barrels, the steam would sterilize them if proper temperatures and duration of steaming are practiced. Thus, this suggestion is related to another problem being experienced namely the control of bacterial growth in the liquid detergent. Periodic steam cleaning of piping, tanks, pumps would greatly help in preventing infection with bacteria in the detergent, or the growth of bacteria in the equipment.

A high pressure nozzle wash and rinse system probably would be more reliable for assuring clean drums after steam cleaning. An automated station in which drums are moved on a guided track over a spray system appears feasible. A spray nozzle would rise automatically to the top portion of the barrel and a stream of wash water under high pressure would be directed against the walls and bottom of the barrel as the nozzle moves into and out of the drum. The wash water would fall to a vat and be picked up by a pump and returned to the nozzle. There may be an intolerable problem with the generation of foam in this system. However, if the preliminary steam cleaning is done thoroughly, the foam generation may be tolerable. A spray of water on top of the foam in the vat could be an effective enough control. The same water can be recirculated to, in effect, control its own foam mechanically.

5. Bacterial Contamination Control

The bacterial contamination of a liquid detergent, which ALKI has experienced and is currently striving to find the best means of control for, is not an uncommon problem in the industry. Success in achieving control is of major importance to wastewater and waste material reduction. The discovery of bacterial growth in a piping system or tank used in production may bring about draining of some product to waste and flushing a great deal of material to the wastewater system during cleanout. Likewise, a manufacturer, upon discovery of a product which is damaged by bacterial growth to the extent that it is discolored or has objectionable odor, may have to discard a large quantity of material.

The most industrial experience with this sort of problem has been in the milk processing industry and in vegetable, fruit, and juice processing plants. In general, to my knowledge, the two predominate methods of bacterial quality control are the use of dilute caustic solution and the use of steam for periodic sterilization of the pipes and equipment. For example, in milk processing, the piping, tanks, and filling equipment may be equipped with clean-in-place systems. A clean-in-place system consists of a means of flushing the system using quick-opening valves so that the product can be pushed quickly from the lines by compressed air or gases so as to minimize loss of product. The emptying is followed by flushing with steam, a wash water containing detergent, a dilute caustic solution, or a combination of these.

There are firms which specialize in providing and installing clean-in-place systems for these industries. Glass pipes may be added to some equipment so that wall growth is minimized. Joints in piping may be special types which can be disassembled quickly so that the pieces may be washed in vats. These systems are used where sterilization of a joint in a clean-in-place system is difficult. Of course, the bacterial contamination of liquid detergents is not the serious matter that food contamination would be. Also, the use of a bacterial growth control agent in the product is possible. Thus, the approach suggested is to use steam when available from the process steam in the plant.

ALKI may not have a steam generating facility. A dilute caustic solution can also be used to sterilize. In the canning and milk industry, the alkaline wastewaters are diluted with other wastewaters of the process which reduces the pH to the point that it can be tolerated in the sewer system. Caustic is not corrosive to steel, concrete, or plastic and is neutralized in a community sewer system by dilution and reaction with buffers and acidic components. The use of caustic in reasonable quantities is usually no problem.

6. Cooling Water Recirculation with Pollution Control

The inspections of the plant made for this assessment did not make note of the use of cooling water. Perhaps this was because the processes were not in operation, this being the maintenance period. In case cooling water is a problem, some information on reduction of volume and polluting materials in wastewaters may be helpful and can be applied by ALKI, if appropriate.

In the usual granular detergent plant, there is a considerable use of cooling water to keep the bearings of pumps handling gritty or high temperature material from eroding rapidly because of these conditions. For example, the paste during mixing of ingredients may be quite hot and it is pumped to the sprays in the drying tower. Multi-stage centrifugal and piston pumps are typically used. The bearings of these pumps must be cooled to achieve reasonable life. The cooling is accomplished by enclosing the bearings in a jacket and passing a stream of water through the chamber around the bearing. Cooling water ordinarily is high quality water and the only problem is its volume for disposal. Some community wastewater systems will not admit once-through cooling water because it just takes up capacity in the system. In case of these high temperature and erosive material pumps, there is frequently a problem with the quality of the cooling water because the material being pumped will leak through the bearing of the pump into the cooling water. This leakage will typically be tolerated to some extent until the quantity is large enough to justify a shutdown for bearing or seal replacement.

