













**d. Seed dehulling** The hulls of oil-bearing seeds are low in oil content. If they are not removed they reduce the total yield of oil at extraction by absorbing oil in the press cake. Waste hulls are produced from this unit and must be separated and discarded.

**e. Seed crushing and rolling** Clean seeds are transported by conveyors to the crushers that reduce the seeds to a reasonable size. Rolling causes partial rupturing of the cells and increases the surface area thus facilitating the extraction of the oil. This unit operation gives rise to solid waste materials, noise and air pollution with dust.

**f. Seed cooking** Cooking of the crushed ground seeds is done by steam to rupture the oil cells, to increase the fluidity of the oil and to kill bacteria.

**g. Seed pressing** Pressing is then performed to produce flakes with a larger surface area resulting in more efficient oil extraction.

**h. Oil extraction** Extraction of vegetable oils can be done by one of the three ways:

- a) Mechanical pressing (hydraulic or screw press)
- b) Solvent extraction.
- c) Prepress solvent extraction, in which the oil is first extracted by mechanical pressing and then by solvent extraction.

Hexane is commonly used as a solvent as it also extracts seed pigment. This may result in the production of off colored crude oil. Solvent vapors cause air pollution.

**i. Filtration** Solvent extraction of the prepressed seeds produces a mixture composed of the meal and the oil-rich solution. Filtration is performed to separate the extract (oil/solvent) from the meal (seeds contaminated with oil and solvent).

**j. Drying** After filtration, direct or indirect steam is used for drying to remove traces of hexane (solvent) from meal, which can be further processed as animal fodder.

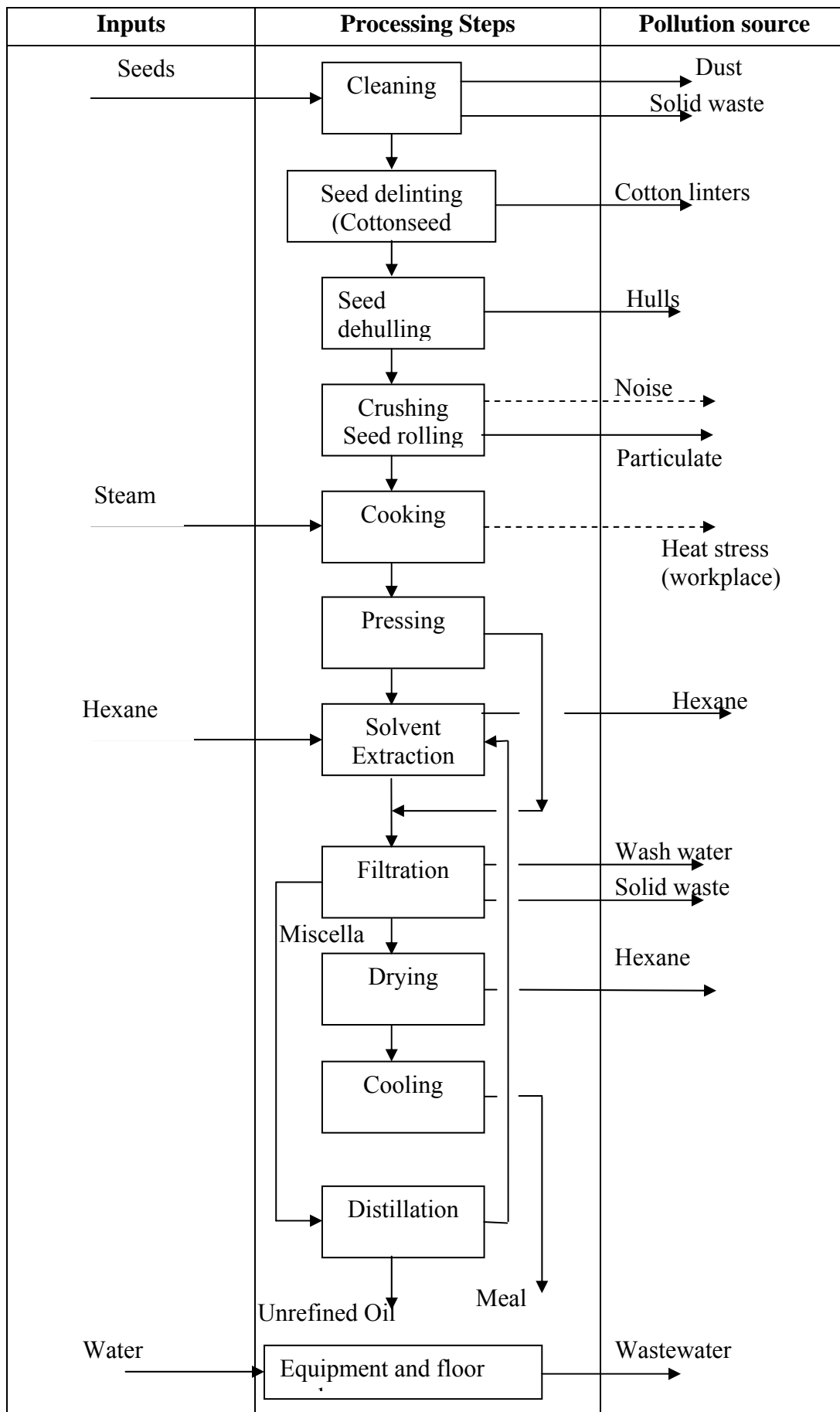
***k. Distillation***

The solvent is recovered by vacuum distillation as a top product and recycled to the extraction unit. The bottom product is unrefined oil contaminated with traces of solvent. The solvent content should be minimized as it is a major source of hexane emissions to air in the subsequent operations.

Hexane minimization is dependent on the separation efficiency of the tower, which is influenced by the cooling effect of the condenser. The condenser usually uses water cooled by cooling towers. The inlet water temperature to the condenser is thus a major parameter that affects the solvent content in the unrefined oil



**Fig (2.1) Seed Preparation and Oil Extraction**



## 2.2.2 Oil refining

### *a. Neutralization*

Fig 2.2 presents the main processing steps in this unit, inputs, outputs and the pollution sources.

The main operations are:

#### ***Crude oil degumming***

Gum and waxes may constitute a part of the crude oil impurities and therefore depend on the type of oilseed used. Soybean oil is richer in gummy substances than cottonseed oil, while sunflower oil is rich in waxes. Thus with soybean oil a step for crude oil degumming prior to refining is essential, specially when the oil will be physically deodorized only.

0.1% phosphoric acid is used to remove gums from crude oil.

The produced gum could be a useful by-product from which lecithin, a natural emulsifier, can be obtained.

#### ***Oil dewaxing***

The waxes are solidified by lowering the temperature and filtering off the oil. The solid wax produced is disposed as solid waste.

#### ***Neutralization***

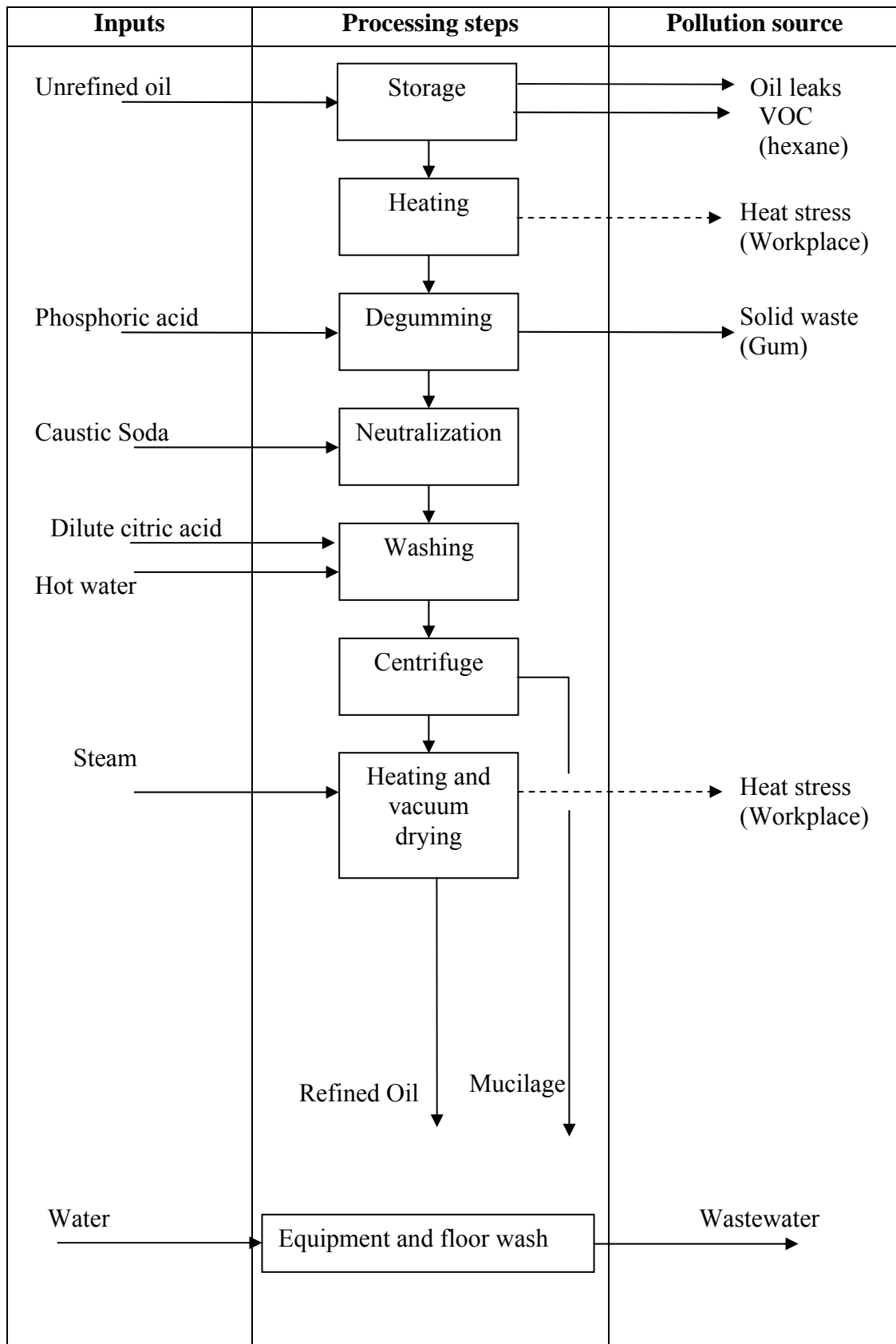
Crude oil usually contains undesirable constituents, which should be removed to make the oil product suitable for edible use. These include free fatty acids, coloring matters and odoriferous substances.

The free fatty acids are removed from crude oil using caustic soda solution then separation of oil from soap. The soap formed by the action of sodium hydroxide on the free fatty acid will settle down with gummy and coloring substances forming a dark brown semi solid known as mucilage. The mucilage is processed into soap stock by addition of caustic soda after concentration by indirect steam. The residual water is heavily polluted.

The refined oil is washed with dilute solution of citric acid to break the soap emulsion then with hot water, after that it is separated from soap water (mucilage) by centrifuge then dried under vacuum at 90°-100°C before bleaching.

Removal of water traces prior to bleaching is essential to avoid the deactivation of the fuller earth.

Fig (2.2) Oil Neutralization



**b. Bleaching**

Fig 2.3 presents the main processing steps in this unit

***Bleaching***

Bleaching of oil by adsorption involves the removal of pigments and colored materials such as carotene, semi like carotene, sterols and tocepherol, which are dissolved in the form of colloidal dispersed particles. Adsorbents usually employed are bentonitic clays such as fuller's earth and Tonsil clays.

The bleaching earth is usually added to the bleaching kettle in the desired amount (1-2% oil by weight), at a temperature of about 82-90°C under vacuum.

***Filtration***

The oil is passed to Ama filter to separate oil from the bleaching agent. The cake of the spent earth in the filter is blown with air and steam to recover as much as possible of the entrained oil.

The spent earth contains about 30-35% of its weight, entrained oil. The spent earth is a solid waste, which is transported and dumped in a public dump.

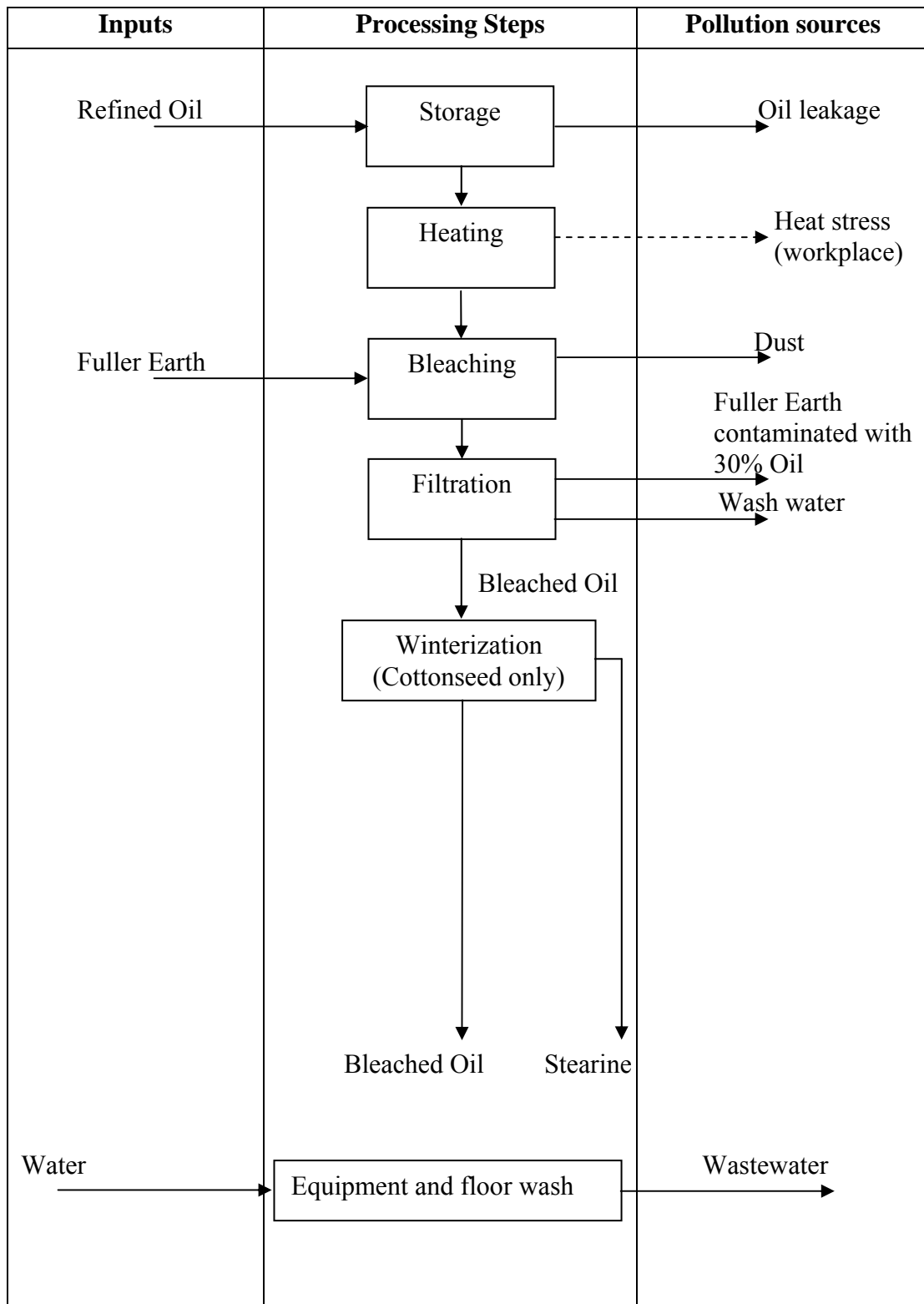
***Winterization***

This process is used for oils with high stearine content such as cottonseed and olive oil, which contain up to 18% stearine. It involves partial settling and crystallization of stearine at 5-9°C in special tanks for a period of about 3 days.

***Stearine filtration***

Stearine is filtered at -3°C and separated by scrapping the press cloth and melting the stearine with steam. The produced stearine is sent to the shortening unit.

Fig (2.3) Oil Bleaching



### *c. Deodorization*

Fig 2.4 presents the main operations in this unit

The bleached oil is treated by superheated steam at 250°C under a very low pressure of 6-12 mmHg absolute to remove all substances which cause undesirable flavor or odor and which are mainly free fatty acids. All the volatile matters with the steam are condensed in a barometric condenser. The refined bleached and deodorized (RBD) oil is cooled and filled in plastic bottles.

The barometric condensate contains volatile substances and free fatty acids and is considered as a great source of pollution.

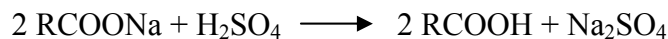
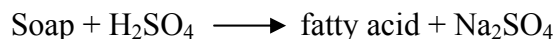
Also emission of heat and steam into air may exist.

### **2.2.3 Soap stock production Unit**

Mucilage resulting from the neutralization process, is concentrated by heating with indirect steam. The latter is treated with sodium hydroxide to produce soap stock.

#### *Soap stock splitting*

The dilute soap water is concentrated by heating using indirect steam. Sodium chloride is used to recover oil from the concentrated soap water, and the recovered oil is recycled back. The residual emulsion is fed to the splitting unit, where sulfuric acid is added to liberate the fatty acids, according to the following equation:



the produced fatty acid is transferred to the soap factory and the residual is heavily polluted wastewater and is discharged to the drain.

