HANDLING INDUSTRIAL FATTY ACIDS

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For most uses, fatty acids can be handled in conventional equipment. Although frequently discussed as a class, fatty acids vary widely in their characteristics, so that methods of handling must be matched to the particular acid used. Methods of handling also differ substantially from those applicable to the oils from which they are derived, or which they may replace in application. The sensitivity of the end-product to quality factors such as color also strongly affects handling requirements.

All fatty acids have some tendency to combine with oxygen to form impurities objectionable from the color or odor standpoint. This tendency is slight for the long-chain saturated acids, except at elevated temperatures. It is more pronounced with the short-chain acids, and particularly with the more unsaturated acids. The reaction is catalyzed by traces of metal, such as iron and copper, which the acids may pick up from containers or storage tanks. Thus, while most fatty acids are not so corrosive as to preclude shipment in ordinary unlined steel drums or tank cars, the character of the end-product may make such shipment inadvisable. It is this contamination factor, rather than tank or container failure, that limits the choice of materials for fatty acids at temperatures below 100°C.

SHIPMENT OF FATTY ACIDS

Stearic acid and other high-titer acids of the long-chain saturated type are solids from 50°C (122°F) or slightly above, and may be shipped and stored as solids in appropriate containers. They may also be shipped in bulk (tank cars) for liquefaction on arrival.

Other fatty acids are classified as liquid (titer up to 20°C) and semi-solid (titer 20° to 50°C). These medium and low-titer groups will include the mixed acids, such as distilled animal fatty acids, the unsaturated long-chain acids, such as oleic, and the short-chain saturated acids, such as distilled coconut fatty acids. All these are shipped in drums or in bulk (tank cars). Deliveries of mixed and long-chain acids have traditionally been made in steel drums or steel tank cars, because the pick-up of iron during the shipping period is inconsequential in many uses. However, where product quality is likely to be affected or color is critical, drums and tank cars must be resin-lined or of non-corrosive metal construction.

Solid Fatty Acids

Stearic acid (55/45 palmitic-to-stearic ratio) has a crystalline structure as supplied in solid slab form. Such cakes or slabs are typically packaged in cartons or boxes (100 lb) or in burlap bags. However, stearic and other solid acids are now increasingly sold in flake, powder or bead form, in multiwall paper bags, cloth or burlap bags, fiber drums, etc. (50, 80, 100 lb.) Polyvinyl or polyethylene liners have proved satisfactory for the powdered material, giving additional protection from contamination.

Unit Loading. Unit loading of solid fatty acids is being widely adopted to reduce the time and manpower required for unloading and subsequent handling operations. It has been estimated that the man-hours required to unload and store carloads and truck loads of solid fatty acids are reduced through unit handling procedures by at least 75 per cent. Unit loads also increase storage capacity, simplify inventory control and improve the condition of shipments on arrival at the customer's plant.

A very satisfactory unit load is one containing 2,000 pounds of product and measuring 40 x 48 inches by approximately 60 inches high. It consists of

eight layers of five 50-pound multiwall kraft paper bags laid on a 1/8-inch thick disposable fiber board pallet having 3-inch edges turned up along two adjoining sides. A series of spots of a high shear strength glue prevents individual bags from shifting in the unit. Yet, because the glue also has a low tensile strength, the units are easily disassembled by lifting the individual bags to break the glue bond. Sliding the bags off without first lifting them free may tear the outer ply of paper.

A power-driven fork-lift truck must be used to achieve any substantial savings from handling unit loads. Forks should have their centers approximately 25 inches apart and ends should be ground down so that they measure 1/16 inch thick at the tip to 3/8 inch thick 2 inches from the tip. Forks should also be well aligned. For easier handling, it is generally advisable to unload each unit onto a 40 x 48 inch permanent wood pallet. The disposable pallets used for shipment do not have sufficient rigidity by themselves to withstand the handling normally encountered while being carried about a plant with a fork truck.

