Reference # 3 Section 5.15 Soaps & Detergents (August 1992) 4 Copies

TECHNICAL INFORMATION REPORT FROM THE TI-2 COMMITTEE
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Air Pollution Aspects of Soap and Detergent Manufacture

Informative Report No. 8 on soap and detergent manufacture is one of a series of survey reports prepared by APCA's TI-2 Committee on air pollution problems and control methods encountered in the chemical industry today.

The soap and detergent industry, consisting of approximately 90 manufacturers, currently produces approximately 4 billion pounds of detergent and 1 billion pounds of soap annually. Detergents are used in scouring powders, shampoos, dentifrices, industrial cleaners, liquid detergents, and in the familiar cartons of home laundry granules. Of the 4 billion pounds of detergent production, about 3 billion pounds is produced in a solid form. The major portion of solid detergents is used in granular form for washday products. No significant air pollution problem results from the production of dentifrices, shampoos, and other liquid cleaners.

Although the predominant use of soap is in bars, small quantities of flakes and granules are still made. The production of soap normally involves the hydrolysis of fats to fatty acids followed by distillation and purification. The unloading and storage of flash dried fat stock and the distillation and purification of higher molecular weight fatty acids will produce odor bodies. These odors that are discharged from vacuum type steam ejectors may be controlled by spray condensers or surface condensers. Dust emissions from the manufacture of soap products are primarily an in-plant environmental dust problem. The spray drying of soaps can result in air pollution problems that are essentially the same as those discussed in the section on spray drying of detergents.

Informative Report No. 8 of the TI-2 Chemical Committee was first submitted to APCA's Steering Committee and Technical Council on February 17, 1966. It was processed in accordance with the 14 step procedure outlined in the March 1963 *Journal* and was finally approved by APCA's Board of Directors on April 1, 1967. In accordance with the objectives of the Association as they appear in Article XV, Section 4 of the By-Laws, each technical coordinating committee has the task of reviewing and amending its studies as often as necessary in the light of technological changes.
In accordance with procedures adopted by the APCA Technical Council and the Board of Directors, it is now published as representing "the best thinking of the Association."

Liquid detergents are generally produced by a small batch-type sulfonation process. Any acid fumes vented from the sulfation tanks can be handled effectively by small acid scrubbers. The intermittent emission of acid fumes would occur during a short period of time.

From an air pollution standpoint, the major area of interest is the spray drying of synthetic detergents. The

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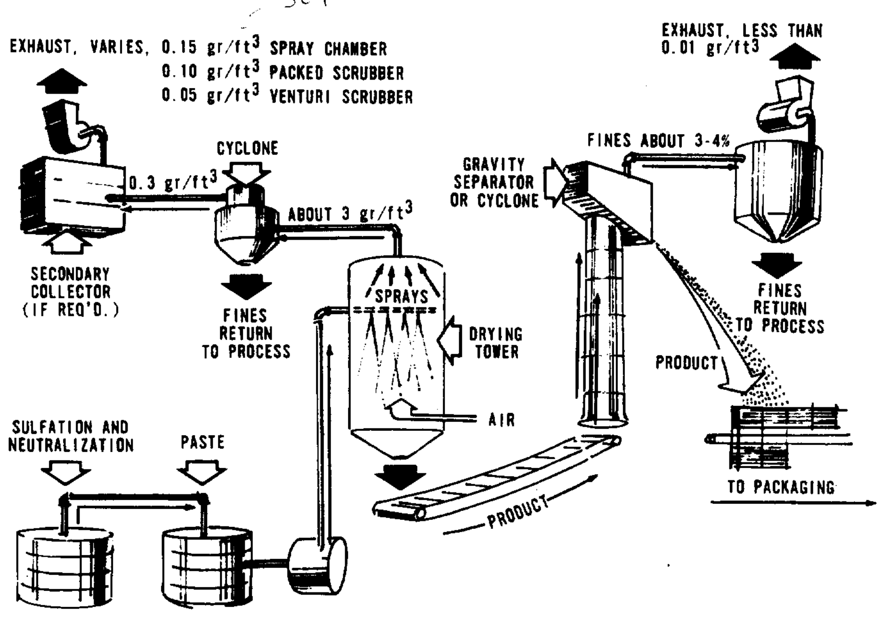

Fig. 1. Flow diagram for a synthetic detergent process.