Fig (2.4) Deodorization

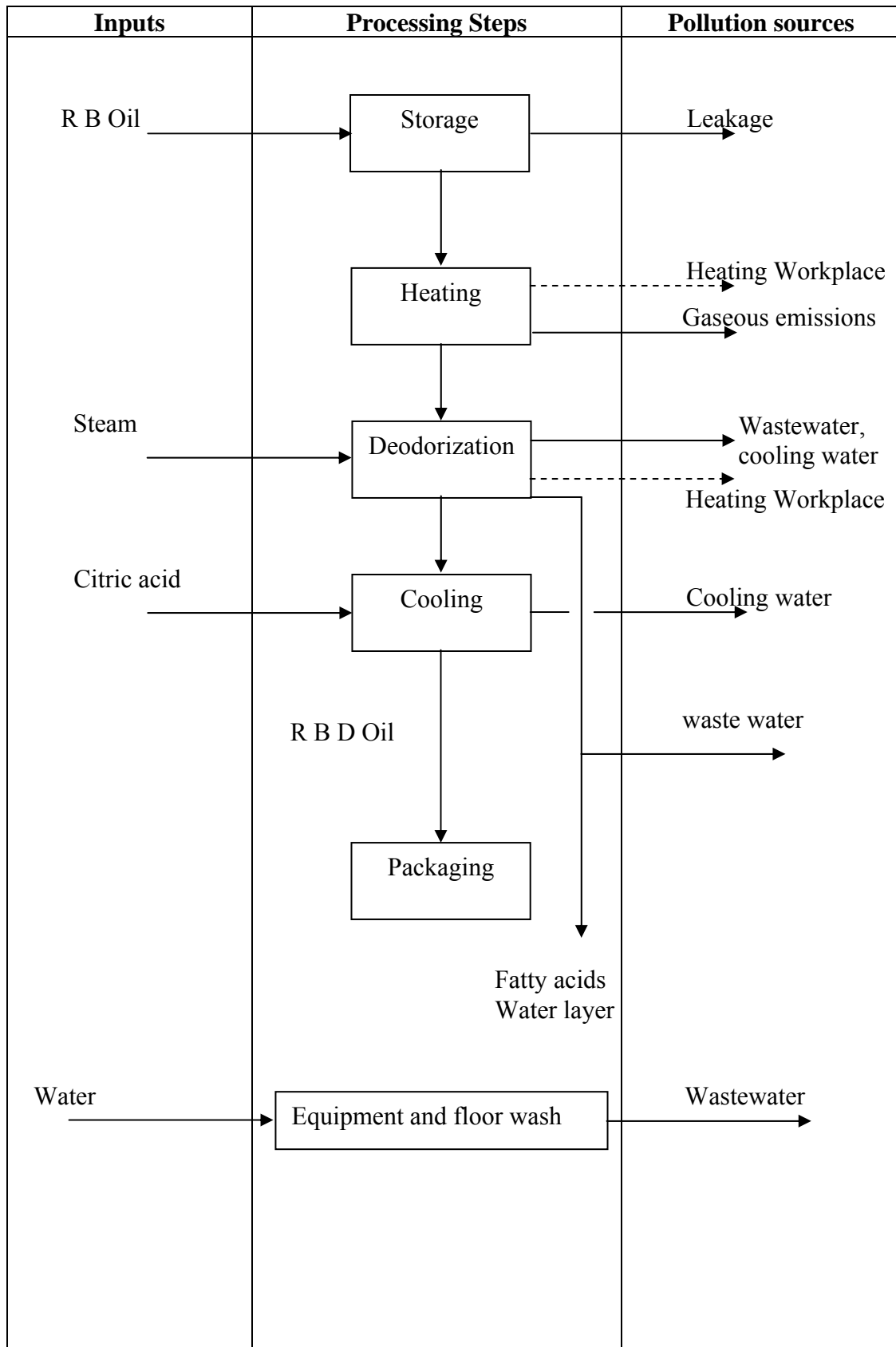
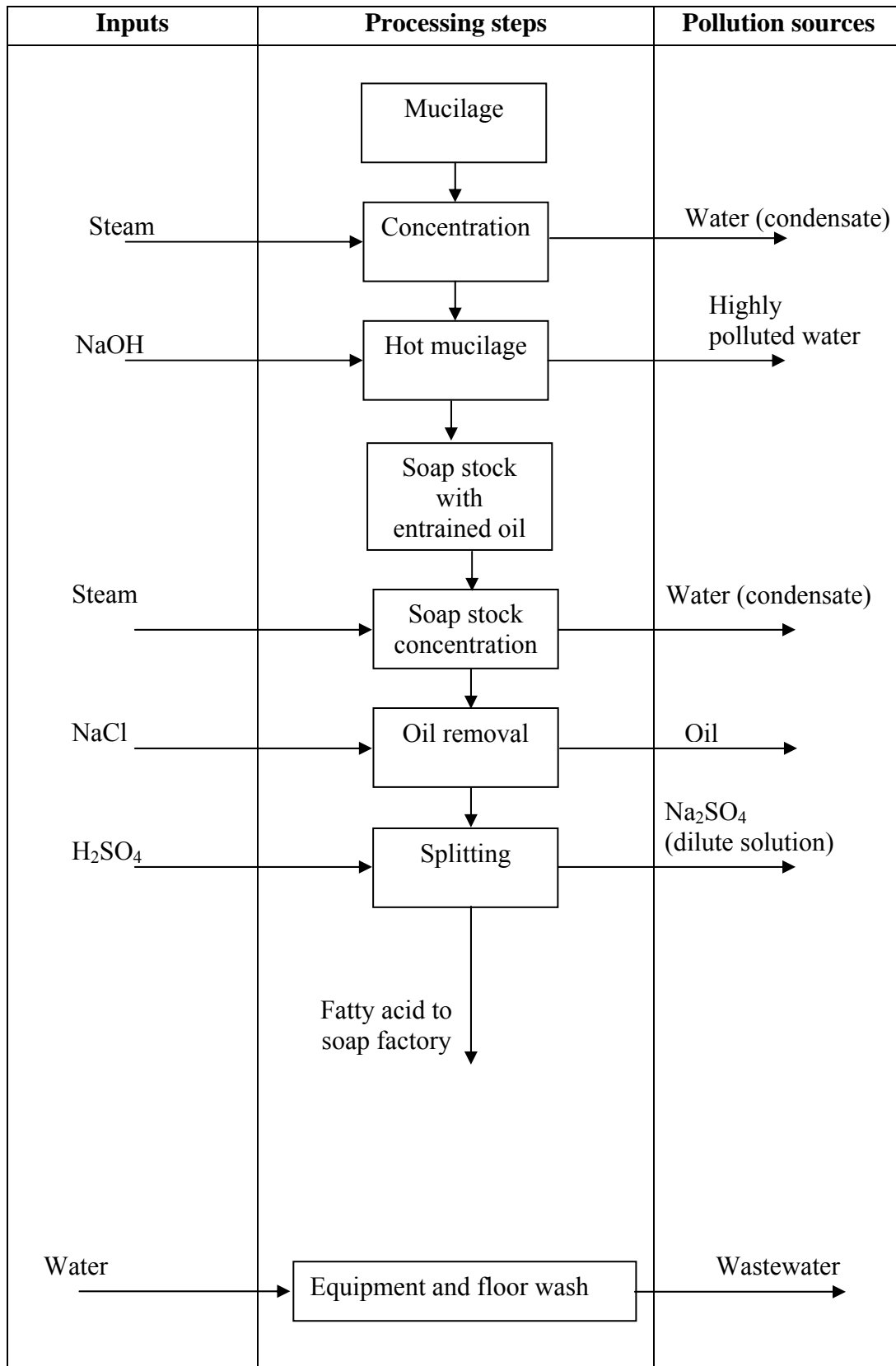


Fig (2.5) soap stock unit



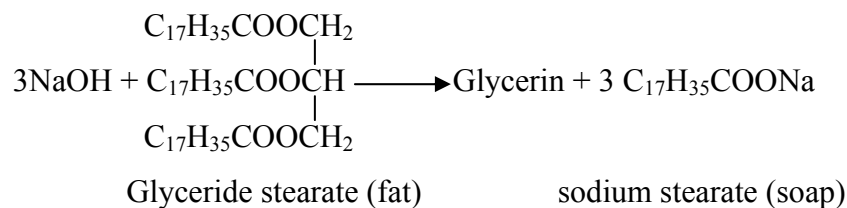


### 2.2.4 Laundry and toilet soap unit

Production of an ordinary fully boiled or settled soap takes place in a steel kettle with slightly conical bottom. The following operations takes place:

- a. Saponification** A solution of caustic soda (15%) is run and the melted fat and grease or oils are then pumped in. The amount of caustic soda is just enough to combine with all the fatty acids liberated. A direct steam jet entering at the base of the kettle provides both heat and agitation. The kettle is kept boiling until saponification is complete.
- b. Soap separation** NaCl salt is then added to separate the soap from the upper layer. The salt used is mainly rock slat that is recovered and reused.
- c. Neutralization** Sodium hydroxide is not added at once. As the reaction proceeds more concentrated sodium hydroxide solution is used and after each addition the lower layer composed of glycerin and slat is withdrawn from the kettle and fed to the glycerin recovery unit.
- d. Graining and settling** As saponification proceeds soap concentration increases and soap graining begins in the kettle with the separation of the lower layer of lye, which is withdrawn from the kettle (run off). Salt is then added and the soap layer boiled with water, then allowed to settle.

Figure (2.6) illustrates the manufacturing steps of this unit.



#### **Flaked soap unit**

Mucilage, obtained from oil neutralization, is fed to a bleaching tank. Caustic soda (NaOH) is used for saponification.

Sodium hypochloride is added until the dark brown color of soap stock changes to relatively white color. The bleached soap stock is left for 24-28 hours in air for cooling then cut into blocks.

The blocks are fed to roller where small amount adhere to the surface and are scratched to give flakes. The flakes are packed in plastic bags.

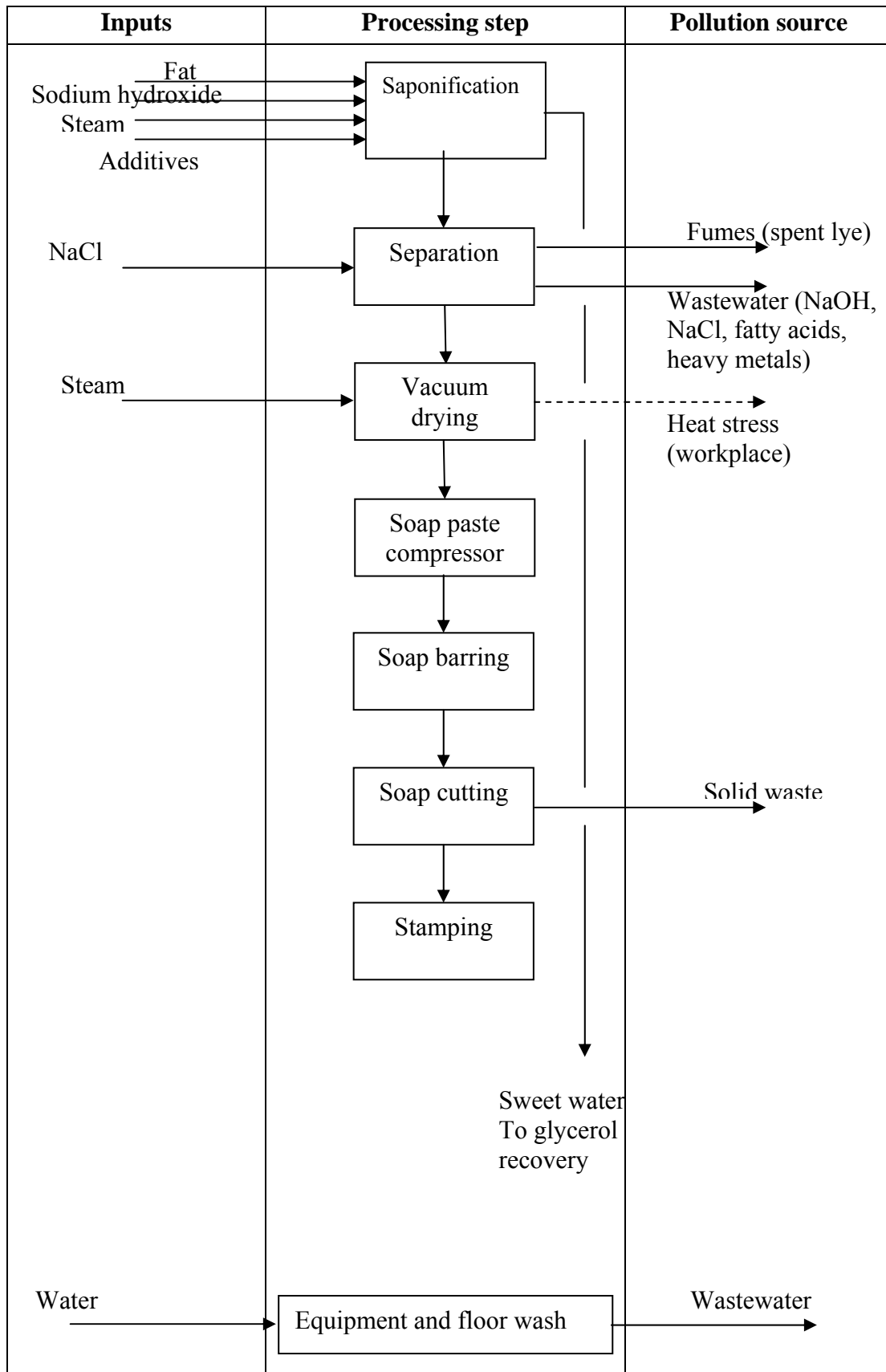
In soap making process the sources of pollution could be acid vapors to air, wastewater, spent lye containing soaps, glycerin, salt and free alkali. Wax or

gum may also exist. Inefficient separation of soap from the spent lye can cause excessive amounts of foams, which overflow on the floor.

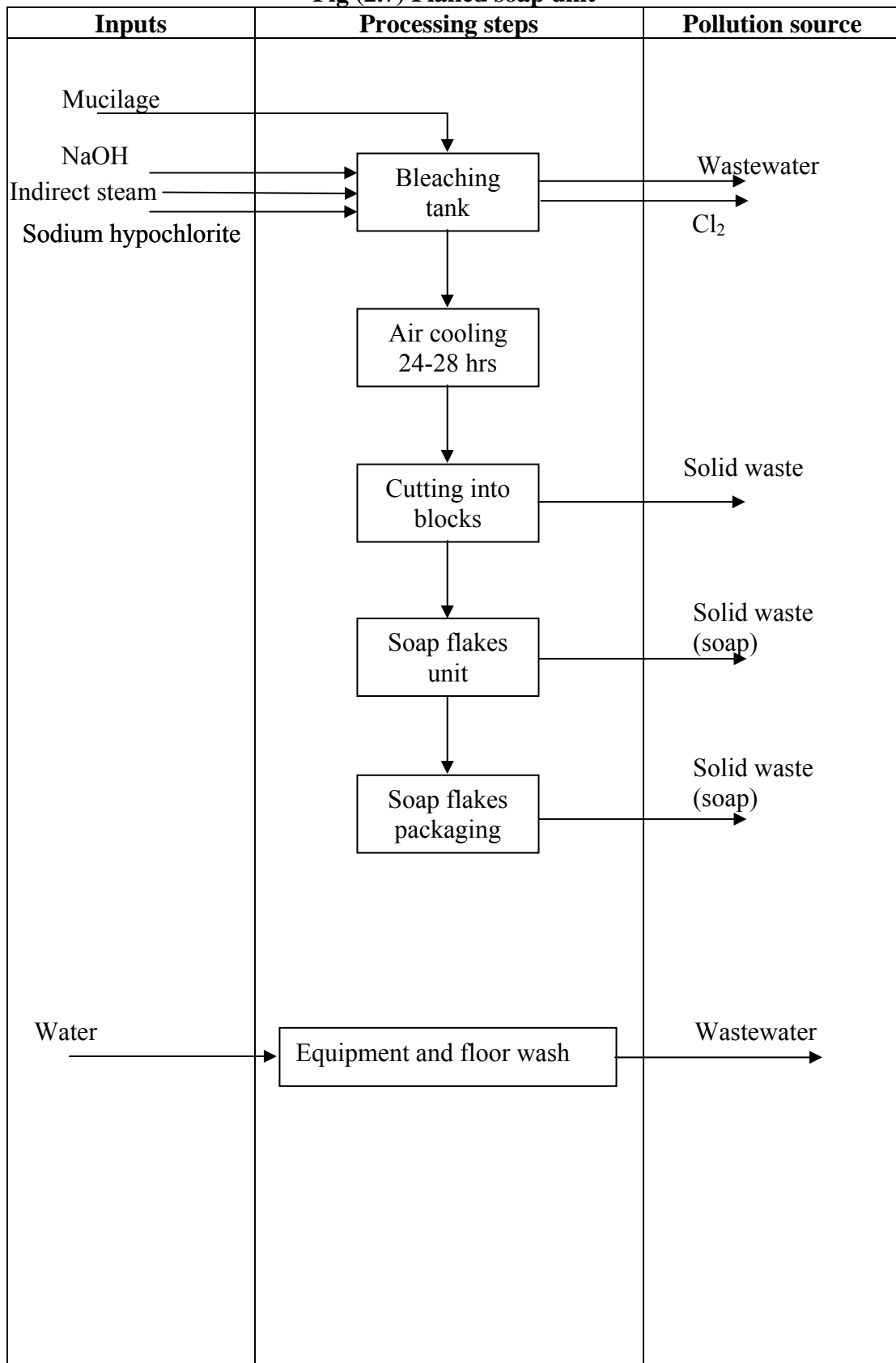
Also soap dust in the processing area of laundry and toilet soap represents losses and is thrown on the floor, which contributes greatly to the pollution load after floor washing, even though this losses may be collected then packed manually in sacs for reuse.

Fig (2.7) illustrate powder soap unit.

Fig (2.6) laundry soap



**Fig (2.7) Flaked soap unit**



### **2.2.5 Oil hydrogenation**

The production of vegetable shortening by oil hydrogenation has been remarkably reduced in recent years. Palm oil is now used as a substitute. However, the hydrogenation units still produce saturated fatty acids (stearine) from distilled fatty acids obtained by acidulation of soap stock. Stearine has several uses in food and chemical industries.