In order to avoid loss of material by pump seal or gland leakage, the pressure of the cooling water in the jacket is maintained higher than the pressure of the material being pumped. Thus, if there is leakage, it will be water into the paste rather than paste into the cooling water. The use of high pressure water assures that paste will not enter the space between the shaft and the bearing so erosion is controlled and bearing life and leakage minimized. This pressure control system may be justified just for its prevention of erosion of bearing without regard to the leakage into the water problem. The cost consists of the valves needed to control the pressure in the water system and the use of electricity for creating the high pressure. If there is a problem of this nature at ALKI, the feasibility of such a system is recommended for evaluation.

The volume of cooling water discharged can be greatly reduced by recirculating the water through a cooling tower for evaporative cooling. The wastewater from the cooling system is thus limited to a small stream discharged to limit the buildup of dissolved solids in the water as evaporation concentrates the normal minerals in the water. The recirculation of cooling water without the pressure control system would save water, but it would not affect the quantity of detergent materials transferred to the recirculating water. Leaked detergent materials would be present in the stream bled to the sewer for mineral control. Recirculation of the detergent laden water would most likely not be practical because of foam generation in the cooling tower. Thus, the two measures should be employed together. Recirculation of cooling water, if there is any use of such at ALKI, is recommended for evaluation particularly if the pressure control sytem is installed to protect its quality.

7. Detergent Drying Tower Washdown Recycle

During the tour of the plant, ALKI engineers did not mention the need to occasionally wash the accumulation of product stuck to the walls of the drier. This may not be the practice at this plant, although such is true for the usual detergent drying tower. The drier may be operated at a low temperature and always with the same formulation so that dry cleaning is all that is needed. However, it may be that this source was just missed in the inventory during the visit.

The wastewaters from tower washdowns can be eliminated by the collection and reuse of this water for purposes of making up the detergent paste in the place of fresh water. The equipment necessary to do this consists of a drainage system for the area surrounding the tower that leads to a sump pump. A pump is located in the sump for transfer of the wastewater to a holding tank. Care is taken so that the area is clean and free of other matter when the wash is carried out. The stored material from the tower wash may or may not be all in solution. The holding tank must be constructed so that both suspended and dissolved material can be removed. This water becomes part of the water supply for the making of paste. Its material content may affect the mix percentages somewhat if the material is different from the next product so only a part of the water for each batch should be this reused water.

8. Drip Pans for Catching Valve Drips and Miscellaneous Leaks.

The quantity of pollutants lost to wastewater can be reduced by the provision of shallow moveable pans for use under the discharge valves of tank trucks or underneath pipe joints prior to their being opened. These pans must be such that they can be handled by one or two men and provisions must be made for their contents to be placed in containers that are used for waste materials. Such a pan is also useful at drum filling stations. The pans are typically made of stainless steel sheet metal.

B. Control of Air Emissions

The fabric filter for removing particulate matter from the drier should produce an emission that is quite low in particulate matter. This particulate matter would be fine particles of the laundry product. ALKI engineers have noticed some fine fall out on the roof near the stack and have taken measures to collect this particular roof drainage in a concrete basin. This water is planned to be used as water supply for process purposes.

There may be occasions when a light rain or condensation of the plume will produce drops of water with considerable detergent content. These drops if allowed to stand on the surfaces of automobiles may result in spots on the painted surfaces. These spots may or may not be removed by water washing. This is a bad situation if it occurs on cars off company property, but usually is tolerated by company personnel. The spots can be prevented if the car is washed each day of such drops and, of course, are minimized by efficient filters.

The emissions from the sulfation process for liquid detergent production may have trace levels of SO_3. A small part of a normal population have a high sensitivity to SO_3 while others can tolerate much higher concentrations. If possible, those workers who may be particularly sensitive can be placed where exposure, if any, is at a minimum.

Another consideration of air quality is that of the workers in the plant. The packaging machines and any place the powder is fed into a bin or the like will be places of dust creation. This happens when the air being displaced rushes out past the powder.

The particulate matter in the air in the packing room should be checked and, if unsatisfactory, a duct system, fan, and filter should be installed to collect the dust at the machines. The machines would be equipped with a collecting duct.