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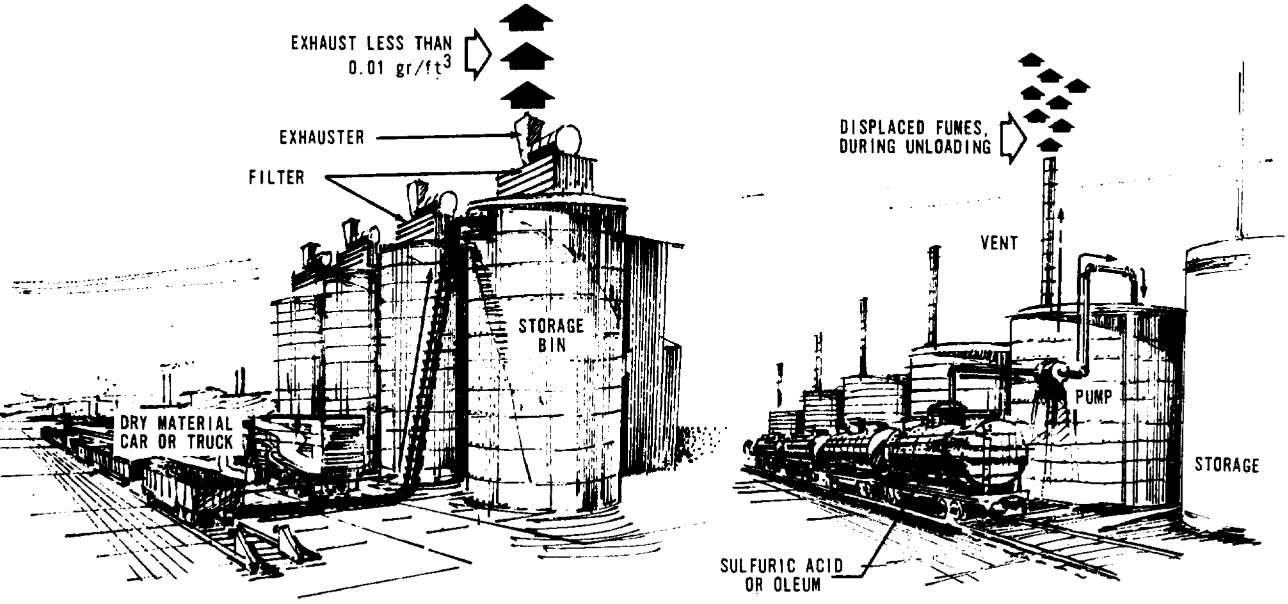

Fig. 2. Raw materials receiving station.

drying normally occurs in large towers, e.g., 20 ft diam × 100 ft high, rather than in a multitude of small units. The large volume of water evaporated is discharged from the dryer exit stack and condenses in the atmosphere to form a dense white plume. Malfunction of collection equipment can lead to particulate fallout problems on occasions and give the erroneous impression that the opacity of the white plume is due solely to dust. Because spray drying is the major source of particulate emissions, the following discussion will be directed to that section of detergent processing.

Synthetic Detergent Process (*See Fig. 1*)

Synthetic detergents are so-called because most of the raw materials used in the manufacturing process are synthesized from natural products. In essence, the process consists of combining a fatty alcohol or linear alkylate with sulfuric acid, and then neutralizing with caustic. The linear alkylate sulfonate produced from the reaction is a paste mixed with water and contains specific components for the particular product use. Additions might be builders, brighteners, dyes, etc. The paste is pumped at high pressure to a spray tower where it falls through hot air and is dryed to the desired moisture content. Control of paste temperature, viscosity, and pressure regulate the size of the granule produced. The desired product for the consumer is a rather coarse granule; one product, for example, has 50% of the particles on 28 mesh, or greater than 500 μ. A large amount of fines are not produced in the spray tower, unlike such spray-dried products as powdered milk or instant coffee. It is to the advantage of the manufacturing unit to produce as few fines as possible and reduce the amount of material discharged with the exhaust. The blown, dried product is then conveyed to storage and packaging. Pneumatic conveying may be used with possible dust emissions.