Tank Car Loading. Tank car shipments of solid fatty acids require melting for removal. Use of ordinary steel tank cars may be expected to result in some discoloration and is not advisable for high-grade material. Negligible deterioration of solid fatty acids will occur during the shipment period if aluminum tank cars are used. Also, certain resin linings have been successfully used. However, the heat required to melt the tank car contents will have some slight discoloring effect on the acids. To minimize darkening of the material, low-pressure steam (15 psi) should be used before unloading at the point of destination. Although completed liquefaction is essential to the unloading of a tank car of fatty acid, high-pressure steam should be used with caution.

Unloading Bulk Solid Acids. Steam should be turned on gradually so that the coils will heat slowly and not expand so rapidly as to cause breaks and leaks. Since there is rapid heat loss from the metal wall of the car, steaming should preferably be carried out in a protected spot where the car is sheltered from the wind. If steam is not available, portable steam generators may be connected to tank car steam lines.

To determine whether the contents of a tank car are completely melted, an inspection from the top of the car should be made, either visually or using a stick or tube sampler. Most steel tanks have the steam coils mounted about several inches above the bottom of the car; if the contents are not fully melted, the bottom of the car will not be as warm to the touch as the side wall, as heat transfer is primarily upward. Most aluminum tank cars have the steam coils very close to the shell and conforming to the contour of the car in order to facilitate melting. With the coils arranged in this manner it is more difficult to determine completeness of melting by touch. It should be emphasized that if solid acids remain in the bottom of the car below the steam coils, it will be impossible to unload completely, and the residual material will have to be chipped out and removed by hand.

Solid fatty acids, such as stearic, require approximately 24 or more hours of steaming, depending on prevailing temperatures, for complete liquefaction. When the acid is completely melted and heated to a temperature about 20°C above its melting point, it is ready for pumping.

Because of the high titer of such acids, it is essential that all pumping lines be equipped with steam tracers (usually copper tubing wound about the line) and kept at an elevated temperature to prevent solidification and blockage of the line. With this precaution, stearic acid can be pumped as readily as any low-titer fatty acid. Clearing pumping lines after use by

blowing out retained liquid is essential to prevent blockage. Inert gases, such as nitrogen or carbon dioxide, are preferable for this purpose, although clean compressed air if often used on all but the highly unsaturated acids with satisfactory results. Steam may be used. It has the advantage of melting out any solidified material, but of course the blown-out product is water-contaminated and must be segregated. Further pumpings may be contaminated with water remaining in the line.

Caution must be exercised in unloading when using the bottom outlet valve. Before removing the outlet nozzle cap and connecting the pumping line, an inspection must be made to determine if the valve is properly seated. This is done by removing the small screw-type plug in the valve cap, commonly known as the "test plug". If the flow of liquid does not quickly cease when the test-plug is removed, a faulty or poorly seated valve is indicated; after replacing the test-plug, an attempt to seat the valve should be made. This is done by turning the valve-operating handle located inside the dome. If the operator is unable to seat the valve so it will hold, the car must be unloaded through the dome. Any attempt to unload through the bottom outlet with the exit valve inoperative will result in extensive loss of material.

Suggestions for Unloading Tank Cars. These suggestions are based in part on Pamphlet 34, Freight Loading and Container Section, Assoc. of American Railroads, on advice of General American Transportation Corp., and on common industry practice. They are offered only as a general guide in setting individual procedures with the cooperation of the carrier.

1. Brakes should be set and wheels locked on all cars before being unloaded. Caution signs should be placed on the track or car.

2. Open the dome of the car. The purpose of this is that otherwise when heat is applied to the car, the contents will expand and build up excessive pressure inside the tank, and possibly damage the car. The cars are equipped with safety valves, but they are not always in working order. Therefore, it is advisable to remove the dome cover. Also, with the dome cover removed, it is possible to take check measurements and inspect the contents.

3. The second step is a precautionary one which should be observed at all times, and may save the unloading party the serious misfortune of discharging a tank of fatty acids on the track. The valve rod handle or control in the dome should be operated a few times and then closed before valve cap is removed. Even if this precautionary measure is taken, the valve may not be seated properly or may have been loosened or damaged in transit, or the valve itself may be defective. Therefore, before applying steam to the car, remove the cap from the outlet valve and attach a nipple with a valve on it to the outlet. Make sure this second valve is closed. When the car is heated, this will prevent any loss of material in case the valve was not closed or properly seated.