C. Ground Water Quality Protection

Protection of ground water quality is of great importance in a country of low rainfall and limited water supplies such as Tunisia. Detergents have the potential of reaching groundwater under some circumstances. Whether or not they do so is a rather complex matter. The fate of detergents in water reaching a land surface is rather complex and very dependent on the local situation.

Detergents readily adsorb on clay soil particles. The detergents also are rapidly degraded by bacteria in soil when oxygen is present. Therefore, detergents in water seeping into a soil in limited quantities are typically adsorbed on the clay and then degraded by soil bacteria in the first few inches of soil. At limited loading of water and detergent, the groundwater will not have detectable levels of detergents. On the other hand, if the wastewater containing the detergents is allowed to pass deep into the soil mantle where oxygen is absent, the detergent can persist for long periods of time.

Thus, if discharged to a fissured limestone or to sand or gravel, the wastewater could carry the detergent into the lower zones where oxygen is absent. In these lower zones, the detergent may persist since oxygen degradation does not occur and there may be only modest adsorbtion on gravel or lime. Thus, the groundwater taken from such an area could foam when agitated.

The use of such water for drinking or industrial process water would not be possible. On the other hand, if the water is brackish or saline, the presence of detergents in the groundwater would not be significant since such groundwater is not used in any case. Such groundwater is not tapped, but may move laterally to the ocean or marsh.

Thus, it is important that the detergent bearing wastewaters from ALKI not be disposed of under circumstances where the detergent could reach groundwater of useabie quality.

Another source of groundwater contamination is from leaking underground tanks. The leakage from these tanks is difficult to detect. Fortunately, ALKI does not have underground tanks except for the vaults for collecting wastewater and for sanitary sewage. ALKI should plan to eliminate these vaults someday when alternatives are available.

D. Land Treatment

An alternative to discharge to a community system and biological treatment in combination with residential and other wastewaters is land treatment of the ALKI plant wastewaters. Land treatment refers to spraying the wastewaters on soil at low rates of application, an average of one centimeter (cm) depth per day on the total land used, and allowing bacteria in the soil to degrade the biodegradable organics. Land treatment of the minimized quantity of ALKI plant wastewaters is a possible economic solution. However, even though the plant is adjacent to land used for agricultural purposes, the ALKI engineers believe that securing an area of land within a reasonable distance of the plant would not be practical. Unproductive foothill land appears to be within a reasonable distance. The wastewaters could be pumped to the site in a pipeline of about 3 cm diameter. Spraying the wastewater on a nearby olive grove may be feasible. Land treatment will not remove dissolved minerals, so consideration would have to be given to the effect of the minerals on the groundwater.

If the wastewaters were limited to 25 cubic meters per day and an application rate of 1 centimeter per day was used, the area required as far as hydraulic loading was concerned would be less than a hectare. The second loading factor would be how much detergent and other organics could be degraded per unit area. Probably only a few hundred pounds per hectare per day could be handled. The control measures outlined may help reduce the quantities of pollutants lost significantly. At low enough application rate, even sloping land could be used. Probably some grass that was tolerant of high LAS concentrations could be found.

The plan of operating a land treatment system would be to wet certain areas with the spray of wastewaters and then let the wet area rest for a day or so. Other areas would be used during the rest period. A high population of micro-organisms will develop in the upper layer of soil. These will be supplied by oxygen from the air. Biodegradable material will be essentially completely removed in a few inches of soil. The soil must be such that it will allow percolation at reasonable rates. The spray will produce foam to some extent but, at low application rates, no ponding will occur and this foaming should not be a problem.

Spraying can be continued during rainfall or snowfall as bacteria will continue to function in the soil. With a good grass coverage and soils with a high-percolation rate, the runoff will be infrequent or nonexistent.

If this method looks feasible, the first thing that should be done is to prove out the practical application rates and effectiveness by a pilot operation. This could be done on a very small scale such as by use of barrel size plots of the candidate soil.

E. Safety Considerations

Safety of personnel in the work place is not the author's expertise.