Materials Unloading and Storage (*See Fig. 2*)

A necessary adjunct to this or any process will be unloading and storage of raw materials which include liquids such as linear alkylate, fatty alcohol, caustic, and sulfuric acid or oleum, and dry materials such as phosphates or other builders. The hydrocarbons and caustics have very low vapor pressures, and unloading and storage of these materials present no particular air pollution control problem. The dry material may be unloaded in any of several ways. Vacuum conveyors and fluidizers are sometimes used, and these systems could present a potential air pollution problem. However, separation of the conveyed product from the conveying air is usually accomplished with a cloth filter. This technique will prevent a dust emission problem.

The unloading of the acid may be done with self-priming pumps or, in some cases, air blows. That is, compressed air or nitrogen is used to provide the motive power to lift the acid out of tank cars and trucks to the storage tanks. Since an emission of acid fumes can result from the use of air blows, this method is not recommended. The emission problem occurs as the car is emptied. The resistance to flow decreases and a large volume of compressed air blows through the car, sweeps it free of vapors, and passes into the tank and out the vent in a noticeable cloud of acid mist. This is particularly true when unloading oleum. This cloud can drift beyond the plant boundaries and create a noticeable odor and visible plume. A minor problem of acid mist emissions can also occur from the filling of storage tanks. The displaced air can result in a carry-over of a noticeable acid mist, although this will usually be only a problem within plant boundaries. One way of handling the problem is by venting through a high stack where sufficient diffusion and dilution can occur. This method is not recommended unless the occurrence is infrequent and the quantity vented is very small. Where small vents are used, it is important to trace and insulate them to prevent any condensation of the acid mist on the vent walls in the winter. This will polymerize and build up on the surfaces of the vent and rapidly plug it. A more positive method for controlling displaced vapors from the filling of oleum storage tanks is by scrubbing the vent gases in a small packed tower with 98% sulfuric acid. Displaced sulfur trioxide can also be reduced by using a submerged filling technique.

Air Pollution Aspects of Detergent Processing

Referring to Fig. 1, the major source of interest to air pollution control is the exhaust from the spray tower. This will be a dust laden gas with temperature in the range of 150–250°F and the wet bulb temperature between 120 and 150°F. There will be up to three grains of particulate/standard cu ft in the hot, humid tower exhaust gas. The quantity of fines will vary depending on tower rates, the fineness of the sprays, the particular product being blown, and other variables. Under most conditions, the fines comprise an economically recoverable portion and cyclones would usually be provided to collect this material and return it dry to where it may be recycled. Dry collection devices are desired here so that the product may be returned directly to the process. Cloth filters are not recommended at this point because of the high temperature and high humidity of the gases. The cyclones, although not of the small tube type, are high efficiency, high-pressure drop cyclones with a pressure drop across them of about 8–10 in. of water and have an efficiency of between 90 and 95%. Although these entrained particles are referred to as fines with respect to the product, where a rather coarse granule is desired, they are relatively large as far as cyclone collection efficiencies are concerned—approximately 50% greater than 40μ.

After the cyclone, the gas will usually contain about 0.3 grain of dust/standard cu ft, although this figure will vary depending upon the efficiency of the cyclones and their inlet concentrations. This level of grain loading is allowed by many air pollution control ordinances. It would not be acceptable to the more stringent requirements of some communities, however, and subsequent control equipment may be required. Much of the weight percentage of this grain loading will be due to a few large particles which pass through the cyclone. If the cyclone is not properly maintained, additional large particles may be discharged through the exit gas stack. They will travel with the plume and the prevailing wind and may become a minor or sporadic particulate fallout problem directly beneath the plume. The collection of such particles on a clean surface, such as a recently waxed car, will attract attention and cause complaints.

Control between the cyclone and the exhaust will vary depending upon the source of emission with respect to boundary lines, and the nature of the surrounding community. This fallout can be controlled rather easily by devices as crude as a simple spray chamber without packing, although packed scrubbers and venturi scrubbers are used. Since the gas is near its saturation temperature and the dust tends to be sticky at high temperatures, cloth filters are not practical because caking and buildup on cloth filters would be a serious problem. The filters would need to be insulated and steam traced to prevent condensation on the bags. If condensation occurs, some of the detergent would go into solution, migrate into the bag, and eventually cake it solid. The dust at this concentration is not economically recoverable and thus, a wet collector is a suitable application. Spray chamber water should not be recirculated because of extreme foaming problems with these detergent dusts. Such a very dilute solution resulting from once-through water may usually be discharged to sewers.