4. Attach the discharge lines and pumps going to storage.

5. Attach the steam hose to the heating coils and a steam trap at the exhaust end. The use of a steam trap will save considerable steam consumption and also insure faster heating of the contents of the car. However, if no steam trap is available, put a valve on the outlet of the steam coil and use it as a bleeder to keep steam coming through the coil. Ten to fifteen pounds of steam pressure is ample. The steam should be kept on the car until the under side of both ends of the car are hot to the touch.

6. After the car is unloaded, the fatty acid line should be blown with inert gas or steam. Also, the steam coils on the tank car should be blown out with air to prevent any water remaining in the heating coils from freezing and possibly damaging the steam coils. The caps for the steam coil should be left off. Before entering the car for inspection, sufficient time should be allowed to elapse, to make sure the temperature is not above 110 to 115°F. **An "outside" man should always be present when one enters the car.**

Aluminum, resin-lined and regular steel tank cars for bulk shipment of fatty acids are usually available in the following sizes:

4,000 gal. (30,000 lb)

6,000 gal. (45,000 lb)

8,000 gal. (60,000 lb)

Semi-Solid and Liquid Fatty Acids

Tank Car Shipments

Currently, most medium titer fatty acids (animal or vegetable) are shipped in steel tank cars wherever larger quantities are required. If fairly rapid turnover of this material is anticipated and if color is not important, such bulk shipment of fatty acids in steel tanks will be satisfactory.

Where necessary, problems of iron contamination can be avoided by the transport of light-colored liquid and semiliquid fatty acids in resin-lined or aluminum tank cars. Aluminum is highly resistant to attack by the higher molecular weight fatty acids and the quality of the material shipped in bulk will be equivalent to material shipped in lined drums.

Even low titer acids, such as oleic, will "titer-out" or solidify in cold weather so that the steaming procedure given above may be required.

Tank Truck Shipments

Tank truck shipments of solid fatty acids and glycerides, thought generally higher in cost than tank car shipments, offer similar packaging and handling savings to the consumer. Additionally, tank trucks permit bulk shipments to

consumers who are without rail sidings and provide the fastest means of delivery available. As a result of this rapid delivery, plus the availability of stainless steel or aluminum trucks with jacketed insulated shells, solid fatty acids and glycerides generally arrive at their destination still in liquid form, eliminating the time and expense of melting for removal.

Arrangements can be made for the use of tank trucks equipped with insulated exterior heating coils to which steam heat can be applied for melting, if required. By I.C.C. regulations, however, such tank trucks are not available to all areas.

Stainless steel, aluminum, or resin-lined tank trucks should be used to insure the product's arrival free from metallic contamination. Standard shipment is made in 4,000 gallon (approx. 30,000 pound) tank trucks with a variety of other sizes and compartment combinations available as required. Less than 4,000 gallon shipments can be arranged at an appropriate added cost. Compartmented tank trucks offer the user the opportunity to order small bulk amounts of several fatty acids at the same time. It should be noted that net weight limitations differ in variour states.

Although the trucker is not obligated to carry a pump, most tank trucks are so equipped. The pump, however, may be made of corrosive materials and is used for any type of material the truck may carry. It can, therefore, be a source of product contamination. In many cases, too, a charge is made for the use of the pump.

Pumpings can be made over most any reasonable distance since extra lengths of hose can be obtained to be carried on the truck. A charge is made by the trucker for all lengths of hose over 36 feet.

Tank trucks must be unloaded immediately on arrival to avoid delay charges by the carrier. The Eastern Tank Carrier Conference ruling states that one hour is allowed for unloading shipments of 4,750 gallons or less,

and one and one-half hours for more than this amount. Any time over this free time is charged by the carrier directly to the consignee at standard rates. The unloading must also be accomplished between 7 AM and 5 PM.

Drum Shipments

Wherever smaller quantities than the ones mentioned above have to be shipped, or if at the point of destination no storage facilities are available, the liquid and semisolid fatty acids are shipped in lined or unlined steel drums. Two different types of steel drums are used: the closed-head or B (Bung type) drums, and the open-head type drums. The latter has a removable head attached to the drum by means of a ring lock with a cellulose or neoprene sponge gasket prohibiting any loss through leakage.