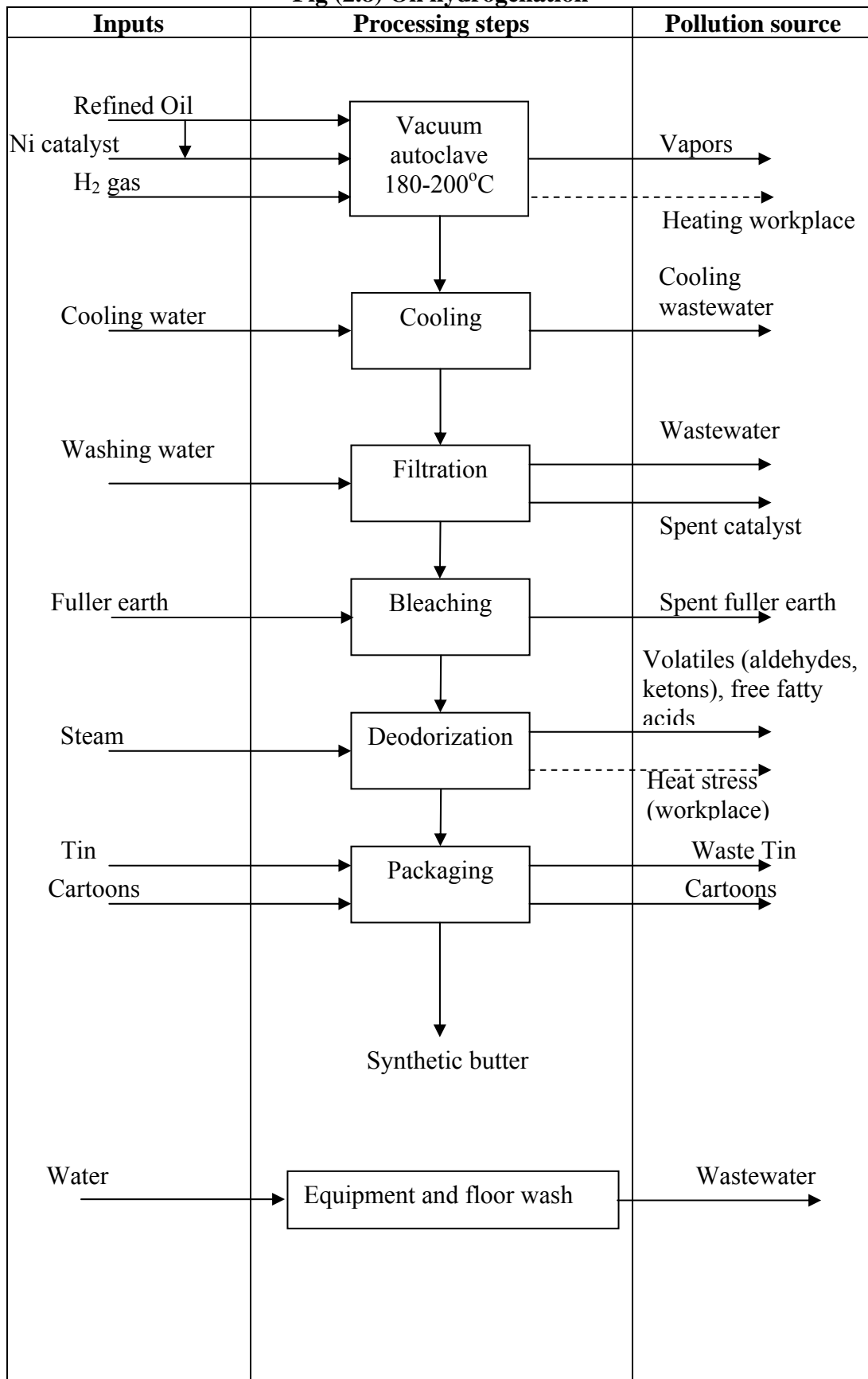
In the oil hydrogenation unit, the refined oil is fed to the reactor, heated and evacuated to drive off air and water. Nickel catalyst oil suspension is fed to the unit. Hydrogenation takes place at 180-200°C under vacuum. The hydrogenation oil-catalyst mixture is cooled, filtered and the exhaust catalyst is separated. The hydrogenated oil is refined by bleaching and deodorization. This treatment is done to remove nickel catalyst traces, and to remove the odor produced from hydrogen treatment. The refined hydrogenated oil is then packed.

Spent nickel catalyst, usually contains up to 50% shortening, causes a solid waste pollution problem. Also hydrogen gas in air with its high dangerous explosion range can be a source of fire hazard.

Wash water from filter back washing may contain nickel catalyst. The spent active clay used in bleaching operation and the low boilers (aldehydes, ketones) evaporating from the deodorization unit are also sources of pollution.

Fig (2.8) presents oil hydrogenation unit.

**Fig (2.8) Oil hydrogenation**



### **2.2.6 Shortening unit**

The materials used are imported palm oil, palm oil stearine and local stearine. Although the imported raw materials is refined, bleached, deodorized (R.B.D.) grade, repeated indirect heating and direct steam heating during discharging in the port of Alexandria to the storage tanks, from storage tanks to transporting trucks, and from the latter to the factory storage tanks, causes a free fatty acid formation and contamination with water.

Therefore the palm oil needs refining, bleaching and deodorization before shortening. The technique is quite similar to that for oil. The required quantities of caustic soda and fuller earth are less than that required for oil refining. Before deodorization the three materials, palm oil (70%), palm stearine (25%) and local stearine (5%) are mixed. After deodorization the mixture is transferred to storage tanks, then packed into cans and barrels.

The soap water is treated with sodium chloride to extract oil which is recycled back. The residual emulsion is subjected to a splitting using sulfuric acid. The splitting process generates free fatty acids.

The expected pollutants from this unit are deodorization distillate, which contains odoriferous volatile substances and free acids. Spent bleaching agent, consumed filter cloth, and oil and soap contaminated water are also generated as wastes.

Fig (2.9) illustrates the shortening unit.

**Fig (2.9) Shortening**

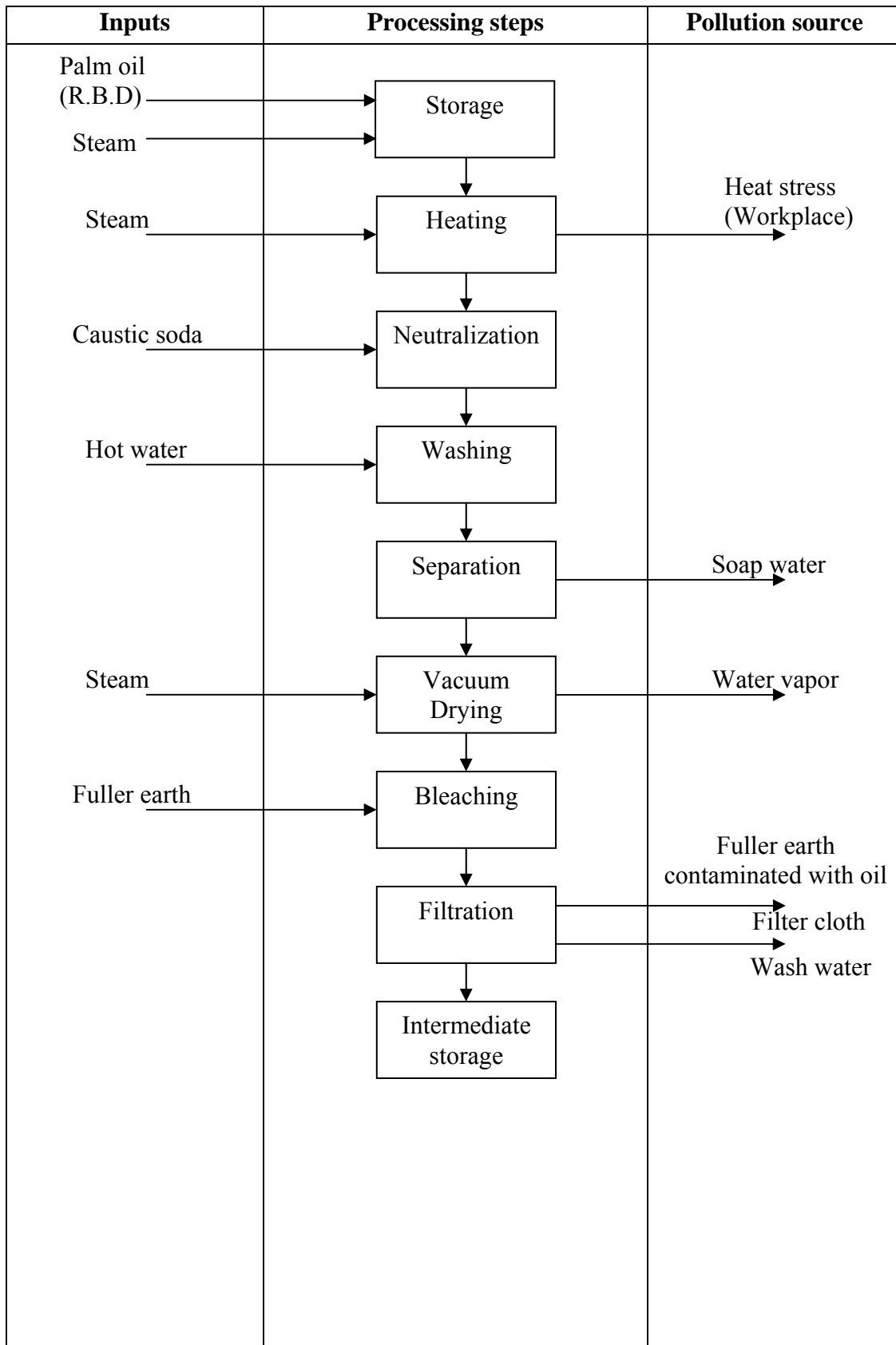
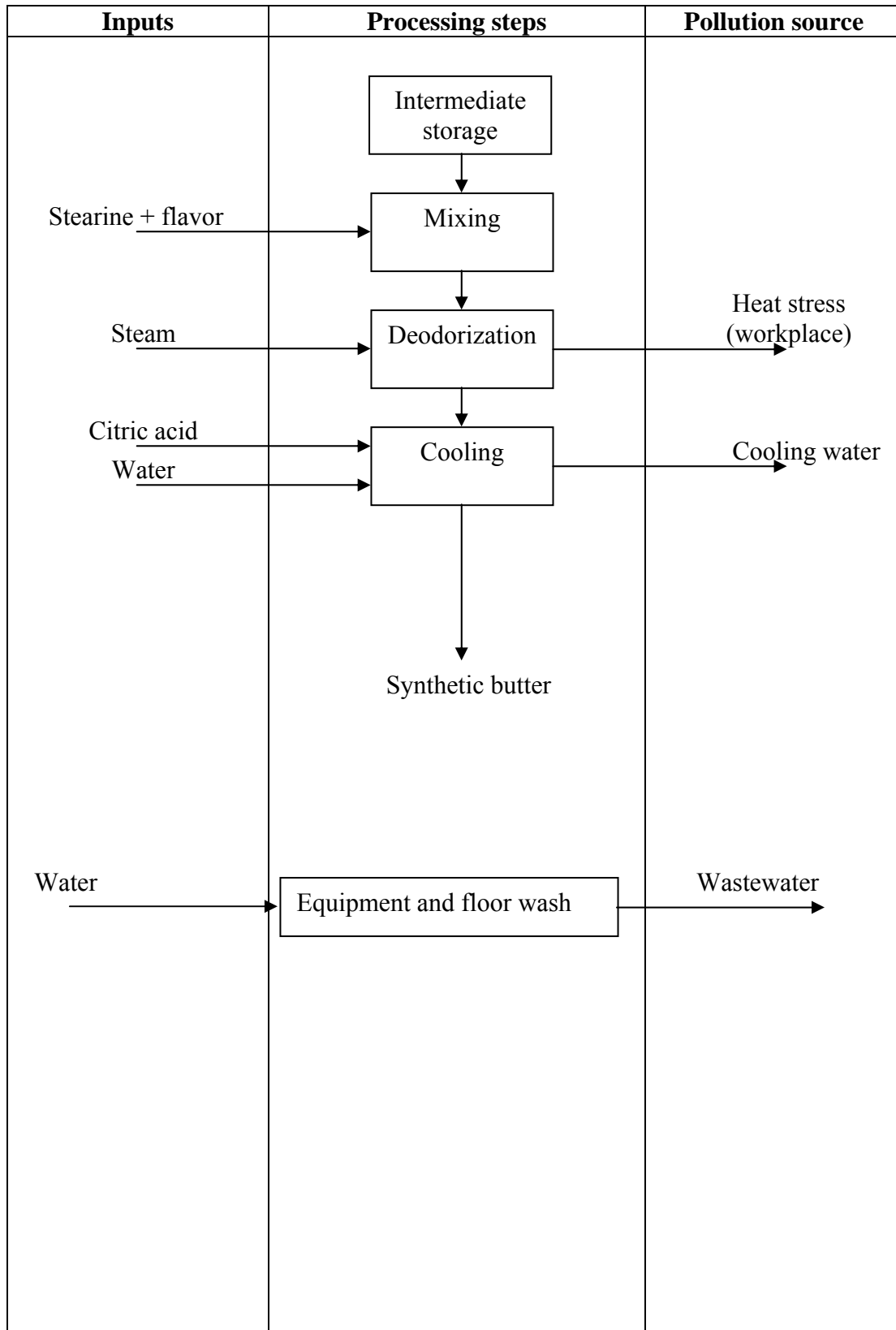




Fig (2.9) Shortening (cont)

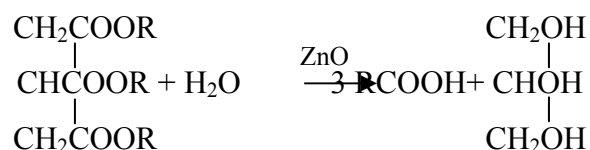


### 2.2.7 Fatty acids production (Splitting unit)

Fatty acids are mainly consumed in the manufacture of detergents and soaps. Fatty acids, saturated (e.g. stearic acid) and unsaturated (e.g. oleic) have long been employed in many other industries such as cosmetics, water proofing, textiles...etc.

Fig (2.10) illustrates hydrolysis process, which mostly used in the soap industry. The reaction is catalyzed by zinc oxide.

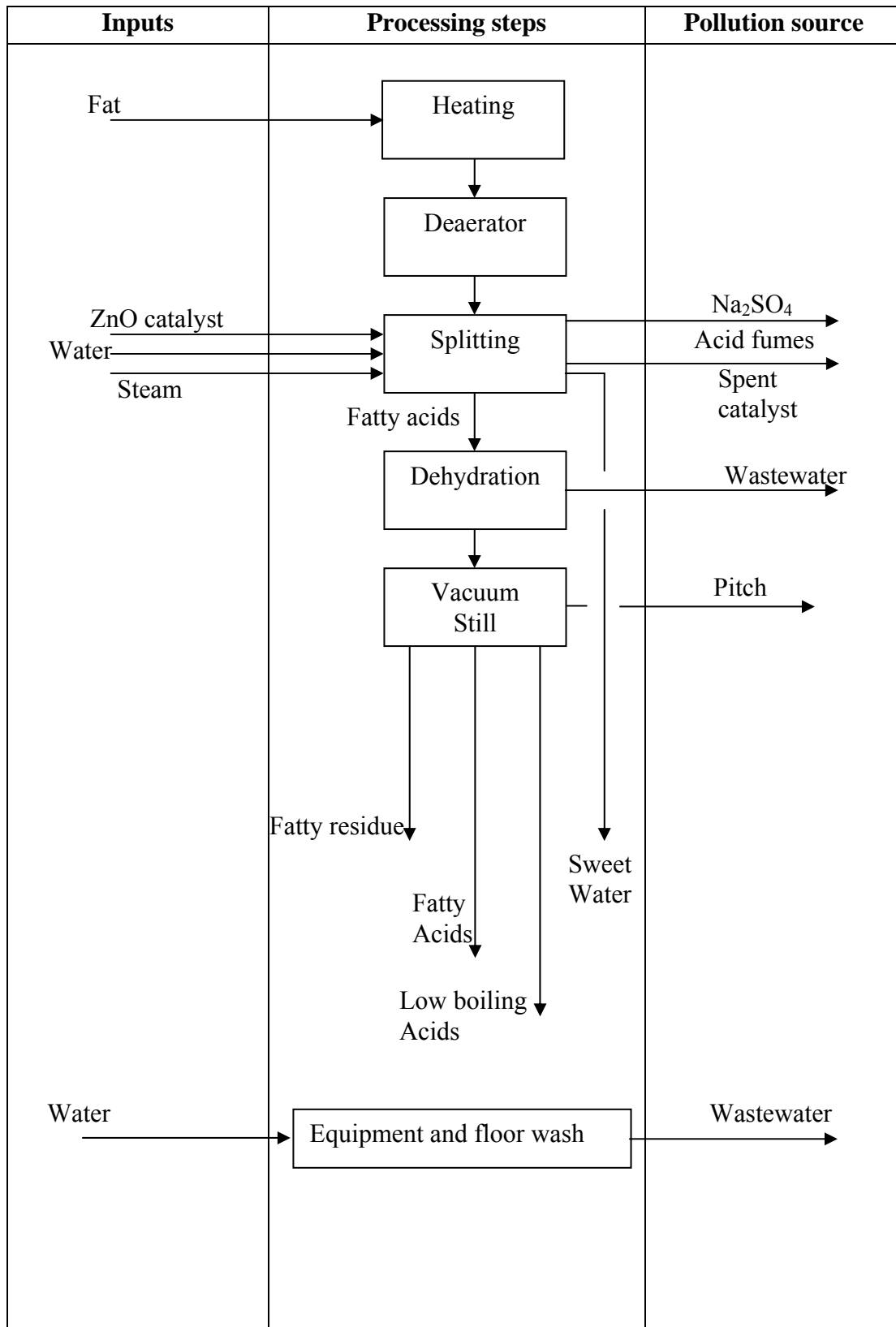
Fatty acids are drawn off from the distillate receiver for sale.



The purification of fatty acids by separating fatty acids of different chain lengths is performed by vacuum distillation. Preheated crude fatty acid is charged to the top of a stripping section of the distillation tower. While it is flowing downward, the air, moisture and low boiling fatty acids are swept out of the top. The top vapors are condensed and part is recycled back to the top of the tower as reflux and the rest withdrawn as non-condensable and overheads. The main cut of low-boiling acids is withdrawn as a liquid side stream near the top.

The side stream withdrawn near the bottom of the tower consists mainly of high-boiling acids. It is heated in a reboiler then introduced to a flash tower where the overhead distillate is withdrawn from the top and condensed. This represents the second fatty acid fraction. The bottoms from the flash tower are returned near the bottom of the distillation tower, reworked and removed as pitch.

Fig (2.10) Fat Splitting



### **2.2.8 Glycerin recovery unit**

Glycerin is an important by-product of the alkali saponification of fats in soap making. The spent lye from soap making contains in addition to about 5-15% glycerin, a considerable and variable quantity of salt, a small amount of free caustic soda, traces of dissolved soap, and certain organic impurities derived from the fat.