The mass in a dust emission will generally be due to the larger particles in the distribution, whatever the absolute size of the distribution. The weight of the 0.15–0.3 grain concentration is due to these and simple devices can make major reductions in grain loading. Particulate loadings in the exhaust after a packed scrubber, as low as 0.1 grain/standard cu ft, are easily obtainable and may be achieved by use of an unpacked spray chamber. Packed scrubbers or spray chambers should be sized for velocities of 250 ft/min or owner, mainly to prevent water entrainment. Scrubbing rates as low as 1–2 gal./min for every thousand cfm are sufficient for scrubbers or spray chambers. Discharge grain loading on the discharge of the venturi scrubber may be as low as 0.02–0.03 grains/-standard cu ft if high-pressure drops are used across the venturi. Larger volumes of water, 4 gal/min/1000 cfm, would be used. A relatively low gas pressure drop of 3–5 in of water would give a grain loading of 0.1 grain/standard cu ft.

The cleaned exhaust is close to the saturation temperature, particularly if wet scrubbers are used, and the resultant plume will be a cloud of steam containing small amounts of particulates.

The odor level of the tower exhaust may run 4 or 5 odor units/standard cu ft. The smell of the tower exhaust odor is similar to that of detergent used in the household. Even with large manufacturing units, the odor is diluted and diffused and, if noted, is generally unobjectionable. Although relatively free of particulates and odor, the highly visible condensing steam plume may generate erroneous impressions of odor and dust. This is most likely to occur when the discharge plume dips to the ground.

In many communities, it would be highly desirable to discharge the exhaust at high velocity from a tall stack. The top of the stack should be well above nearby buildings to prevent turbulent downwash on their leeward side which can frequently bring the plume to ground level. Although the plume will be more visible from farther away when carried aloft, it usually will generate fewer complaints.

Returning to Fig. 1, the dried product at the bottom of the tower must be cooled and conveyed to a packing department. A common conveying method is the pneumatic conveyor or air lift which raises the product to a point high enough to permit the use of gravity feed for subsequent screening, handling, and storage. The air lift serves a dual purpose of cooling the product as well as conveying it. Some of the products become sticky if left at high temperatures. Large volumes of air, in the order of 1 cfm/lb/hr of product, are used for conveying in order to provide the necessary cooling. This mixture of air and product will pass through an inertial device, which might be a low-efficiency cyclone or a gravity separator, and which separates the marketable large particles from fines. Product passes down through screens and other handling devices and may present local dust problems at each transfer point; however, these are in-plant environmental problems and will not normally contribute to an outside air pollution problem. The exhaust from the inertial device will contain undersized particles in a concentration equivalent to 3–4% of the amount conveyed. This presents an economically important fraction of production which would normally go to a cloth filter. The dry, cooler air presents no problem to cloth filters at this point and complete recovery of the product is desirable in dry form as it may then be conveniently recycled to the paste.

The above describes normal operation. There are some misoperations which can cause air pollution problems. Air pollution control may often be best directed initially toward preventing *misoperation* rather than by adding additional control devices to an existing plant. Since the carry-over dust from the tower is warm and sticky and in a moist atmosphere when it leaves the tower, the fines from the exhaust can plug cyclone outlets and the rotary air locks. If this occurs, all of the particulate going to the cyclone will pass on to the second pollution control device, if there is one. This device, in turn, with larger inlet concentrations, will pass larger concentrations out to the atmosphere. Cyclone plugging is the most likely source of occasional particulate fallout problems. Level control devices or pressure measuring devices which can indicate cyclone plugging are recommended. Another source of dust emission is from broken or torn filter bags which are used in the air lift or unloading systems. This condition would also result in large losses of valuable material and would normally be corrected quickly. Dust emissions will also occur if water for the wet collectors is not turned on or is cut off inadvertently. Water-flow measuring devices and alarms may be in order if this is a frequent occurrence.