Comments on materials being handled or stored that warrant safety considerations for worker protection and environmental protection are offered. Two of the materials used at ALKI are hazardous, namely, caustic and sodium silicate/caustic solution. The sodium silicate is not a hazardous material in itself, but its use requires it to be a solution in caustic.

While ALKI is aware of the properties of these materials, the tanks and areas where these materials are used did not contain any warning or caution signs that were noticed.

A formal safety program is recommended including:

- labels on tanks containing hazardous materials
- exhibition of safety data sheets on the tanks or in the immediate area
- records of employee training including, dates and type
- elimination of any overhead piping of these materials where possible
- provision of secondary spill containment for storage tanks and unloading areas for these materials

F. Treatment with the Combined Wastewaters of the Community

There is at present no publicly-owned sewer close to the plant property. The site is bordered on one side by land which has been zoned for agricultural use. On the other sides, however, and in the neighborhood, there are considerable numbers of businesses and residences. Undoubtedly, the public sewers will be extended to this area in time.

A system of a local wastewater agency which has been found to be of maximum societal benefit is that of having the local agency provide wastewater services for all members of the community: residential, commercial, and industrial. Of course, the community systems taking this approach would accept only industrial wastewater with constituents and characteristics compatible with transport and treatment in systems. The present regulations for industrial use in Tunisia do not allow such an approach since they limit pollutants which can be adequately treated by the same processes that are used for residential wastewaters. The limitations on toxic pollutants specified in the local sewer use regulations in Tunis, however, would allow such an approach and are much like those imposed by agencies accepting all compatible constituents.

The system where an agency provides services to all customers in the areas served is called joint treatment--indicating all users join the effort. Industrial users properly consider the agency sewers and treatment plant as an extension of the manufacturing facilities. Industries can be involved in the operation of the facilities regarding their effectiveness and their operation to a like degree that the industries are concerned with making a quality product.

Joint treatment is practiced by most local agencies in the United States. Each wastewater agency has appropriate sewer use regulations. The local regulations incorporate requirements imposed by the United States Environmental Protection Agency. Such regulations do not require the reduction in concentrations of compatible pollutants by pretreatment.

The constituents of the products of the detergent industry are obviously contained in residential wastewaters. Such is the result of their normal use and disposal. The materials are necessarily compatible with treatment of the residential wastewater in the community facilities. These same materials are present in the process wastewaters from detergent manufacturing operations and are therefore compatible with the treatment of the residential wastewater in community facilities. The quantity of these materials in the industrial wastewaters is a small percent of the total normally seen in the community wastewaters.

The concentration of constituents discharged from any one source is not significant, in itself, but only as to its contribution to the concentration at the treatment plant when mixed with other community wastewaters. The total mass of materials from all users determines the concentration at the treatment plant and the contribution of a small volume of concentrated wastewaters will make an incremental addition of little consequence.

In the normal practice of joint treatment, the agency issues each industrial user a permit in which the quantity of each important material in the wastewaters involved would be registered. Thus, the agency knows the treatment capacity provisions which must be included for the industry.

For an industry to have a high concentration in its wastewaters is not a bad, undesirable fact, in itself. A practice of conserving water will increase the concentration of constituents in an industry's wastewaters.

A system which requires industry to install and to operate costly and unrewarding pretreatment will require extensive policing of industry. The pretreatment equipment may be installed and demonstrated but not operated regularly and consistently. When pretreatment is impossibly difficult and costly, industry may choose to haul the wastewaters to a place of disposal. The hauler may make midnight dumps on the beaches, beds of any wash, and other remote places.

The costs of pretreatment will be much higher than the costs for treatment in the community system. The costs of a community system can be shared equitably among users. The industry must provide a means for measuring its wastewater volume and enough monitoring must be done to confirm wastewater concentrations so that a fair charge for use of the system can be made. The agency would be expected to confirm these measurements of concentrations and quantities by periodic independent checks. All costs of serving and policing industry would be born by industry via the service charges. The residential users need bear none of the industry-generated costs. In fact, because a treatment plant large enough for all community members will be larger than one for the residential class alone, the scale factor will result in lower costs for all individual users including residential.

The pretreatment of compatible pollutants is difficult for industry. Typically, industrial people are not expert in wastewater treatment technology. Many failures and misoperations may be encountered. In many cases, the same treatment processes used by an industry would also be used for the community wastewaters, namely biological treatment.