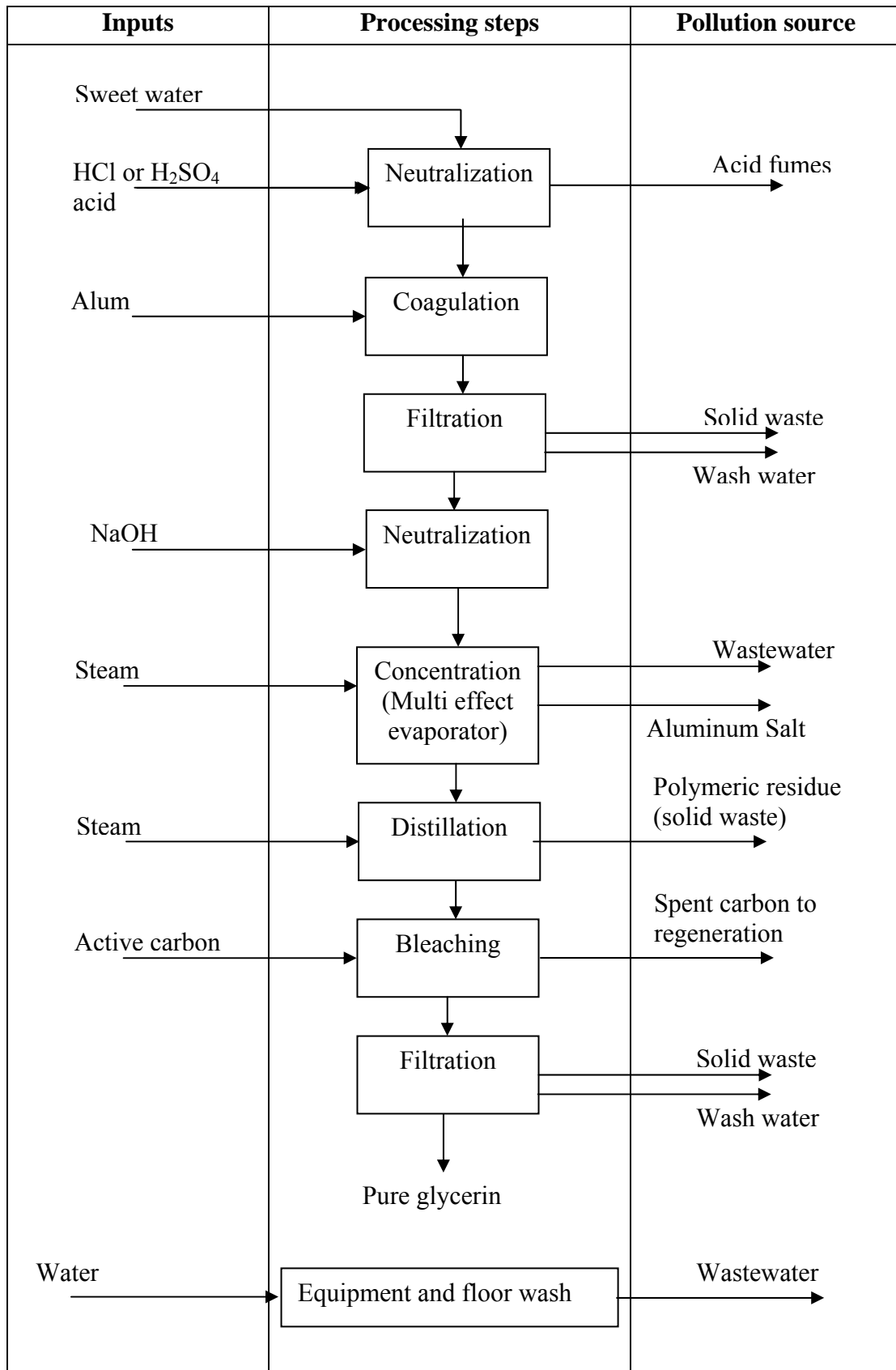
The first step in glycerin recovery is the treatment of the lye with addition of hydrochloric or sulfuric acid to neutralize any caustic soda remaining in glycerin. Aluminum sulfate is then added to precipitate any dissolved soap in the form of insoluble aluminum salts and reacts with the excess caustic soda to form a flocculent precipitate of aluminum hydroxide, which has a high adsorptive capacity for aluminous material or other organic impurities. After treatment is completed the clarified lye is filtered. The treated lye is evaporated to separate the bulk of the salt and to concentrate the solution to give 80% crude glycerin. Double effect evaporator is used to concentrate the glycerin. The salt settles at the bottom of the second evaporator and is withdrawn to salt storage drums. The recovered salt is washed, dried and reused. The glycerin consists of is crude glycerin 80%, produced small amounts of salt and various other impurities both organic and inorganic.

Purification and further concentration of the latter product is done to yield commercial grade of glycerin by fractional vacuum distillation with the aid of super heated steam and bleaching the distilled product with active carbon. Also glycerin can be purified by an ion-exchange method.

Fig (2.11) illustrates the glycerin recovery unit.

As shown in figure the expected pollutants are aluminum soap, aluminum sulfate, and organic impurities from fat, water with some soap also results. A polymeric residue may be formed in the glycerin distillation unit due to overheating.

Fig (2.11) Glycerin recovery

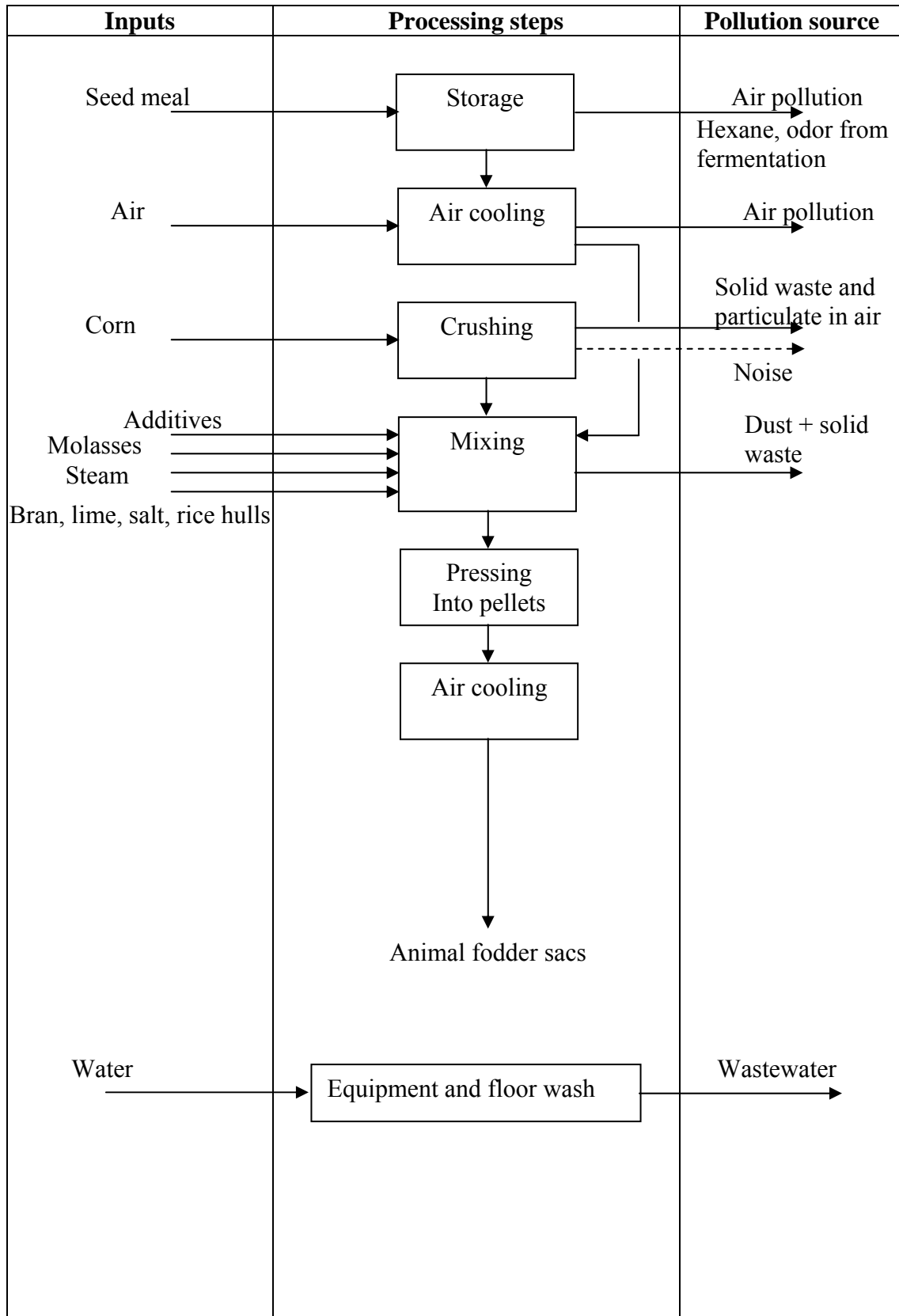


### **2.2.9 Animal fodder production**

The seed meal obtained after oil extraction (contain 1.5% oil) is cooled by air to remove solvents. The cooled seed meal is then mixed with different additives such as bran, rice hulls and molasses. Steam is used to obtain certain humidity, and then the mixture is pressed in the form of pellets and cooled by air. The animal fodder is finally packed into sacs for marketing.

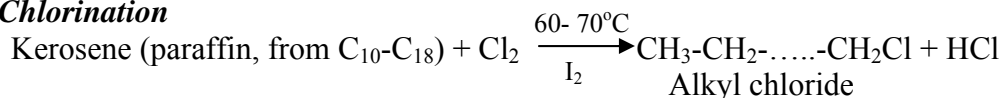
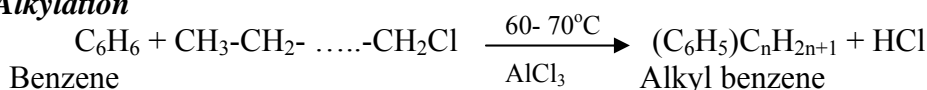
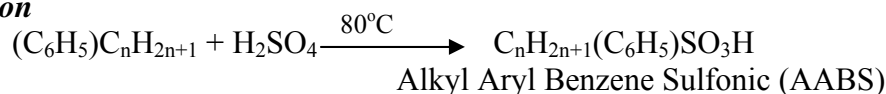
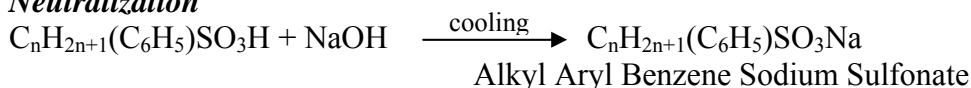
Fig (2.12) presents this unit. In this unit emission to air could be great source of pollution such as particulate during the mixing ingredients, odor from fermentation of organic materials, particulate during corn crushing and vapors of residual hexane. Also solid waste from mixer, crusher and packing unit.

Fig (2.12) Animal fodder plant



**2.2.10 Anionic surfactants (Alkyl Aryl Benzene Sodium Sulfonates) AABSS**

This compound is prepared in four-steps process using cheap petroleum raw materials

**Chlorination****Alkylation****Sulfonation****Neutralization**

Kerosene feed stock may be fractionated by a molecular sieve process in vapor phase. Molecular sieve adsorbents are synthetic zeolites of controlled pore size such that normal paraffins are adsorbed internally, but iso-paraffins and cyclic hydrocarbons are not adsorbed. This is required to obtain linear alkyl benzene for biologically degradable detergents (soft detergents). According to equation (1) kerosene is chlorinated by chlorine gas into linear alkyl compound. Alkylation of benzene with the formed alkyl chloride in presence of aluminum chloride catalyst leads to the formation of linear alkyl benzene.

Chlorination and alkylation occur in agitated reactors fitted with cooling system and external reflux condensers to cool the liberated hydrogen chloride gas and reflux the entrained organic mist back to the reactor. The evolved hydrogen chloride and chlorine gases must pass through series of scrubbers to recover such gases.

The third reaction (sulfonation) takes place using H<sub>2</sub>SO<sub>4</sub> 98%, SO<sub>3</sub> or oleum. In case of using sulfuric acid, excess acid is used to complete the reaction with heating by steam jacket to 80°C. sulfonic acid produced from the third equation is then diluted with water to precipitate the sulfonic acid from reaction mixture and separated.

Finally, step (4) is a neutralization process using sodium hydroxide to obtain the sodium salt AABSS. The latter is dried by spray drier to have fine granules or by drum dryer to obtain flakes.

Some plants cancel step (1) and (2) and start from alkyl benzene produced in petroleum refinery.



***Regulators***

Generally synthetic detergents regulation is necessary for surfactants to do an efficient job of cleaning in a washing machine. This is often achieved by combining different types such as anionics with non-anionics or soaps as foam inhibitors.

***Builders***

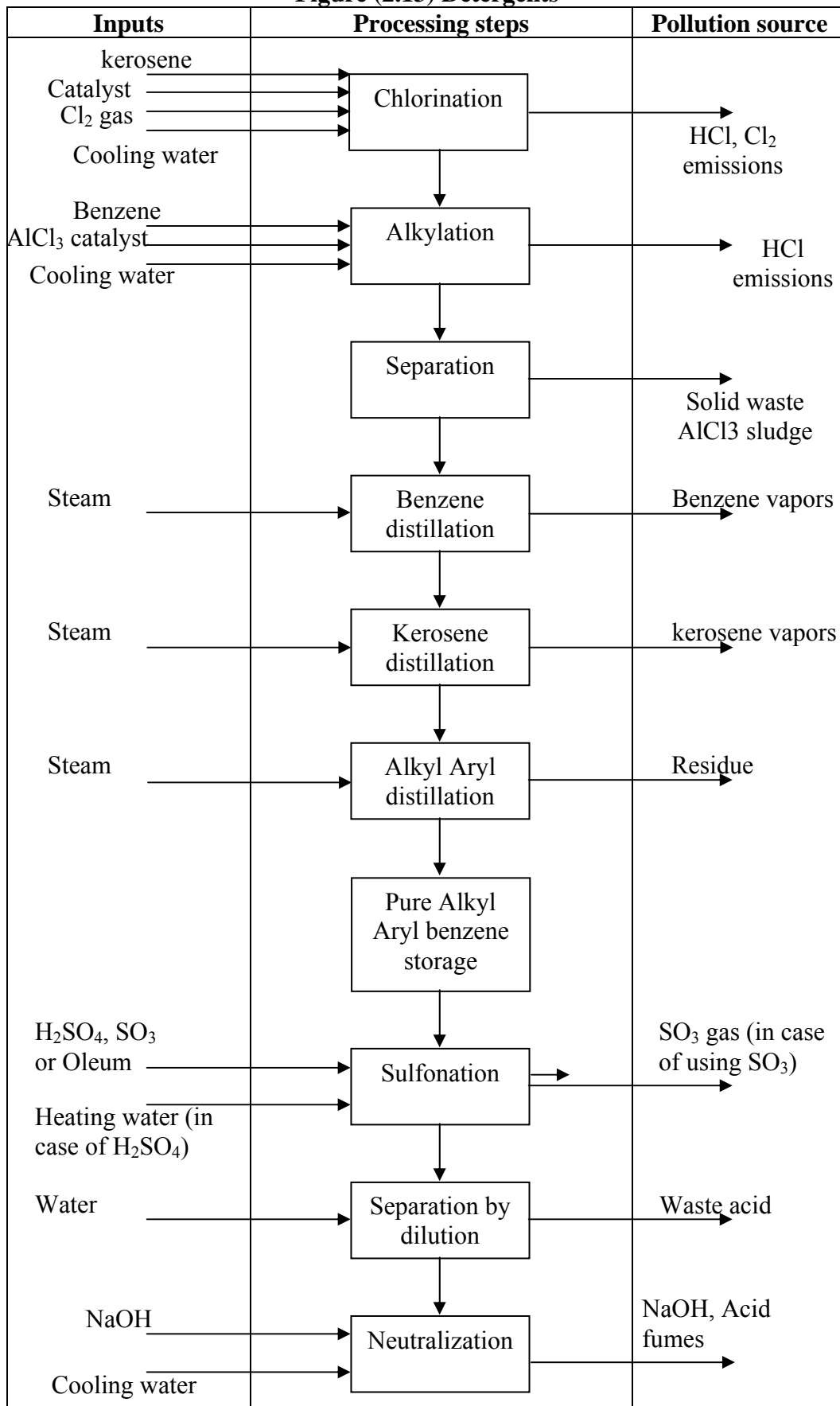
Also builders boost the detergents power. Complex phosphates such as sodium tripoly phosphate, have been used most extensively [30-50%]. These are water softeners prevent redeposition of soil from the wash water on fibers. During 1960s the growth of algae causes eutrophication in lakes become linked to the presence of phosphates in detergents and a substitute has to be found.

***Additives***

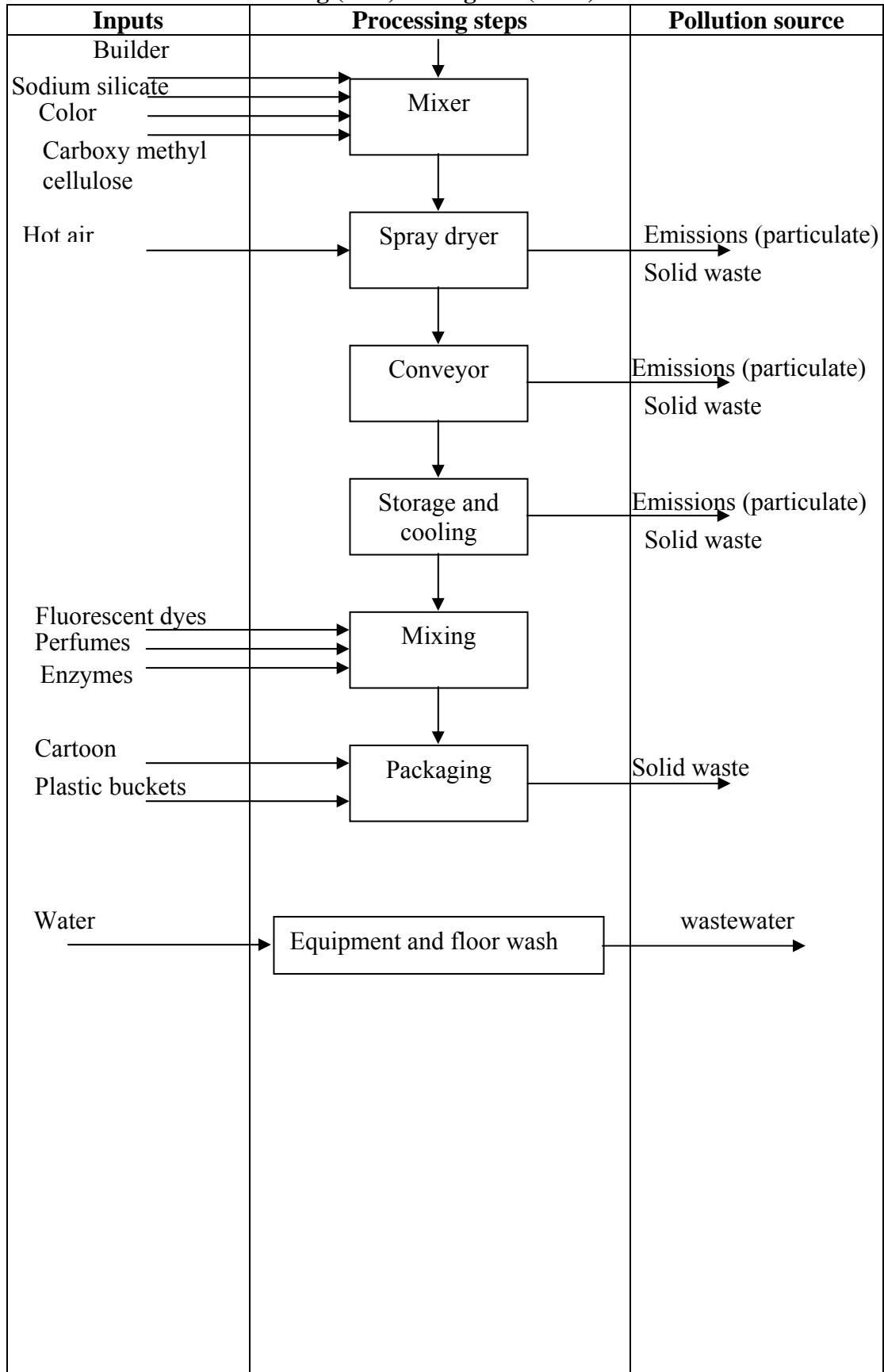
Some additives (up to 3%) are used to add certain properties to the detergents such as sodium silicate, which acts as corrosion inhibitor to protect metal and washer parts. Carboxy methyl cellulose has been used as an antiredeposition agent. Tarnish inhibitors carry on the work of corrosion inhibitor and extend protection to metals such as German silver. Fabric brighteners are fluorescent dyes. Enzymes are also added to reduce the stain, particularly those of a protein nature.