In all cases where the preservation of color is important and metallic contamination has to be avoided, lined drums are used to ship fatty acids. The linings are mostly of the phenolic or "Epon" resin type or a mixture of both and they protect the shipped fatty acid from discoloration and contamination.

Drums of aluminum or stainless steel can also be expected to offer excellent product protection, but because of the expense factor, may require a deposit charge. They are not subject to the possibility of physical damage to the lining, as is the case with lined drums.

The standard size of both types of drums used in the shipment of fatty acids has a net content of approximately 55 gallons. As most fatty acids weigh about 7.5 pounds per gallon, a net weight of approximately 410 pounds may be shipped in one drum.

The tare weight of steel drums of this size is around fifty pounds.

STORAGE OF FATTY ACIDS

Bag Storage. The saturated fatty acids available in flake or bead form are subject to little or no deterioration under normal conditions. They should be stored in a clean, dry warehouse or building, however, since the bags are readily subject to atmospheric deterioration if stored in the open. The bags should not be stored next to radiators, or hot pipes nor on hot floors or in areas where temperatures exceed the melting points of the acids. Care should also be exercised to prevent tearing the bags during handling. If lift trucks are available the bags can be readily handled or stored on pallets. If bags are stacked more than six high it is generally desirable to tie the individual stacks together with boards or pallets to prevent toppling of the piles. Despite the stability of the flaked or beaded acids, it is advisable to warehouse the bags in such a manner than the oldest inventory is used first.

Drum Storage. Fatty acids in drums may be stored in outside areas if necessary, but inside storage is much preferred if the acids are to be stored more than a week or two before being used. Outside storage will tend to obliterate drum markings and rust the drums. Where the contents of the drums are subject to alternate surface liquefaction and solidification due to continued reheating by the sun's rays, there may be some tendency toward color deterioration, particularly on the surface and around the sides. It is by far the best practice to store drums of fatty acids under conditions of reasonably constant temperature.

The full open head, leverlock drums generally used for semisolid fatty acids should, so far as possible, be handled in the upright position. Regular drum hand trucks or mechanical lift trucks make vertical handling easy. If it is necessary to handle drums in the horizontal position, care should be taken in lowering the drum from the vertical position not to allow the

drum to fall on the cover closing ring since that can dislodge the cover gasket and cause leakage of liquid acids.

Fatty acid drums should always be stored in the vertical position. If drums are stacked, pallets or boards should be placed between each two tiers to prevent toppling and to protect the drums against unnecessary damage.

Solidified fatty acid drum stocks should be melted before use to insure uniformity. Since fatty acids are poor heat conductors it is necessary to avoid localized overheating conditions. Drum stocks should be warmed in a hot room or on a drum heater. Electric drum mantles may also be used. Care should be taken to loosen bungs prior to heating. So long as localized overheating is avoided, the color degradation from heating will be negligible. If the stock is withdrawn in increments of such magnitude that a whole drum will be consumed within a matter of a day or two, it is better to maintain the drum in a melted condition rather than to remelt the contents several times. The temperature at which such melted stock should be maintained is approximately 5-10° C over the titer point.

Bulk Storage. Fatty acids in bulk are successfully stored in certain synthetic resin-lined steel tanks, glass-lined steel tanks, aluminum tanks, stainless steel tanks and reinforced plastic tanks. Cypress wood tanks may be used, although the dehydrating effect of fatty acids presents a continuing maintenance problem.

Synthetic resin-lined tanks are satisfactory at temperatures below the maximum levels recommended by the manufacturers. Alkalies should not be used in cleaning resin-lined tanks.

Glass-lined tanks are entirely resistant to attack by fatty acids, but the brittleness of the glass lining can present a maintenance problem. Use of second-hand glass-lined tanks obtained from the brewing industry has not proved satisfactory.

Aluminum tanks (alloy 3003) are entirely satisfactory for fatty acid storage, provided no moisture or mineral acidity is present. Of course, they must not be cleaned with alkalies.

Stainless steel tanks are the most versatile since they are both fatty aicd and alkali-resistant. Types 304 and 347 stainless steel are resistant to fatty acid corrosion at normal storage temperatures and up to 200°F. They can be used in the form of solid stainless steel tanks, stainless steel clad tanks or light gauge stainless steel backed with a cradle of structural steel.