The duplication is poor economic practice. Community facilities would be operated by people with special training and experience.

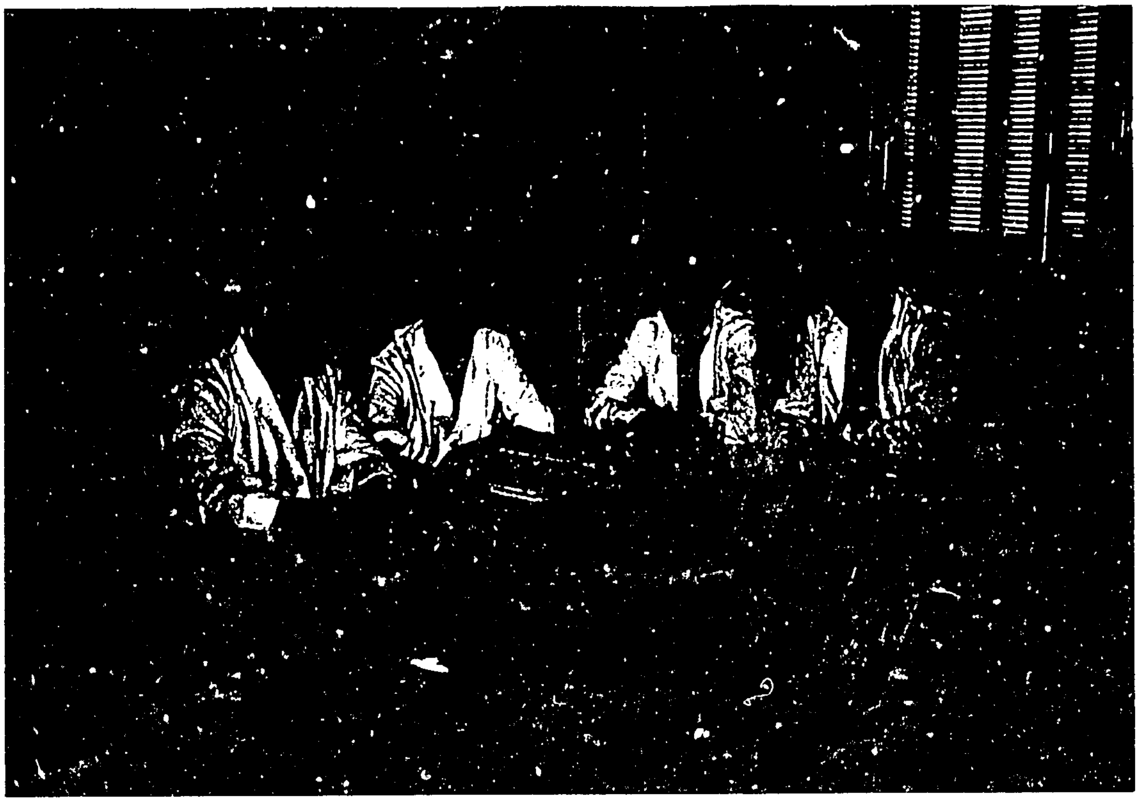
If required, the wastewater treatment processes that an industry will likely install for compatible pollutants will produce volumes of sludge for disposal. Dewatering to produce a moist cake of these solids instead of the thin slurry may not even be practical for individual industries. Operating expenses for such dewatering equipment at small scale will likely be extremely costly compared to the alternative of joint treatment. In frustration, some industries may dump the liquid slurry on a back lot, dump it somewhere at night, or pile it up on its property where it will be an unsightly nuisance.

In summary, the best system is that which allows the local agency to provide joint treatment facilities and for experts to run them. Such a system is less costly for everyone, more effective, and much easier to manage and police. Furthermore, the environmental impacts of misoperations will be minimized and the environmental cause, generally, will be better served.