Fig(2.13) presents the detergents manufacturing process, raw materials, products and expected pollutants.

Figure (2.13) Detergents

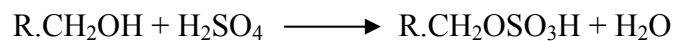


**Fig (2.13) Detergents (cont.)**

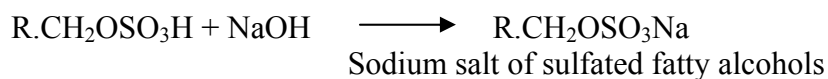


### 2.2.11 Sulfated fatty alcohols (anionic)

This compound is prepared by sulfation of fatty alcohols, which are produced from hydrogenation of fatty acids. Oleum or an excess of 98% sulfuric acid is added to the purified fatty alcohols to form acid sulfate according to the following equation:



Then the acid is converted to sodium salt using caustic soda:

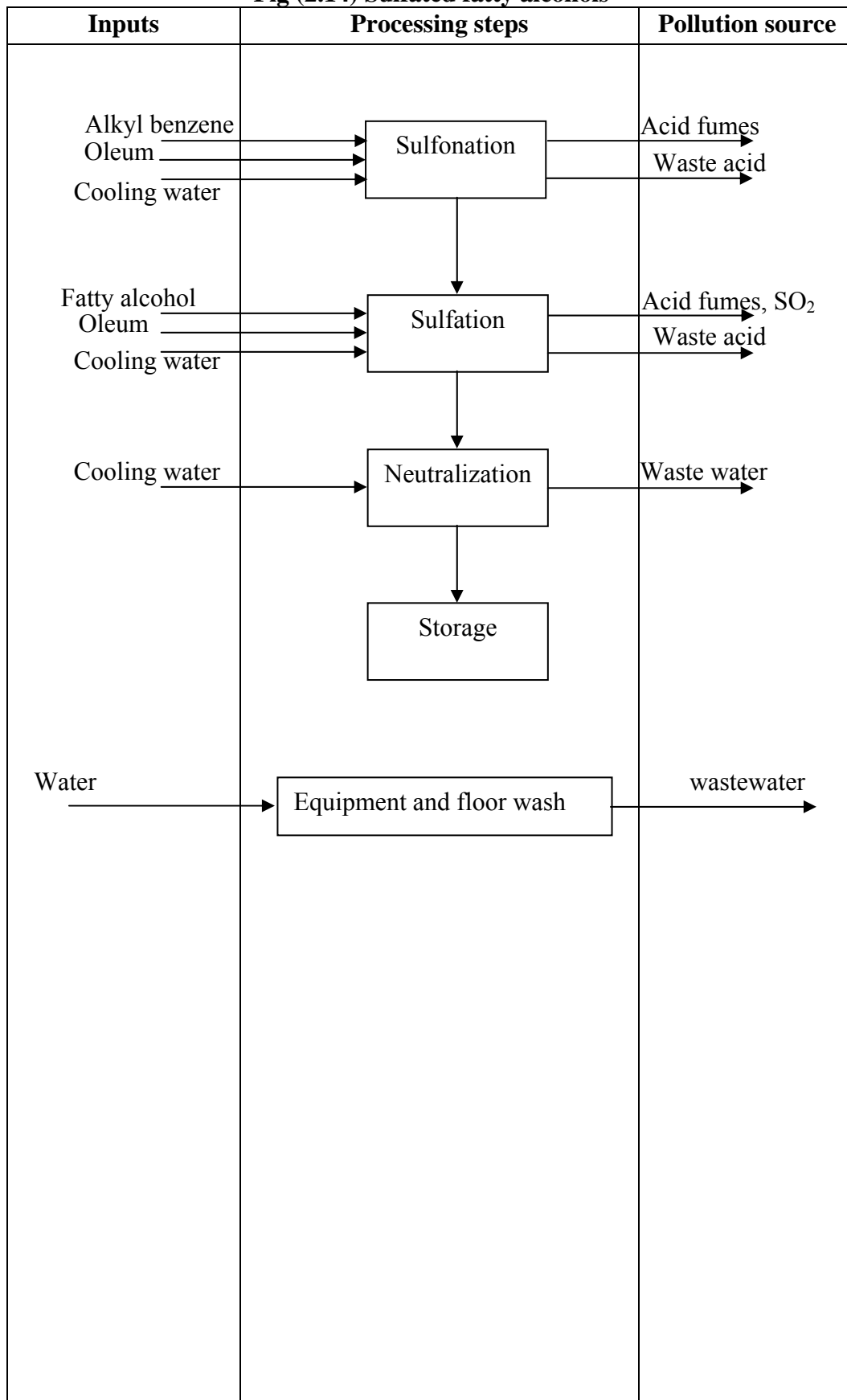


Any excess acid is neutralized and the sodium sulfate is usually left with the entire mixture and dried.

AABSS may be combined with sulfated fatty alcohol to produce a mixture of detergents as shown in the following figure (2.14).

Also side reactions of alcohols sulfonation may produce  $\text{SO}_2$  gas.

Fig (2.14) Sulfated fatty alcohols



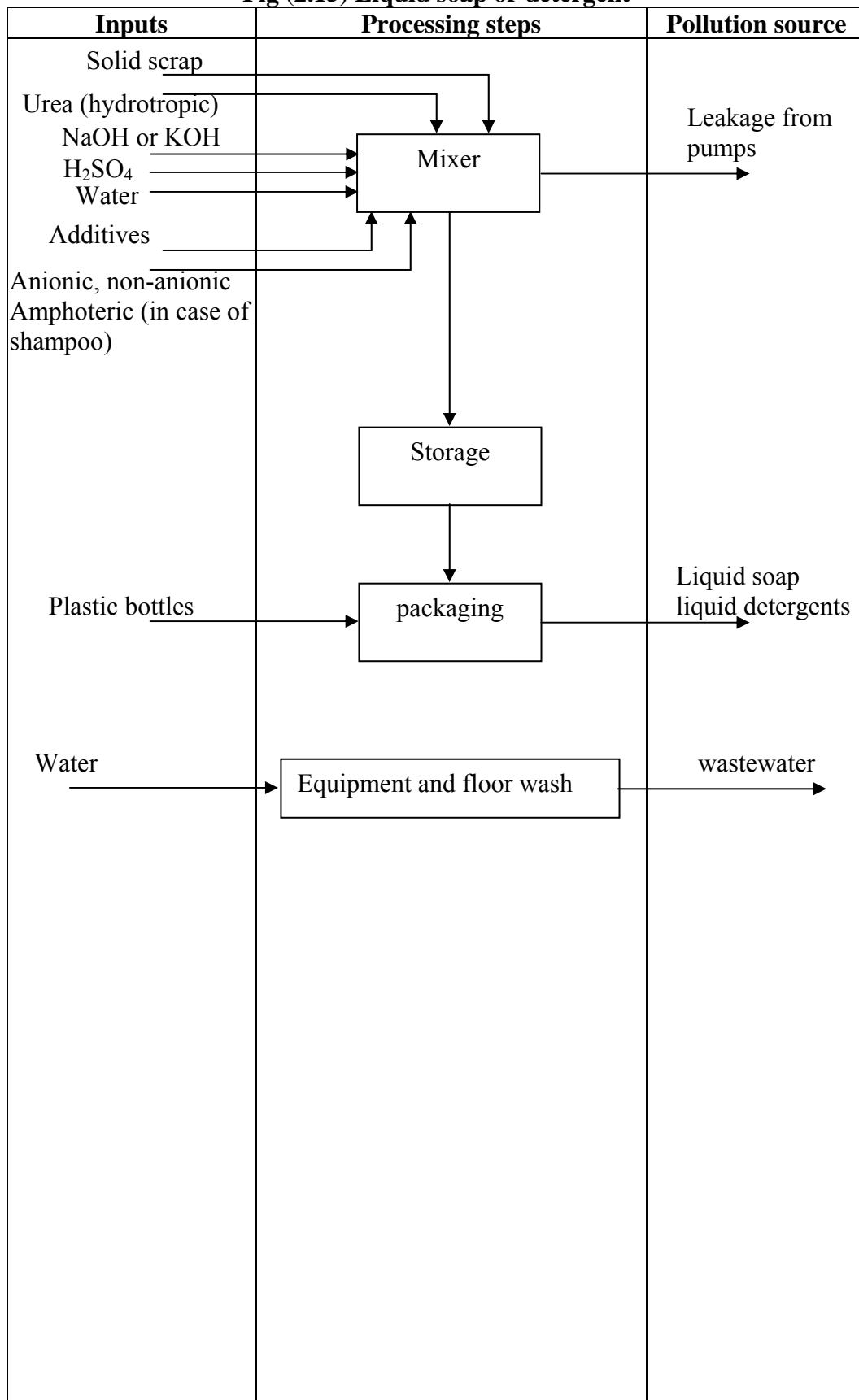
### **2.2.12 Liquid soap or detergent**

Liquid soap such as shampoos and dish liquid soaps are usually made by diluting semi boiled potash soaps of coconut and olive oil soap or by mixing synthetic detergents and other ingredients with water.

Figure (2.15) illustrates liquid soap production and materials used.

The main constituents are the non-ionic surfactants (is used for degreasing the articles), anionic surfactants, alkalis (NaOH or KOH), acids, solid scrap from soap or detergent plant, preservative such as formaldehyde, hydrotropic agents such as urea, colors ,perfumes and any other additive such as glycerin are also added to a mixer where a uniform admixture is formed, then stored and packed into plastic bottles.

**Fig (2.15) Liquid soap or detergent**



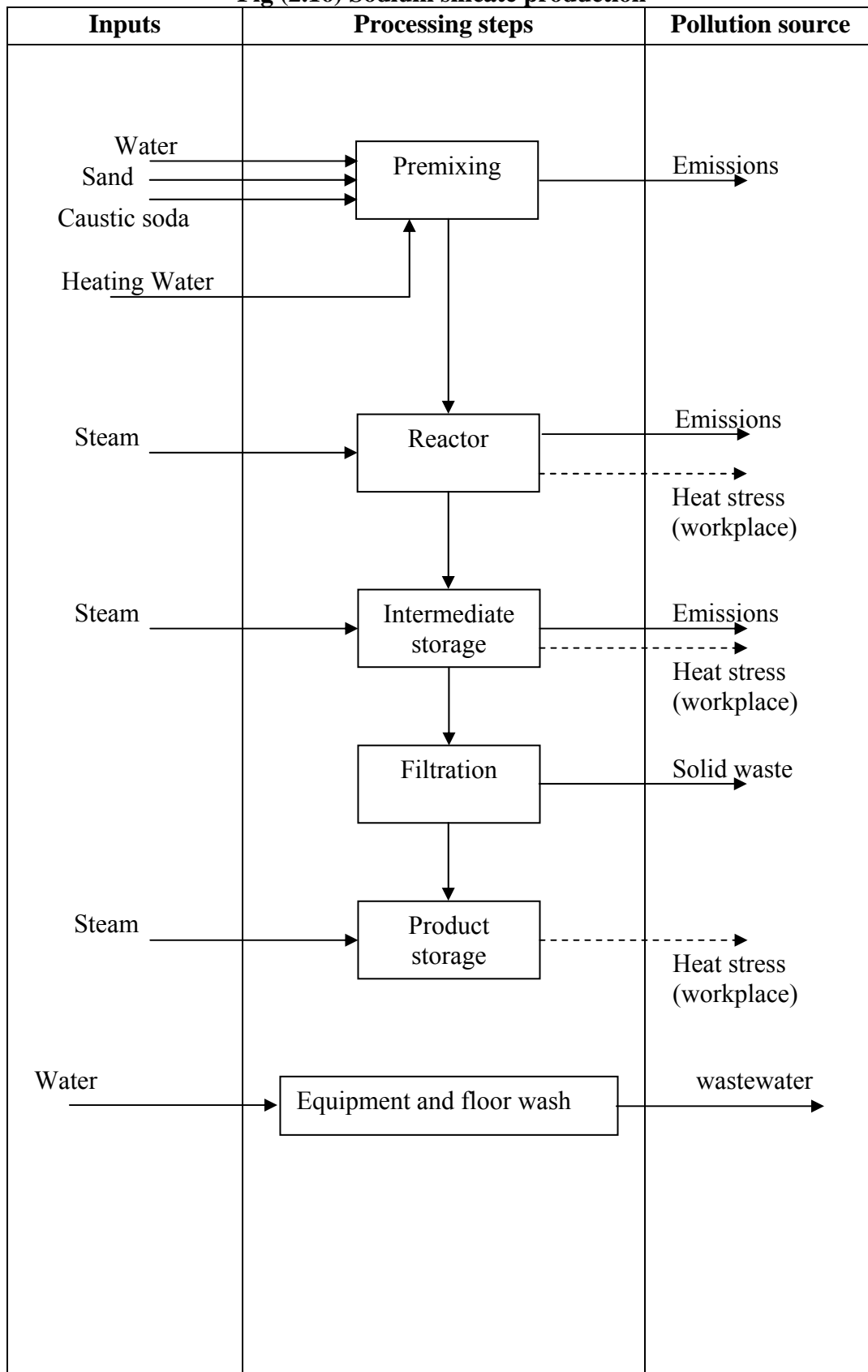
### **2.2.13 Sodium silicate**

Some detergent plants manufacture sodium silicate, which is used as an additive for soap and detergents. Sodium silicate is produced in the form of solution by mixing water, caustic soda and sand in a mixer, heated with water. The reaction between caustic soda and sand occurs in a steam heated reactor where sodium silicate is produced. A filter press is used to separate the sodium silicate solution from the suspended matter and unreacted sand particles. The sodium silicate solution is stored in a heated tank for use.

Figure (2.16) presents steps of sodium silicate production, raw materials and pollutants.

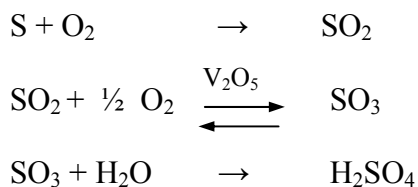


**Fig (2.16) Sodium silicate production**



### 2.2.14 Sulfuric acid production

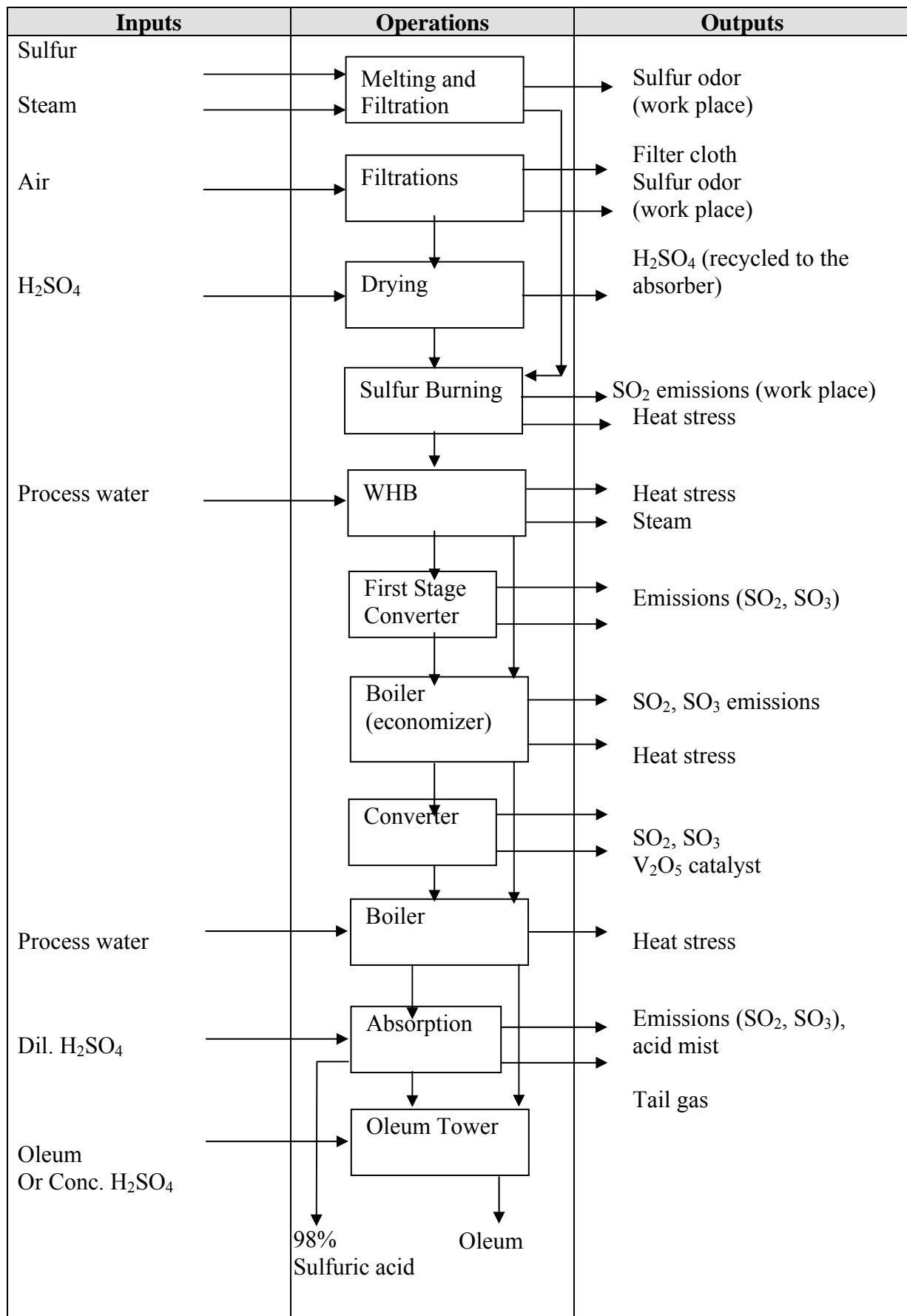
The process used is the contact process. Fig (2.17) presents the raw materials, products and expected pollution source. Elemental sulfur is usually used as raw material and is oxidized to sulfur dioxide. The sulfur dioxide is then oxidized to sulfur trioxide using vanadium pentoxide catalyst. The chemical reactions taking place can be expressed by the following equations:



Sulfur is first melted using steam. The liquid sulfur is burned in a sulfur burner using filtered dry air. The air has been dried using concentrated sulfuric acid. The result of burning is a gas containing 8-11% SO<sub>2</sub> and 8-13% oxygen, which is cooled in a waste-heat boiler to about 420° C. the specific inlet temperature of the gas entering the converter is dependent upon the quantity and quality of the catalyst and the composition and flow rate of the sulfur dioxide gas, but it is usually in excess of 426°C. The converter contains layers of catalyst, usually vanadium pentoxide, placed in horizontal trays or beds arranged so that the gas containing SO<sub>2</sub> and an excess of oxygen passes through two, three, or four stages of catalyst. As the gas passes through the converter, approximately 95 to 98% of SO<sub>2</sub> is converted to sulfur trioxide, with the evolution of considerable heat. Maximum conversion cannot be obtained if the temperature in any stage becomes too high. Therefore, gas coolers are employed between converter stages. The concentration of sulfur trioxide leaving the converter at 426 - 454°C is approximately the same as that of the entering sulfur dioxide.

The converter gas is cooled to 232 to 260° C in an economizer or tubular heat exchanger. The cooled gas enters the absorption tower where the sulfur trioxide is absorbed with high efficiency in circulating stream of 98 to 99 % sulfuric acid. The sulfur trioxide combines with the excess water in the acid to form more concentrated sulfuric acid. To reduce the emission of sulfur trioxide in the exit gases, a second absorption stage is added where exit gases from the absorption tower are introduced into a second absorption tower. The gases leaving the absorbing tower may pass through a heat exchanger, in which they are reheated to about 426° C before reentering the converter. They are then passed through the catalyst, cooled, and flow through the absorption towers and then to the atmosphere. A great source of pollution in this process is due to the emission of SO<sub>2</sub>, SO<sub>3</sub> gas with acid mist from the absorption tower and leaks from heat exchangers.

**Fig (6) Process Flow Diagram for Sulfuric Acid Manufacturing**



## 2.3 Service Units, Description and Possible Pollutant Sources

### 2.3.1 Boilers

In oil and soap industry boilers are necessary for steam generation. Steam is used for heating, stripping, or as primary fluid in jet ejectors. Fuel is burned in boilers to convert water to high-pressure steam. The gaseous emissions, due to boilers burning fuel oil (Mazot) or diesel oil (solar), contain primarily particulates (including heavy metals if they are present in significant concentrations in the fuel), sulfur and nitrogen oxides (SO<sub>x</sub> and NO<sub>x</sub>) and volatile organic compounds (VOCs). The concentration of these pollutants in the exhaust gases depends on firing configuration (nozzle design, chimney height), operating practices and fuel composition.

Wastewater is generated due to the blowdown from boilers to keep the concentration of dissolved salts at a level that prevents salt precipitation and consequently scale formation. The blowdown will be high in (TDS).

Also significant amounts of water are used for cooling, which pollutes the discharged wastewater. The amount of wastewater generated depends on whether cooling is performed in open or closed cycle and on the recycling of steam condensate. Contamination may arise from lubricating and fuel oil. The steam condensate from the production processes may return to the boiler (closed circuit) or discharged as wastewater causing pollution source to effluents.

The heat stress may be high, in work place, in case of absence of thermal insulation for steam pipelines.

### 2.3.2 Water Treatment Units

There are different treatment processes, depending on the water source and the application in the industry.

- i) ***Water softening for medium hardness water:*** calcium and magnesium ions are removed from hard water by cation exchange for sodium ions. When the exchange resin has removed the ions to the limits of its capacity, it is regenerated to the sodium form with a salt solution (sodium chloride) or NaOH solution in the pH range of 6-8. This is performed by taking the softener out of service, backwashing with the salt or NaOH solution, rinsing to eliminate excess solution, and then returning it to service. The anionic exchangers are regenerated by hydrochloric acid. The treated water has a hardness level of less than 1 ppm expressed as calcium carbonate. NaCl discharging from softener creates a great source of pollution
- ii) ***Water softening for very high bicarbonate hardness:*** Water from wells and canals is pre-treated before softening. Water is treated first by the lime process, then by cation exchange. The lime process reduces dissolved solids by precipitating calcium carbonate and magnesium hydroxide from the water. It can

reduce calcium hardness to 35 ppm if proper opportunity is given for precipitation. A coagulant such as aluminum sulfate (alum) or ferric sulfate is added to aid magnesium hydroxide precipitation. Calcium hypochlorite is added in some cases. Currently the use of organic polyelectrolytes is replacing many of the traditional inorganic coagulant aid. Sludge precipitates and is discharged to disposal sites whereas the overflowing water is fed to a sand filter followed by an activated carbon filter that removes any substances causing odor and taste. A micro filter can then be used to remove remaining traces. A successful method to accelerate precipitation is contacting previously precipitated sludge with the raw water and chemicals. The sludge particles act as seeds for further precipitation. The result is a more rapid and more complete reaction with larger and more easily settled particles.

- iii) **Reverse Osmosis:** Demineralization can also be performed by reverse osmosis. In this process water is forced through a semi-permeable membrane by applying pressure.

### 2.3.3 Cooling Towers

Moderate quantities of cooling water is used for cooling purposes in this industry. Cooling towers provide the means for recycling water and thus minimizing its consumption. The cooling effect is performed through partial evaporation. This causes an increase in the concentration of dissolved salts, which is controlled by purifying some water (blowdown). The blowdown will be high in TDS and will represent a source of pollution to the wastewater to which it is discharged. If the cooling tower is not working efficiently it can affect the cooling and condensation operations leading to escaping of volatile matters.

### 2.3.4 Laboratories

Laboratories, in oil & soap industry, are responsible for:

- Testing chemicals, water, wastewater, ...etc. to check compliance with required standards.
- Quality control of product to check agreement with standard specifications.
- Check the physical and chemical properties of products.

Chemicals, including hazardous materials, are used in laboratories. Storage and handling should be checked by the inspectors.

### 2.3.5 Workshops and Garage

Workshops are very important in most industries, where they are divided into mechanical and electrical workshops. They are responsible for repairing and maintenance of the foundry equipment. Environmental violation could be due to:

- Noise
- Rinse water contaminated with lube oil

Pollution in the garage will depend upon the services offered. The presence of a gasoline or diesel station implies fuel storage in underground or over the ground tanks that require leak and spill control plans.

Replacing lube oil implies discharge of spent oil to the sewer system or selling it to recycling stations.

### **2.3.6 Storage Facilities**

The specifications for the storage facilities depend on the nature and properties of the stored material

- Environmental laws stipulate that special system should be applied for handling and storing hazardous chemicals.
- Fuel is kept in under/or above ground tanks. Storage requires proper preventive plans for spills and leaks.

Table (2) shows the service units related to the Oil, soap, and detergents industries and their pollution sources.

Table (2) Service Units and their Related Pollution Sources

Inputs	Service Units	Pollution
<p>Water Lime + chemicals</p> <p>Fuel</p>	<pre>                     graph TD                         subgraph Inputs                             W[Water] --&gt; T[Treatment]                             LC[Lime + chemicals] --&gt; T                             F[Fuel] --&gt; B[Boilers]                         end                         T --&gt; SU[Softening Units]                         SU --&gt; B                         B --&gt; S[Steam]                         T --&gt; Sl[Sludge]                         SU --&gt; BW[Back wash]                         B --&gt; BBD[Boiler Blow Down (TDS)]                         B --&gt; FG[Flue Gases]                     </pre>	<p>Sludge</p> <p>Back wash</p> <p>Boiler Blow Down (TDS)</p> <p>Flue Gases</p>
<p>Hot Water</p>	<pre>                     graph LR                         HW[Hot Water] --&gt; CT[Cooling Towers]                         CT --&gt; CTBD[Cooling Tower Blowdown (TDS)]                     </pre>	<p>Cooling Tower Blowdown (TDS)</p>
<p>Chemicals</p>	<pre>                     graph LR                         C[Chemicals] --&gt; L[Laboratory]                         L --&gt; W[Wastewater]                         L --&gt; HW[Hazardous wastes (handling)]                     </pre>	<p>Wastewater</p> <p>Hazardous wastes (handling)</p>
<p>Lube Oil</p> <p>Floor and equipment rinse water</p> <p>Cleaning Chemicals</p>	<pre>                     graph LR                         LO[Lube Oil] --&gt; EMW[Electrical &amp; Mechanical Workshops]                         FER[Floor and equipment rinse water] --&gt; EMW                         CC[Cleaning Chemicals] --&gt; EMW                         EMW --&gt; ORW[Oily Rinse Water]                         EMW --&gt; SW[Solid Wastes]                     </pre>	<p>Oily Rinse Water</p> <p>Solid Wastes</p>
<p>Fuel</p> <p>Oil</p> <p>Rinse Water</p>	<pre>                     graph LR                         F[Fuel] --&gt; G[Garage]                         O[Oil] --&gt; G                         RW[Rinse Water] --&gt; G                         G --&gt; ORW[Oily rinse water]                         G --&gt; SW[Solid wastes]                     </pre>	<p>Oily rinse water</p> <p>Solid wastes</p>
<p>Raw materials</p> <p>Fuel</p> <p>Chemicals</p> <p>Products</p>	<pre>                     graph LR                         RM[Raw materials] --&gt; S[Storage]                         Fu[Fuel] --&gt; S                         Ch[Chemicals] --&gt; S                         Pr[Products] --&gt; S                         S --&gt; Sp[Spills]                         S --&gt; RM2[Raw material]                         S --&gt; HM[Hazardous material]                     </pre>	<p>Spills</p> <p>Raw material</p> <p>Hazardous material</p>

## 2.4 Emissions, Effluents and Solid Wastes

Table (3) summarizes the major polluting processes, process inputs, their outputs, the pollution parameters and corresponding impact.

### 2.4.1 Air Emissions

There are two sources of air emissions in the oil, soap and detergents industry.

- Exhaust gases, resulting from fuel consumption used to generate steam from boilers.
- Fugitive emissions, volatile organic compounds (VOCs) as hexane in extraction process; fatty acids, aldehydes and ketones in deodorization and hot well; benzene and kerosene from distillation tower in detergents unit; HCl vapors in glycerin neutralization process; H<sub>2</sub> and water vapor from vacuum autoclave in oil hydrogenation unit; acid fumes in splitting of fats in fatty acid production unit; HCl gas in chlorination and alkylation processes for detergents production. Also there is Cl<sub>2</sub> gas emissions in chlorination process, SO<sub>2</sub> gas and acid mist from sulfation unit of fatty alcohols and SO<sub>2</sub>, SO<sub>3</sub>, H<sub>2</sub>SO<sub>4</sub> mist in sulfuric acid production unit, caustic soda and water vapor emissions from silicate production unit. Particulate matter (PM<sub>10</sub>) results from seeds screening, crushing, flaking, boilers and soap and detergents drying and conveying.

### 2.4.2 Effluents

The major pollution loads of the oil, soap and detergents industry is the waste water from the various sources. Liquid effluents is generated from equipment, vessels, tanks, process and cooling water and washing of products, equipment and floor. The effluents contains oil and grease (O&G), BOD, COD, synthetic detergents, pH, heavy metals (Ni) and TDS.

Specific effluents are:

- Blow downs from the cooling tower and boilers as well as back wash of softeners are high in TDS and TSS.
- The highly polluted water resulting from treatment of mucilage with NaOH in soap stock unit is high in BOD, COD and O&G and treated by dissolved air flotation (DAF) and by biological treatment.
- Benzene spills in synthetic detergents unit is collected through ground traps, then accumulated in an underground reservoir and recovered by distillation.

### 2.4.3 Solid Wastes

The main sources of solid wastes are:

- Empty containers of raw materials and chemicals contaminated with traces of chemicals.
- Spent catalyst, which is considered as hazardous waste.



- Spent filter cloth contaminated with oil.
- Spent fuller's earth contaminated with oil.
- Sludge generated from the biological wastewater treatment plant. It may contain heavy metals (hazardous).
- Pitch formed in fat splitting unit may be used as paving material.
- Foreign particles as nails, stick from seeds screening unit

#### **2.4.4 Work Environment**

There are many sources of air emissions to the work environment in the oil, soap and detergents industry. The emissions result from the various operations (e.g. mixing, extraction of oil, refining, detergents, drying).

Noise could be occur in crushing and screening of seeds.

Heat stress should be checked near heaters and boilers.

Table (3) specifies the types pf emissions generated from each process of a production line.

### 3. Environmental and Health Impacts of Pollutants

#### 3.1 Impact of Air Emissions

**Particulate matters** Recent epidemiological evidence suggests that much of the health damage caused by exposure to particulates is associated with particulate matters smaller than 10 $\mu$ m (PM<sub>10</sub>). These particles penetrate most deeply into the lungs, causing a large spectrum of illnesses (e.g. asthma attack, cough, bronchitis). Emissions of particulates include ash, soot and carbon compounds, which are often the result of incomplete combustion of fuels. Particulates from process include; lints, fullers earth dust, soap and detergent particulates, animal fodder particulate from crushing and mixing.

**Sulfur Oxides** Air pollution by sulfur oxides is a major environmental problem. This compound is harmful to plant and animal life, as well as many building materials. Another problem of great concern is acid rain which is caused by the dissolution of sulfur oxides in atmospheric water droplets to form acidic solutions that can be very damaging when distributed in the form of rain. Acid rain is corrosive to metals, limestone, and other materials.

**Nitrogen Oxides** Nitrogen oxides also dissolve in atmospheric water droplets to form acid rain.

**Carbon dioxide** Combustion of fossil fuels to produce electricity and heat contribute to the green house effect caused by the formation of carbon dioxide. The greenhouse phenomenon occurs when heat radiation from earth is absorbed by the gases causing a surface temperature increase.

**Carbon monoxide** It is absorbed through lungs and in addition to its reaction with hemoglobin, it combines with myoglobin, cytochromes, and metalloenzymes. The binding of CO with hemoglobin producing decreasing the oxygen carrying capacity of blood, this is appear to be the principle mechanism of the toxic action of low-level carbon monoxide exposure.

**Water Vapor (Humidity)** Humidity in workplace is regulated by law 4/1994 due to its effect on the respiratory system especially for people suffering from asthma.

- Hydrogen*** It has a wide explosive limit range (4.1 to 74.2 %). It causes embitterment to steel at high temperature.
- Benzene*** Benzene is classified as a known human carcinogen (category A) for all routes of exposure. It is also irritating to skin and by defatting the keratin layer may cause erythema, vesiculation, and dry and scaly dermatitis. Benzene also has specific toxic effect on blood formation causing aplastic anemia and tendency to hemorrhage. Skin and eye irritation has been noted at occupational exposure. It has high mobility in soil.
- Glycerin*** Glycerin can exert systematic toxic effect when given orally or parenterally in very large doses. Osmotic effect of glycerin may also produce tissue dehydration and decrease in cerebrospinal fluid pressure. Oral administration may cause mild headache, dizziness, nausea, vomiting, thirst and diarrhea. Glycerin causes strong stinging and burning sensation to human eye with tearing and dilation of the conjunctival vessels.
- Sulfuric acid*** There is sufficient evidence that occupational exposure to strong inorganic acids mists is carcinogenic to human (group A). It also attacks enamel of the teeth. Inhalation of concentrated vapors may cause serious lung damage. Contact with eyes may result in total loss of vision. Skin contact may produce severe necrosis. It leads to formation of acid rain and may also cause corrosion of steel; discoloration and deterioration of limestone, marble, roofing slate, and mortar; fading of dyed materials and loss of strength by leather; increased brittleness of paper.
- Hydrogen chloride*** It may cause burns on the skin may produce serious disfigured scars. Hydrogen chloride in the lung can cause pulmonary edema. Contact of HCl with the eye may cause extensive necrosis of the conjunctive and corneal epithelium. Hydrogen chloride in water dissociates almost completely, with the hydrogen ion captured by the water molecules to form the hydronium ion. In addition to the harmful effect of hydrogen chloride gas on human health, it could damage every thing in the plant (pipes, pumps, floor,...etc.).

**Hexane** It causes pain on contacting the eye. It is also considered a mild central nervous depressant in acute exposure. It is also irritant to the skin. The biodegradation of n-hexane may occur in soils; however, volatilization and adsorption are expected to be far more important processes.

**Kerosene** It is gastric irritants and when swallowed cause nausea and vomiting. Liver and kidney damage may occur in severe cases. Kerosene is irritating to skin and eyes; vapor causes irritation of eyes and nose. If released to soil or water, kerosene is expected to biodegrade under both aerobic and anaerobic conditions. If released to the atmosphere, kerosene may undergo oxidation by a gas-phase reaction with photochemically produced hydroxyl radicals.

**Ketones** Ketones are a volatile and flammable organic chemical. Ketones are irritating to the eyes, nose, and throat. Symptoms of exposure to large quantities of ketones may include headache, unsteadiness, confusion, lassitude, drowsiness, vomiting, and respiratory depression. Ketones can affect the respiratory system, especially in sensitive individuals such as asthmatics or allergy sufferers. Repeated exposure to moderate to high amounts may cause liver and kidney effects.

There is currently no evidence to suggest that these chemicals are carcinogenic.

If released into water, ketones will be degraded by microorganisms or will evaporate into the atmosphere. Degradation by microorganisms will be the primary removal mechanism.

Ketones is highly volatile, and once it reaches the troposphere (lower atmosphere), it will react with other gases, contributing to the formation of ground-level ozone and other air pollutants.

**Aldehydes** Aldehydes are probable human carcinogen. They can cause irritation and lung edema. Large doses may cause death by respiratory paralysis. Repeated exposure to vapors causes dermatitis and conjunctivitis. They are irritating to human eyes, and their inhalation can cause irritation to the mucous membranes and ciliastatic effects on the upper respiratory tract.

If they are released to water it will rapidly biodegrade and volatilize. If spilled on land it will also rapidly evaporate and leach into the ground where it will biodegrade. In the atmosphere it will degrade in a matter of hours.

<b>Sodium hydroxide</b>	Caustic dusts or mist are irritating to upper respiratory system. Ingestion of lye causes swallowing to become painful and difficult, burning pain extended down to stomach. Liquid or solid sodium hydroxide is a severe skin irritant and is very injurious to eyes.
<b>Phosphoric acid</b>	It is not irritating to respiratory tract unless it is introduced into the atmosphere as a spray or mist. It causes severe eye and skin irritation.
<b>Aluminum sulfate</b>	In solutions it is irritating but in dry powder it may cause marked inflammation or corrosion of the skin and mucous membranes. Its dust is irritating to eyes, nose and throat. Its presence in water increases the aluminum concentration of finished water above its original concentration in the raw water.

### 3.2 Impact of Effluents

The environmental impact of the wastewater depends on the receiving water body. The Ministry of Irrigation has set limits for the pollutants in the wastewater discharged into agriculture canals and drains as well as the Nile river for their detrimental effect on agriculture. The parameters of relevance to the Oil, Soap and Detergents industry are O&G, BOD, COD, TSS, TDS, S.S, surfactants, temp., color, and pH.

Discharge of polluted wastewater high in BOD, O&G, and COD into lakes and sea can cause eutrofication and impact bio-diversity. Eutrofication is a natural aging process in which the water becomes organically enriched, leading to increasing domination by aquatic weeds, transformation to marsh land, and eventually to dry land. Eutrofication can be accelerated by human input of nutrients. Die-off and settling of plant growth results in sediment oxygen demand, which tends to decrease dissolved-oxygen levels. The organic material in wastewater stimulates the growth of bacteria and fungi naturally present in water which then consume dissolved oxygen.

In addition, surfactants are large organic molecules that are slightly soluble in water and cause foaming in wastewater treatment plants and in surface water if discharged into. This foam layer tends to prevent the air and sunlight from reaching the aquatic life.