V. APPENDICES

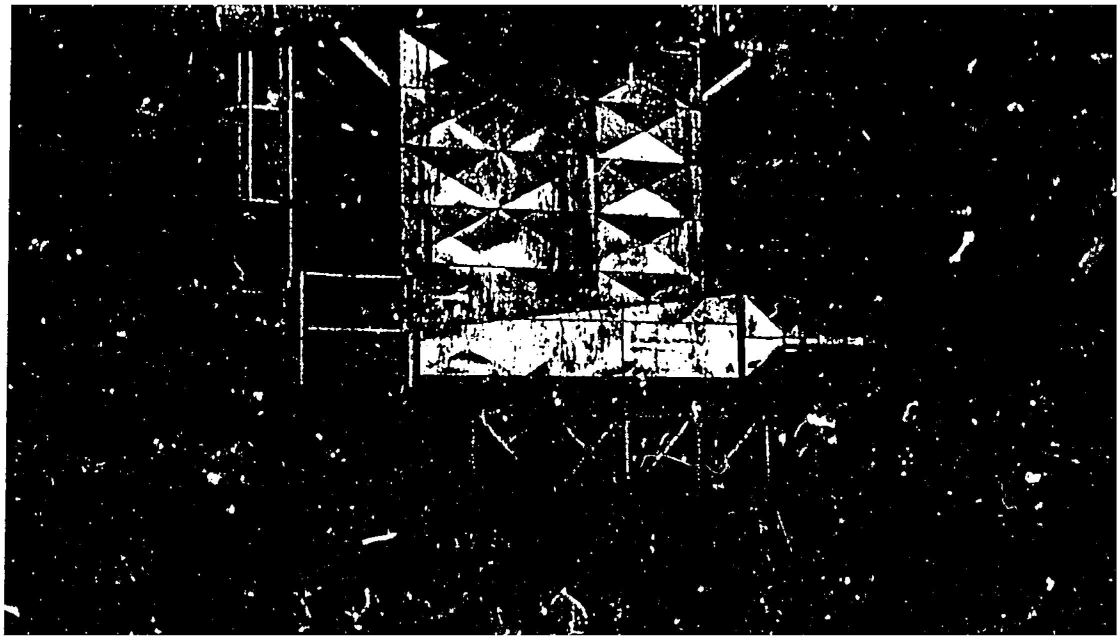
Appendix A: Photographs

ALKI Plant Manger Zoghlami leading the management team in review of emision control from sulphators

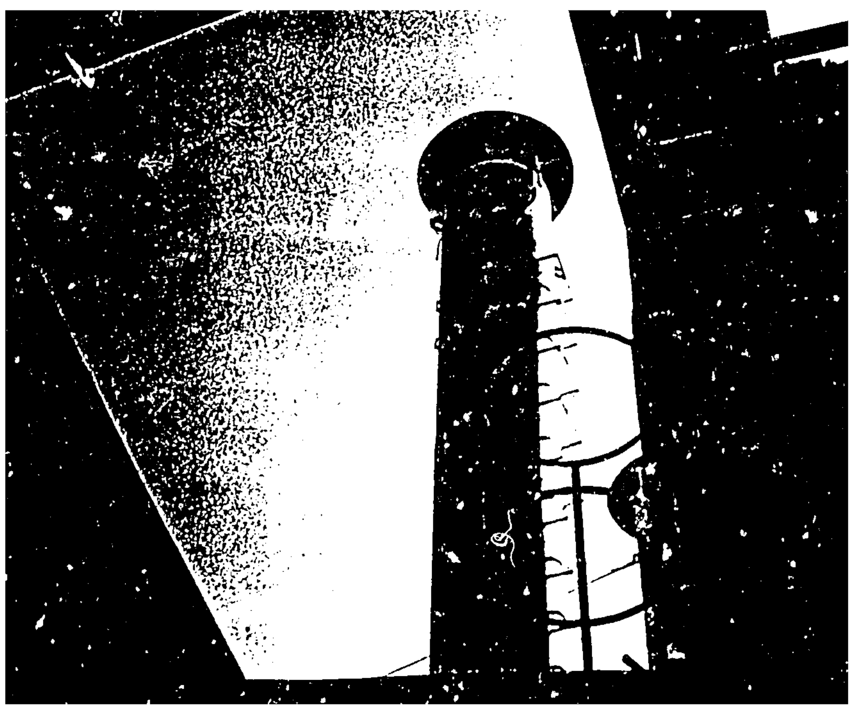


ALKI team of Directors of Technology Development, Environmental Control, Laboratory, and Manufacturing discussing environmental program.