Discharge of high O&G, BOD, and COD loads to the public sewer system will have an indirect environmental impact. Increased loads can cause malfunction of the domestic wastewater treatment plant.

Spent lube oils from garage and workshops could be a cause for concern if discharged into the sewer system because they tend to coat surfaces causing maintenance problems. Also, if they discharged to

surface waters, they can interfere with the aquatic life in these surface waters and create unsightly floating matter and films.

In addition, spent acids and caustic wastewater could make corrosion of the internal sewer system of the plant, if discharged.

### **3.3 Environmental Impact of Solid Wastes**

Most of the generated solid waste is considered hazardous waste.

Sludge generated from the filters and WWTP (if exist) could contaminate the soil, surface water and underground water, if disposed.

Organic solid waste such as spent fuller's earth, and animal fodder losses, if not stored well, could be fermented and cause soil contamination, and bad odor.

Empty containers of chemicals, may be sold to contractor. This solid waste could affect the human health, if used domestically (food packaging,...).

## 4. Egyptian Laws

There are a number of laws and regulations that address the different environmental violations. The following are the laws applicable to the oil & soap industry.

### 4.1 Concerning Air Emissions

Article 40 of Law 4/1994, article 42 of the executive regulations and annex 6 deal with gaseous emissions from combustion of fuel. The statutes relevant to the fuel combustion are:

- The use of mazout and other heavy oil products, as well crude oil shall be prohibited in dwelling zones.
- The sulfur percentage in fuel used in urban zones and near the dwelling zones shall not exceed 1.5%.
- The design of the burner and fire-house shall allow for complete mixing of fuel with the required amount of air, and for the uniform temperature distribution that ensure complete combustion and minimize gas emissions caused by incomplete combustion..
- Gases containing sulfur dioxide shall be emitted through chimneys rising sufficiently high in order that these gases become lighter before reaching the ground surface, or using fuel that contains high proportions of sulfur in power generating stations, as well as in industry and other regions lying away from inhabited urban areas, providing that atmospheric factors and adequate distances to prevent these gases from reaching the dwelling and agricultural zones and regions, as well as the water courses shall be observed.
- Chimneys from which a total emission of wastes reaches 7000 – 15000 kg/hr, shall have heights ranging between 18 – 36 meters.
- Chimneys from which a total emission of gaseous wastes reaches more than 15000 kg/hour, shall have heights exceeding at least two and a half times the height of surrounding buildings, including the building served by the chimney.

The permissible limits of emissions from sources of fuel combustion are given in tables (3 and 4) (Ministerial decree no. 495, 2001).

**Table (3) Maximum Limits of Emissions from Sources of Fuel Combustion in Boilers**

<b>Pollution</b>	<b>Maximum limit mg/m<sup>3</sup> of Exhaust</b>
Sulfur Dioxide.	3400
Carbon Monoxide.	250
Smoke.	50

**Table (4) Maximum Limits of Emission from Fuel Burning Sources**

<b>Pollutant</b>	<b>Maximum Permissible Limit, mg/ m<sup>3</sup></b>
SMOKE	250
DISPERED ASHES	250 (sources existing in urban regions, or close to residential areas)
	500 (sources far from habitation)
	500 (burning of wastes)
SULPHUR DIOXIDE	Existing 4000 New 2500
ALDEHYDES	Burning of waste 20
CARBON MONOXIDE	Existing 4000 New 2500

## 4.2 Concerning Effluents

Limits for pollutants in wastewater vary depending on the type of receiving water body. The parameters that should be monitored and/or inspected are BOD, COD, pH, temperature, residual chlorine, TSS, TDS, Oil and Grease.

Table (5) presents the permissible limits for discharges to the different recipients (sea, Nile, canals, agricultural drains, public sewer) according to the different relevant laws.

Spent lube oil has a negative impact on water and soil and therefore its disposal should be monitored/inspected. A record should be kept for this purpose.



Table (5) Egyptian Environmental Legal Requirements for Industrial Wastewater

Parameter (mg/1 unless otherwise noted)	Law 4/94: Discharge Coastal Environment	Law 93/62 Discharge to Sewer System (as modified by Decree 44/2000)	Law 48/82: Discharge into :			
			Underground Reservoir & Nile Branches/Canals	Nile (Main Stream)	Drains	
					Municipal	Industrial
BOD (5day,20 deg.)	60	<600	20	30	60	60
COD	100	<1100	30	40	80	100
pH	6-9	6-9.5	6-9	6-9	6-9	6-9
Oil & Grease	15	<100	5	5	10	10
Temperature (deg.)	10C>avg. temp of receiving body	<43	35	35	35	35
Total Suspended Solids	60	<800	30	30	50	60
Settable Solids	—	8 cm <sup>3</sup> /1 (10 min) 15 cm <sup>3</sup> /1 (30 min)	—	20	—	—
Nickel	0.1	1	0.1	0.1	—	—
Total heavy metals	—	<5	<1	1	1	1

### **4.3 Concerning Solid Waste**

A number of laws address solid waste management. The following laws apply to scrap and sludge from the WWTP:

- Law 38/1967 which addresses public cleanliness, regulates the collection and disposal of solid wastes from houses, public places, commercial and industrial establishments.
- Ministry of Housing, Utilities and Urban Communities (MHUUC) decree No. 134 of 1968, which provides guidelines from domestic and industrial sources, including specifications for collection, transportation, composting, incineration and land disposal.
- Law 31/1976, which amended law 38/1967
- Law 43/1979, the Law of Local administration, which provided that city councils are responsible for “physical and social infrastructure”, effectively delegating responsibility for infrastructure functions.
- Law 4/1994 regulates incineration of solid waste

### **4.4 Concerning Work Environment**

Violations of work environment could be encountered:

- Wherever burning fuel is performed: gas emissions, regulated by article 43 of Law 4/1994, article 45 of the executive regulations and annex 8. The limits for the relevant pollutants are presented in table (6).
- Wherever heating is performed: temperature and humidity are regulated by article 44 of Law 4/1994, article 46 of the executive regulations and annex 9. Table (7) shows the maximum limits for heat stress.
- Near heavy machinery: noise is regulated by article 42 of Law 4/1994, article 44 of the executive regulations and table 1, annex 7. These limits are given in the tables (8, 9 and 10).
- Ventilation is regulated by article 45 of Law 4/1994 and article 47 of the executive regulations.
- Work environment conditions are addressed in Law 137/1981 for Labor, Minister of Housing Decree 380/1983, Minister of Industry Decree 380/1982.

**Table (6) Threshold Limits for Some Pollutants in Work Place**

Material	Threshold			
	Time average		Exposure limits for short periods	
	ppm	mg /m <sup>3</sup>	ppm	mg/m <sup>3</sup>
Carbon Dioxide	5000	9000	15000	27000
Carbon Monoxide	50	55	400	440
Ammonia	25	18	35	27
Cyclo hexane	300	1050	375	1300
n-hexane	50	80		
Sulfuric acid		1		10
Sodium hydroxide		2		
Nickel (metal)		1		
Phosphoric acid		1		3
Acetaldehyde	100	180	150	270
Chlorine	1	3	3	9
Benzene	10	30	25	75
Sulfur dioxide	2	5	5	10

**Table (7) Maximum Permissible Limits for Heat Stress (law 4/1994)**

Type of Work	Low Air Velocity	High Air Velocity
Light work	30° C	32.2 ° C
Moderate work	27.8 ° C	30.5 ° C
Severe work	26.1 ° C	28.9 ° C

**Table (8) Maximum Permissible Noise Levels (law 4/1994)**

No	Type of place and activity	Maximum permissible noise decibel (A)
1	Work place with up to 8 hour and aiming to limit noise hazards on sense of hearing	90 dB
2	Work place where acoustic signals and good audibility are required	80 dB
3	Work rooms for the follow up, measurement and adjustment of high performance operations	65 dB
4	Work rooms for computers, typewriters or similar equipment	70 d.B
5	Work rooms for activities requiring routine mental concentration	60 dB

**Table (9) Noise Intensity Level Related to the Exposure Period**

<b>Noise intensity level decibel (A)</b>	95	100	105	110	115
<b>Period of exposure (hour)</b>	4	2	1	½	¼

**Table (10) Noise Intensity Level In Intermittent Knocking Places**

Noise Intensity db	Max Allowable Knocks During Daily Work Period
135	300
130	1000
125	3000
120	10,000
115	30,000

#### 4.5 Concerning Hazardous Material and Wastes

Law 4/1994 introduced the control of hazardous materials and wastes. The oil & soap industry does not generate any hazardous wastes. The hazardous chemicals used in the lab and the fuel for the boilers, fall under the provisions of Law 4/1994. Articles 29 and 33 of the law makes it mandatory for those who produce or handle dangerous materials in gaseous, liquid or solid form, to take precautions to ensure that no environmental damage shall occur. Articles 25, 31 and 32 of the executive regulations (decree 338/1995) specify the necessary precautions for handling hazardous materials. Storing of fuel for the boilers is covered by the Law 4 as hazardous material There is no explicit articles in Law 4/1994 or in decree 338/1995 (executive regulations), regarding holding a register for the hazardous materials; article 33 is

concerned with hazardous wastes. However, keeping the register for the hazardous materials is implicit in article 25 of the executive regulations regarding the application for a license.

#### **4.6 The Environmental Register**

Article 22 of Law 4/1994 states that the owner of the establishment shall keep a register showing the impact of the establishment activity on the environment. Article 17 and Annex 3 of the executive regulations specify the type of data recorded in the register.

The emergency response plan and the hazardous materials register will also be part of the environmental register as stated in law 4/ 1994.

## **5. Pollution Abatement Measures**

This section deals with pollution abatement (preventions) in the three media air, water and soil. Three types of interventions will be considered:

- In-plant modifications, which are changes that are performed in the plant to reduce pollutant concentrations in streams through recovery of materials, segregation and/or integration of streams, reducing the flow rate of the wastewater streams that need further treatment to reduce the hold-up of the required WWTP.
- In-Process modifications, which are changes performed on the process such as the introduction of newer technology, substitution of a hazardous raw material, performing process optimization and control.
- End-of-pipe (EoP) measures, which involve treatment of the pollutant or its separation for further disposal. Whereas in-plant and in-process modifications usually have an economic return on investment, end-of-pipe measures will be performed for the sole purpose of compliance with the laws without economic.

Egyptian Environmental Laws do not require water and energy conservation measures. These measures have been considered in this manual since resource depletion and hence conservation is a worldwide-recognized environmental issue that could be implemented in Egypt in the near future. Water conservation measures can lead to higher concentrations of pollutants in the effluent streams. Both energy and water conservation measures will provide both financial and economic benefits.

The term Cleaner Production (CP) refers to the same concepts of pollution reduction through in-process, in-plant and resource conservation, in contradistinction to end-of-pipe treatment. In many cases, the adoption of CP can eliminate the need for (EoP) treatment.

The oil, soap, and detergents industry sector has a great potential for implementation of cleaner technology measures. Newly installed factories employing manpower above 100 has acquired relatively newer technologies, which need little in-process or in-plant modifications and are carrying out end-of-pipe treatment to meet the requirement of environmental laws. However, medium size enterprises as well as public sector companies badly need the 3 types of modifications. Small private enterprises are using primitive technologies.

Control or abatement of pollution based mainly on efficient separation of materials- such as oil and soap- in neutralization unit, good utilization of materials which prevent over dosage that escape to wastewater and recovery of by products.

The following CP and EoP measures have been identified for the oil, soap, and detergents industry.

## 5.1 Air pollution

### *Flue gases*

*Particulate matter* in flue (exhaust) gases are due the ash and heavy metal content of the fuel, low combustion temperature, low excess air level, high flow rate of flue gases. *Sulfur dioxide* is due to the sulfur content of the fuel. *Nitrogen oxides* are formed when maximum combustion temperature and high excess air. *Carbon monoxide* is formed when incomplete combustion occurs at low air to fuel ratio.

The following measures can be adopted to minimize air pollution from flue (exhaust) gases:

- Replace mazout by solar or natural gas. Mazot is high in sulfur content.
- Regulate the fuel to air ratio for an optimum excess air that ensures complete combustion of carbon monoxide to dioxide.
- Keep the combustion temperature at a moderate value to minimize particulate matter and nitrogen oxides formation.
- Preheat the fuel to ensure complete combustion.

## 5.2 Work Environment Pollution Abatement Measures

### *VOCs*

*(hexane, benzene, kerosene,...)*

Using VOCs control equipment such as; adsorbents (activated charcoal)/ biofilters on exhaust systems, water scrubbers should be implemented where necessary to achieve acceptable odor quality for nearby residents.

### *Soap*

*Particulates*

Use bag filters to collect the soap dust emitted in the work place in the soap production unit.

### *Benzene*

*spills*

In case alkyl benzene is produced in the facility, benzene spills on ground, in work place, should be collected through ground traps, then accumulated in an underground reservoir and recovered by distillation (heating and condensation), it could be reused.

### *Aldehydes & Ketones*

- To prevent the soap dust emissions in the work place, keep the temperature of the rollers between 100 - 105 oC, because over heating may cause emissions of volatile components such as aldehydes and ketones.
- Use suction system in the work place to prevent emissions during heating.

### *Particulates*

- Using control equipment such as; Fabric filters, and

- Control*** dust collectors, to control particulates, from the processes, to below 50 milligrams per normal cubic meter (mg/Nm<sup>3</sup>).
- Feed the fuller's earth dust by suction from the sacs to the bleaching unit.
  - Using dust collectors, for soap particulates, in the soap production unit.
  - In seeds cleaning process, screens shakers could be closed to prevent dust emissions.
- Cl<sub>2</sub> or SO<sub>2</sub> gaseous emissions***
- SO<sub>2</sub> and Cl<sub>2</sub> gases are scrubbed with dilute caustic soda solution, to form dilute sodium hypochlorite and sodium sulphite solution respectively.
- HCl gas and acid mist or fumes***
- HCl gas which evolves in alkylator is removed by scrubbing with water, to form dilute commercial grade hydrochloric acid.
  - Covering the barrels of HCl during processing.

### **5.3 Water Pollution Abatement Measures**

- In-plant modifications***
- Segregation of process water from water of different production units.
  - Cooling water could be recycled as it is clean water.
  - Collection of the oil leakage (specially from spillages in the bottling department) can be done easily from ditches by means of small bucket and recycled to the refinery for processing. For that point specially, There is a designed system for collecting the oil spills and recycling it again.
  - Caustic soda barrels must be fully closed with lids to avoid leaching, leakage due to rains since such barrels are stored always outdoors. Also, it is possible to avoid the use of sodium hydroxide barrels and using caustic solution in closed tanks.
  - Predictive maintenance approach is used to avoid any leakage from pumps, pipelines and connections. Double seal is used for pumps to avoid leakage.
  - Continuous cleaning of heat exchangers and cooler condensers, to improve the condensation or separation, which intern decreases the emissions to air.



- Collection of spent lubricating oils and then it could be sold for petroleum to deliver it to recycling company.
- Oil losses during loading and unloading must be kept at minimum level by emptying the vehicles completely and better control during handling.

***In-process modifications***

- Reduce the load of wasted mucilage by calculating the exact amount required of alkali and avoid crude pigment fixation (produced by bad storage conditions).
- Dry cleaning and removal of any solids must be carried out, using mechanical screens, before wet cleaning.
- Hexane consumption can be optimized by ensuring that cotton seeds are properly delinted. Also adjustment of seeds feed rate and modifications of solvent spray nozzles can improve extraction and optimize hexane consumption.
- In glycerin plant, accurate adjustment of temperature and pressure in the glycerin distillation unit to prevent polymer formation.
- Use of centrifuges for separation in degumming, refining, and washing sections instead of gravity settlers.
- Substitute any raw materials identified as hazardous or toxic specially in the boiler water treatment plant.
- Utilization of volatile distillate; this is the volatile matter produced in the deodorization unit. It contains fatty acids, ketones, and aldehydes. It can be used to produce copherol. The free acids have several uses in food and chemical industries.
- Improving the efficiency of the coolers condensers for good separation of volatile components in the deodorization unit, to prevent its losses, which finally emitted from the hot well.
- Lecithin can be recovered from gums produced in the degumming unit and sold to the food industry as an emulsifier.
- During the hydrogen production (for hydrogenation of oil), oxygen is generated as a by product. If generated in sufficient quantities, it could be recovered, compressed, and sold for use in medical sector.

- Prevent the formation of molds on edible materials by controlling and monitoring air humidity.
- Use citric acid instead of phosphoric acid, where feasible, in degumming operations.
- Improving the efficiency of the cooling system, by adjusting the condenser temperature, in the hexane recovery system, in the extraction and refining process, could minimize the losses of hexane.
- In glycerin recovery plant, HCl fumes and mist cause corrosion of the steel structure and pipe lines of the factory, to prevent the corrosion, using polyethylene (PE) or poly vinyl chloride (PVC) pipes.
- Detergents create problems in municipal sewerage plants due to excessive foaming and inability to reduce the organic load, soft detergents which are biodegradable (linear chain alkyl benzene) should replace hard ones (branched chain alkyl benzene).

***End-of-pipe  
treatment***

- In oil and soap plants, the wastewater is characterized by high levels of BOD, COD, and O&G. It could be treated using;
  - High efficient oil and grease traps
  - Gravity oil separators (GOS)
  - Dissolved air flotation (DAF) unit
  - Biological treatment unit
- In case of semi solid waste materials are present in wastewater, mechanical skimming is used.
- Reduce the pollution load discharging from the saponification unit by collecting the wastewater in pan and treating with fat to neutralize the caustic soda, boil with steam and allow to settle.
- Hot spent lye with some soap due to inefficient separation causes overflow of foam on the floor, which is usually washed down causing problems in wastewater (inability of biological treatment). The solution is feeding the hot spent lye to a saponification unit with a predetermined amount of fatty acids to form soap.

## 5.4 Abatement Measures for Solid Waste Pollution

### *Scrap from workshops and garage*

- Scrap metals are collected and sold.
- Off cuts and scraps from the manufacture of cans can be pressed and sold to metal processing factory.
- Damaged plastic bottles and cartons can be collected and sold for recycling.