ALKI Plant Manager and Managers of Production Units discuss system for collection and reuse of rainfall runoff from roofs near detergent drying tower.



Fabric filters for detergent drying tower gases.



Detergent drying tower stack.

Appendix B: Itinerary for Gerald N. McDermott

June 24-27	Conferred and observed, ALKI, Société de Fabrication de Produits Chimiques

Appendix C: Persons and Organizations Visited

Organization: Société de Fabrication de Produits Chimiques, ALKI

Personnel:
Thameur Choukaier, Director General
Fethi Brahmi, Laboratory and Control Director
Mohamed Gargouri, Director Technical Dev. Dept.
Hatem Zdghol, Environmental Control Manager
Fethi Zoghlami, Plant Manager
Unrecorded, Assistant Plant Manager

Thameur CHOUKAIER
Directeur Général

ALKI
Z.I. Ariana - B.P. 251 - 1080 Tunis cedex
Tunisie Tél. : (01) 717.740 - Fax : (01) 719.451
Télex : 15.118 ALKI TN.

ZOGHLAMI. Fethi
Resp. usine.

Société de Fabrication des Produits chimiques ALKI

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Gargouri Mohamed
Technical Dev. Dep

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Zghal Hatem
[illegible] Tr.

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Brahmi . Fethi
Laboratory
and Control

Société de Fabrication des Produits chimiques ALKI

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Appendix E: List of Documents Received

none

GERALD N. McDERMOTT, P.E.

Principal
Environmental Engineer

Years Experience: 40+

Education:

Massachusetts Institute of Technology, Sanitary Engineer
Harvard University, S.M., Sanitary Engineering
University of Wyoming, B.S., Civil Engineering

Experience:

- Mr. McDermott was a member of the Commissioned Corps of the United States Public Health Service and has assigned his entire public career to the Water Pollution Control Research division in Cincinnati, Ohio. He was instrumental in industrial waste studies that developed guides to water pollution control for several major industrial categories. He participated in several field studies of water quality including the Ohio, the Pearl, the South Platte, the Yellowstone, and other rivers.

  During this work, he was the first to measure and report the quantity and characteristics of municipal landfill drainage; the first to employ bioassays in industrial waste source surveys for identification of toxic streams; and the first to investigate the use of clays for the removal of trace levels of oil and other organics. He supervised an exhaustive investigation of the tolerance level of heavy metals in biological treatment.

  He served as Chief of Process Development, Advanced Waste Treatment Program for the Public Health Service. He supervised field application of activated carbon adsorption, integrated biological chemical treatment, foam separation, reverse osmosis, algae harvesting, powdered activated carbon treatment of wastewaters, and supervised research on use of the Total Organic Carbon measurement and the dissolved oxygen monitoring for control of an activated sludge plant.

- During his employment with Procter & Gamble Company, he first served as group leader and then as Wastewater Technology Leader. He provided design and engineering service in the treatment of wastewaters for direct discharge. These facilities included activated sludge treatment, aerated lagoon treatment in the largest such facility in the world, the largest land application system in the citrus industry, reverse osmosis treatment of food oil refining wastewaters, and granular activated carbon treatment of sulfation wastewaters of a chemical plant.

  As a technology leader, his assignment included keeping abreast of all developments in wastewater treatment technology. He did this by studying the current literature, by site visits to new process installations, and attending technical sessions of various organizations.

  He also supervised research conducted by consultants and university researchers for P&G and was acquainted with most of the leaders in such work. He was particularly active in maintaining relationships with the municipalities which received P&G wastewaters and was called upon to help solve technical and financial problems of the plants and agencies.

ERALD N. McDERMOTT, P.E.

Professional Affiliations:

American Academy of Environmental Engineers
Water Pollution Control Federation
American Society of Civil Engineers
American Chemical Society

Registrations:

Registered Engineer in California

Additional Accreditations:

Former Task Group Chairman for BOD and Oil
Analytical Methods, Standard Methods

Represented P&G in Industrial Associations:

Edible Oil, Soap, and Detergent
Chemical Manufacturers Association
National Food Processors Association
Associated Municipal Sewerage Agencies
Oil Chemists Society