### *Solid wastes from processes*

- Storage of raw materials; incoming seeds should be stored out of the rain and sun in a secure clean area, as seeds left in the sun will heat up rapidly, increasing the levels of fatty acids which will in turn increase the acidity of the extracted crude oil. The heat will also convert proteins and carbohydrates into fat soluble compounds, resulting in a strong color in the crude oil, which is difficult to eliminate. Use shelter or off the ground on palettes far from physical damage by passing vehicles and personnel. Also on the ground, seeds can become contaminated by dirt, stones, solid and liquid wastes, and subject to consumption by insects and rodents. Any seeds spills from sacs during handling must be gathered and reused.
- Soap stock is stored in an open area. This constitutes a huge lump of dark solid. The entrained oil spread on the ground making it sticky and slippery. Soap stock has to be converted immediately to produce a lowest grade soap.
- In the soap production plant, pipelines carrying molten soap should be steam jacketed. If pipelines are not adequately protected and a power cut occurs, the soap will cool rapidly, solidifying and clogging the whole system. Use of an emergency generator to be used in case of power cut off.
- Any waste is recovered and recycled to the saponification unit, through a closed loop operation system.
- Reduce soap dust losses by the following procedure:
  - Charging the rubber gasket in the powder precipitator regularly to reduce the leakage.
  - Recovery of soap dust from the floor using vacuum cleaner.
  - Collection of soap dust in the work place using dust collector
  - Discharge the contents of the powder precipitator directly to the powder soap unit by mechanical rather than manual means.
- Salt separated from glycerin unit should be used in soap production only and should not be used in other purposes.
- Recovery of solid ingredients; animal fodder production unit

is characterized by heavy dust emissions. This result in losses, clogging of machinery and generating unpleasant working conditions. Cyclone vacuum system could be used to recover particulates and recycle them to raw materials intake system.

- The used fuller earth may be used as conditioner for sandy soil to increase its water retention.
- Volatile fatty acids escaping from the deodorizer will accumulate on the surface of the hot well, and could be skimmed off manually or using traps/separators, could be used as an animal fodder constituent.
- Pitch formed in the fat splitting into fatty acids may be used as a waterproofing or paving material.
- Aluminum soap formed in glycerin plant can be used as metallic soap.
- In oil hydrogenation process, particulates of Nickel catalyst should be removed from the synthetic butter through filters clothes (clothes of cotton) and garckaskeen filter papers. The collected Nickel particulates should be safely disposed into a landfill.

***Sludges from water and wastewater treatment***

- Effluent treatment processes generate sludge. It can also be hazardous to health by absorbing pathogens that multiply in this favorable medium and toxins. Raw sludge is saturated with water, should be de-watered and disposed of into landfills.
- Sludge also generated from water treatment unit due to addition of lime and chemicals to water.

## **5.5 Water and Energy Conservation**

Water and sewer service costs have been rising, and these increases can cut into profits. Using water more efficiently can help counter these increases.

***Water Conservation***

- Using proper techniques for washing equipments such as jets to reduce the amount of water consumption.
- Install water meters and monitor water use.
- Use automatic shut-off nozzles and mark hand-operated valves so that open, close and directed-flow positions are easily identified.
- Use high-pressure, low-volume cleaning systems, such as CIP (clean in place) for equipment washing especially for heat exchanger cleaning.
- Install liquid level controls with automatic pump stops where overflow is likely to occur.

- Recycle cooling water through cooling towers.
- Minimize spills on the floor minimizes floor washing.
- Repair leaks.
- Handle solid waste dry.
- Recycle steam condensate whenever economically viable.

***Energy  
conservation  
measures***

- Coverage of uncovered heated vessels or tanks.
- Insulation of steam lines.
- Installation of steam traps.
- Repair or replace steam valves.
- Use the optimum excess air to perform efficient combustion process
- Install pressure regulators on steam lines.
- Return steam condensate.
- Improvement of power factor and electrical circuits.

## **6. Industrial Inspection**

The inspection of the oil, soap, and detergents industry will follow the procedures described in the Inspection Guidelines. This chapter presents a summary of the inspection process regarding the purpose and scope of various types of inspection, and the proposed inspection procedure for the oil, soap and detergents Industry.

The overall purpose of inspections is to enforce environmental laws. Table (11) lists the various types of inspections and the objectives that have to be fulfilled for each type.

**Table (11) The different types of inspections and their objectives**

<b>Inspection type</b>	<b>Objectives</b>
<b>Site Inspection</b>	
1. Comprehensive	Evaluate compliance status regarding all aspects of Law 4.
2. Specific	Evaluate compliance status regarding some aspects of Law 4 (usually complaint driven). Review special conditions set by EEAA in EIA studies. Investigate complaints.
3. Follow-up	Check environmental register and implementation of compliance measures.
<b>Inspection campaign</b>	
1. Geographic	Check pollution sources to specific receiving media Check pollution sources from facilities in a specific area.
2. Sector specific	Check aspects relevant to specific sector.

As evident from the above table, comprehensive inspection deals with all aspects of environmental laws and therefore is considered in this manual. Other inspection types can be tailored accordingly.

Developing an inspection strategy and quarterly and/or monthly plans are the responsibility of the inspectorate management. Developing site-specific inspection plans for carrying out the scope of work that fulfills inspection objectives is the responsibility of the inspection team. Planning for inspections is presented in more detail in the General Inspection Manual, GIM (EPAP-2002).

## **7. Inspection Planning at the Inspectorate Level**

The responsibilities of the inspectorate management regarding the specific inspection are to state clearly, in writing, the type of inspection and related objectives as well as the time schedule necessary to carry out inspection. The inspectorate management is also responsible for providing preliminary information about the facility, inspection tools, and logistics.

### **7.1 Activities Characteristic to the Oil & Soap and Detergents Industry**

Taking the comprehensive inspection as an example, the objectives stated in Table (11) dictate the activities required for covering all aspects of compliance with environmental laws and regulations. The required personnel, equipment and logistics are determined accordingly.

Discharge to sea or to surface water of large self-purifying capacity, to canals and agriculture drains is not allowed unless treated to reach the limits set by the law. However, discharge to the public sewer system could be allowed for a surcharge. Large facilities are expected to have most production lines and most service units. These facilities could most probably, sustain pollution abatement measures.

### **7.2 Providing Information about the Facility**

Chapters (2-5) present the technical aspects regarding the oil, soap and detergents industry, its pollution sources and relevant environmental laws. Information regarding compliance history related to other inspecting parties (irrigation inspectors, occupational health inspectors, etc.) can be helpful in anticipating potential violations and preparing necessary equipment. Compliance action plans, Environmental Impact Assessment (EIA) studies and IPIS data bases are also important sources of information.

### **7.3 Providing Resources**

The required personnel, tools and equipment depend on the size of the facility to be inspected. The inspection team leaders, in coordination with the inspectorate management, are responsible for assessing the inspection needs. The number of inspectors required depends on the size of the facility and the planned activities. Usually the team members are split and assigned different tasks during the field visit to allow the required activities to be performed in parallel. Each task is rotated among the inspectors to diversify their experience.

#### ***Small and***

#### ***Medium size facilities***

These facilities could have a number of production lines or specialize in one or two products with medium production capacity. Inspection of these facilities will be similar to inspection of large facilities using a smaller inspection team depending on the number of production lines and service units.

***Large facilities***

Large facilities will typically have many production lines with large production capacity. Planning for the comprehensive multi-media inspection will require several inspectors, sampling equipment to provide proper samples for analysis as well as measuring devices. A lab technician will also be needed. The inspectorate management will provide the inspection checklist presented in Annex 1.



## **8. Preparation for Field Inspection (inspection team)**

As presented in the General Inspection manual, GIM (EPAP-2002), tasks necessary for preparation for field inspection, are:

- Gathering information about the specific facility to be inspected
- Preparing of the inspection plan
- Preparing the checklists and other inspection tools.

This manual presents the case of a comprehensive multi-media site-inspection of a large oil, soap and detergents facility since it represents the highest level of inspection complexity. Tasks for carrying out less complicated inspections can be easily deduced.

### **8.1 Gathering and Reviewing Information**

The inspection team should review the general information prepared for the oil, soap and detergents industry (chapters 2-5) and then check - if possible - what production lines and service units are present at the targeted facility. In addition to the required information listed in Annex (a) of the General Inspection Manual, GIM (EPAP-2002), it is important at this stage to determine the following:

- The type of receiving body for the industrial wastewater and review relevant Egyptian laws (Chapter 4).
- The scope of inspection and related activities based on the type and objectives of inspection required by the inspectorate management.
- The potential pollution hazards as addressed in section 2.4, and accordingly, define measurement and analyses needs.
- The characteristics of the oil, soap and detergents industry as presented in section 2.5, and their implications on the inspection process of the targeted facility.

### **8.2 Preparation of the Inspection Plan**

An example of an inspection plan is included in Annex (E) of the General Inspection Manual, GIM (EPAP-2002). The plan should take into account the following:

- For large oil, soap and detergents facilities, the inspection team could be divided into smaller groups. Each group will be responsible for inspecting a number of production lines and service units.
- At the beginning of the field visit, the inspection team should check the environmental register for completeness using the checklist provided in Annex (G) of the General Inspection Manual, GIM (EPAP-2002).
- At the end of the field visit, the information included in the environmental register should be checked based on the field visit observations. If not confident with measurements and analyses results, the inspector should make his own.

*Notes to inspector:*

- *When the final effluent is expected to be in violation of environmental laws, sampling should be planned.*
- *Because of possible shock loads a grab sample at the time of discharge should be performed. If grab samples are taken when no shock load is discharged the results will not reflect the actual pollutants loads.*
- *To prove that a shock load has been discharged, a composite sample over the shift duration should be analyzed. If the results show higher pollutant concentrations than those of the grab sample, then a shock load was discharged.*
- *Make sure that the polluting production lines are in operation since some factory management resort to halting the polluting lines during the inspection.*

### **8.3 Preparation of the Required Checklists**

The checklist for the oil, soap and detergents industry is presented in Annex 1 of this manual. The checklist has been prepared in such a way that it starts with general information about the facility and its operation. Separate checklists are then filled for each production line/service unit independently for relevant environmental aspects and media. The inspection team will compile the checklists relevant to existing production lines and service units in the targeted facility.

The development of the checklists goes through the following steps:

- Draw the block flow diagrams for the production lines with their pollution sources as presented in Figures 2 to 7. Similar figures can be developed for other oil, soap and detergents production lines that were not covered by this manual.
- Identify the areas of possible non-compliance and the parameters that need checking. For example, noise should be checked near the mixers, mills, and compressors, but temperature and humidity where steam leaks occur.
- Identify what to observe, ask and/or estimate that can convey information about pollutants. For example:
  - the type of solvent, caustic wash solutions, and other raw materials, determines the contaminant in the wash streams,
  - oily effluents from production lines or oily cooling water indicates the contamination of the plant effluent with oil,

***Note to inspector:***

*Law 4 does not specify standards for effluent from production lines but only for final disposal points. However, effluent quality from production lines is an important indicator of the final discharge.*

## **8.4 Legal Aspects**

As evident from chapter 2, a large facility is expected to be in violation of several environmental laws, specifically with respect to wastewater if no treatment is performed. The inspection team should be prepared for legally establishing such a violation.

*Note to inspector:*

*It is the responsibility of the inspector to assess the seriousness of the violation upon which the enforcement action will be based. His information about the nature and cause of the violation must be well documented and the evidence sound. The case could be contested in court and the inspector will be asked to defend his technical judgment.*

## **9. Performing the Field Inspection**

### **9.1 Starting the Field Visit**

The General Inspection Manual, GIM (EPAP-2002) describes the procedures involved for entering an industrial facility. The inspector's attitude and behavior are very important from the start and will dictate the factory's personnel response to the inspection tasks.

*Note to inspector:*

- *It is better at this stage not to ask direct questions about the spent solvents and caustic wash wastewater, and chemicals empty containers. Interviewing the workers on-site in an indirect manner can give better results.*
- *Check the results of effluent analyses, time and place of sampling. If suspicious make your own analyses.*
- *The disposal method of the spent solvents and caustic solutions, used for cleaning are important information for determining the type of pollutant in the effluent. In this case a direct question is preferred.*
- *Get a sketch of the factory layout with sewer lines and final disposal points.*

### **9.2 Proceeding with the Field Visit**

Information gathered during the facility tour is dependent on interviews of facility personnel and visual observation. Annex (H) of the General Inspection Manual, GIM (EPAP-2002) presents some useful interviewing techniques.

Using the facility layout, start by checking the final disposal points and the various plants and/or service units connected to each point. This will determine where and how to take the effluent samples. Visual observations about the condition of the sewer manholes should be recorded. In some facilities the discharge to the receiving body is performed through a bayyara (cesspit), septic tanks or holding tanks. If the lining of the holding tank is defective, contamination of the underground water could occur.

*Note to inspectors:*

*Cesspits, septic tanks and holding tanks are a form of pre-treatment that generates settled sludge. Check:*

- *The presence of accumulated sludge and related hygienic conditions*
- *The disposal of the sludge*

Inspection of the production lines should start with the feeding of raw materials and end with the product packaging and storage. Referring to Figures 2.1 to 2.16, check the following:

## **Production Lines**

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### ***Oil Extraction production Line***

- Check the suspended solid emission in the screening, crushing, delinting and dehulling of seeds.
- Check the temperature and humidity in seed cooking and flaking.
- Is the screening and crushing of seeds occurs in open area or closed area.
- In closed area, is cyclone present.
- Is dehulling operation, and delinting operation ( in case of cotton seeds) exist in the facility.
- Check the odor of hexane vapor in the extraction unit.
- Check the odor of fermentation products from seeds preparation or from seed meal after hexane extraction.
- What happens for seed meal after hexane operation

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### ***Oil Refining production line***

- Check any oil spills in that section.
- Check the disposal of gums after degumming operation.
- Check pH.
- Check the handling of mucilage produced in neutralization oil with caustic soda.
- Check the treatment for soap wastewater stream produced for oil washing with water and citric acid.
- Check the temperature stress (in workplace) due to oil drying, bleaching, and deodorization.
- Check the method used for addition of fuller earth.
- Check the disposal of fuller earth contaminated with oil after bleaching step in the facility.
- Check the emission of free fatty acid, aldehydes and ketones in deodorization step.

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### ***Soap Production Line***

- Check the use of proper quantities of raw materials
- Check the handling of caustic soda as hazardous material
- Check the temperature stress and humidity if soap kettles are present in closed areas.
- Check the emergency plan in case of power switched off in soap forming section, check of storage tank – reconditioning of soap paste – check presence of emergency power generator.
- What happens for any rejected batches?

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### ***Glycerin production line***

- Check the HCl tank.
- Check the receiving of spent lye in glycerin unit without foaming
- Check no overflows on floor.
- Check temperature stress in distillation and evaporator units for concentration of glycerin.

- Check the disposal of polymeric solid residue obtained after distillation & evaporation.
- Check the residual NaCl tank.
- Check spills of glycerin.

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***Animal fodder production line***

- Check the molasses tank and unloading place.
- Check the suspended solids in crushing of raw material and mixing operation.
- Check the suspended solids during transportation of mixture before adding the binding material (molasses, vinasse).
- Check the noise in that section
- Check the disposal mechanism for any rejected solids remained from raw materials

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***Shortening production line***

- Check the hygienic instructions
- Check the packaging section (of spills, product leak).
- Check if the floor is slipping.

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***Oil hydrogenation production line***

- Check the hydrogen storage.
- Check the disposal of spent nickel catalyst.
- Check the disposal of filters used.
- Check the method of removing and treatment of Ni catalyst.

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***Detergents production line***

- Check any spills of active components.
- Check handling of oleum in case of any sulfonation.
- Check the temperature stress beside the spray dryer.
- Check the suspended solids in the production area (spray dryer and filling, packaging).
- Observe the behavior in case of any solid material on floor, how the workers get ride of it!
- Check the presence of cyclone to catch particulate matter.
- Check the ventilation system exist in the facility

## **Service Units**

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### ***Water treatment units***

- Check the chemicals used and method applied (ion exchange –lime process – reverse osmosis.
  - Check the amount of wastewater from backwash.
  - Check for recording of results.
- 

### ***Boilers***

- Check the chimney's height and amount of gases emission kg/hr.
  - Perform exhaust gases analysis and compare with limitation in law 4, 1994.
  - Check fuel storage regulations and spill prevention.
  - Check noise in boiler area.
  - Check the blow-down as wastewater from boiler.
- 

### ***Cooling towers***

- Check the amount of blowdown from cooling tower.
  - Check the tower basin for algae and contamination.
  - Check the temperature difference across the tower.
- 

### ***Garage, and Workshops***

- Check for noise.
  - Check for used oil collection system.
  - Check for classification of scraps from workshop from source.
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### ***Storage facilities***

- Check storage and handling of hazardous materials according to instructions described in law 4, 1994.
  - Check the spill prevention and storage classification (liquids flammable, explosive, volatiles compounds ... etc).
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### ***WWTP***

- Check for efficiency of wastewater treatment unit by analyzing the outputs from the unit.
  - Check for sludge disposal
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## **Effluent analysis**

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### ***Receiving body***

- The nature of the receiving body determines the applicable laws.
  - Check if effluent discharge is to public sewer, canals and Nile branches, agricultural drains, sea or main River Nile.
  - Accordingly, define applicable laws, relevant parameters (BOD, COD, TDS, TSS, S.S, pH, O&G and temp.) and their limits.
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### ***Sampling***

- A composite sample must be taken from each final disposal
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point over the duration of the shift or a grab sample at peak discharge. Each sample will be analyzed independently.

- According to legal procedures in Egypt, the effluent sample is spilt and one of them is sealed and kept untouched.
- 

### **9.3 Ending the Field Visit**

When violations are detected a legal report is prepared stating information pertaining to sampling location and time. Violations of work environment regulations should also state location and time of measurements. Other visual violations such as solid waste accumulation, hazardous material and waste handling and storage, and material spills should be photographed and documented. It is preferable that facility management signs the field-inspection report but this is not a necessary procedure. A closing meeting with the facility management can be held to discuss findings and observations.

*Note to inspector:*

*The less certain the team leader is about a specific violation the more reason not to discuss it at the closing meeting.*



## **10. Conclusion of the Field Inspection**

The activities performed during the site inspection are essential for preparation of the inspection report, for assessing the seriousness of the violations, for pursuing a criminal or civil suit against the facility, for presenting the legal case and making it stand in court without being contested, and for further follow-up of the compliance status of the facility.

### **10.1 Preparing the Inspection Report**

An example of an inspection report is included in Annex (K) of the General Inspection Manual (EPAP, 2002). The inspection report presents the findings, conclusions, recommendations and supporting information in an organized manner. It provides the inspectorate management with the basis for proposing enforcement measures and follow-up activities.

### **10.2 Supporting the Enforcement Case**

Many issues may be raised and disputed in typical enforcement actions. Enforcement officials should always be prepared to:

- Prove that a violation has occurred. The inspector must provide information that can be used as evidence in a court of law.
- Establish that the procedures were fairly followed.
- Demonstrate the environmental and health effect of the violating parameter.

*Note to inspectorate management:*

- *Although the inspector is not required to suggest pollution abatement measures, the inspectorate management should be able to demonstrate that a remedy for the violation is available.*
- *Enforcement should not cause financial collapse of the facility and inspectorate management should demonstrate the ability of the violator to pay.*

### **10.3 Following-up Compliance Status of Violating Facility**

After performing the comprehensive inspection and detecting the violations the inspectorate management should:

- Decide on the sanctions and send the legal report to the judicial authority.
- Plan routine follow-up inspections. This type of inspection focuses on the violating source and its related pollution abatement measure. Self-monitoring results are reviewed during the visit.
- Follow-up the enforcement case (legal department).