Fiber glass reinforced epoxy or polyester resin tanks are being increasingly used for fatty acid storage.

Tanks can be vertical or horizontal, round or rectangular, to best suit available space. When removing contents from the tanks, agitation should be applied to maintain product uniformity. This can be provided by mechanical agitators, by sparging with inert gas or by circulating the tank contents with external pumps.

In designing tanks for storage, it is good practice to provide storage for one and one half (1½) times the quantity usually purchased. Thus, if one purchases 8,000-gallon tank cars, it would be well to construct a tank with a holding capacity of 12,000 gallons. Usually the most economical tank to construct is one with an L/D ratio of 1:1. However, the exact dimensions are best worked out with the fabricator based on sheet length and width available. Cylindrical tanks are usually best because they permit the use of thinner shell sections. Cone bottom or disc bottom tanks permit easier

(Half-Tone)

(Aluminum storage tank of 1,000,000 lb capacity constructed of 3/8 in. and 1/2 in. sheet aluminum (3003) directly on a concrete base. The bottom slopes to one side to facilitate drainage.)

(Half-Tone)

(A group of 12,000-gallon aluminum holding tanks mounted on structural steel supporting frames. The tanks have shallow cone-shaped bottoms, are covered and equipped with stainless steel heating coils. This size tank is recommended for 8,000 gallon tank-car purchases.)

and more complete drainage though flat bottom tanks will give more capacity, where head space is a factor.

Heating coils should be constructed of type 316 stainless steel. Aluminum can be used for coils, but the mechanical properties of aluminum tubing are such as to invite higher maintenance than will be encountered with stainless steel.

Care should be taken not to overheat fatty acids. It is advisable to limit the temperature of heating surface in contact with fatty acids to avoid discoloration and other objectionable effects.

Tank heating can be accomplished by the use of built-in pipe coils, plate coils or dimpled jackets, utilizing hot water or low temperature steam, by circulating the liquid or semiliquid fatty acids through external heaters or by external heating coils. External heating coils are usually spaced between the tank supports of vertical tanks and along the bottom outside one-third of the circumference of horizontal tanks. The external heating coils should not be allowed to come in contact with the tank proper and it is desirable to insulate tanks heated in this manner since this indirect heating is rather slow. Successful installations have been made by setting the tank on a concrete slab in which heating coils have been imbedded.

Indoor tanks maintained in a temperature-controlled "hot room" can eliminate the need for heating coils.

Some bulk users of fatty acids employ inert gas (carbon dioxide, nitrogen or mixtures of the two produced from combustion gases) to blanket the fatty acids and protect them from air oxidation. However, this is necessary only where color sensitivity of the product is critical. When inert gas is used, provision should be made to prevent excess pressure build up when the tank is being filled or creation of vacuum when the tank is emptied. The blanketed tanks should also be thoroughly aerated and workmen provided with proper safety equipment before the tanks are entered for inspection or maintenance purposes.

Temperature Limitations for Stored Fatty Acids

Bulk stocks of fatty acids are best maintained in the liquid phase rather than by remelting periodically as the fatty acids are used. There are no definite temperature limitations for fatty acids in storage, but best results against deterioration of quality are obtained by maintaining the fatty acids at the lowest temperatures at which they are completely liquid and which permit satisfactory handling for the user. Unsaturated fatty acids can generally be handled at maximum temperature of 120° F and saturated acids at maximum temperatures of 150° F. Transfer lines of sufficient length to cause trouble by product freezeups should be steam jacketed, steam traced or heated by electrical tapes.

Fire Protection

Fatty acid fires, like oil fires, are not readily combatted with water alone. Unless complete and instantaneous fogging or flooding is achieved, there is the possibility of spreading fires by the floating of burning fatty acids. Carbon dioxide gas, carbon tetrachloride or finely powdered sodium bicarbonate are effective for small localized fires. Fires covering large areas can best be extinguished with foams.

PROCESSING EQUIPMENT FOR FATTY ACIDS

Piping, Pumps and Valves. Stainless steel and aluminum are the preferred material of construction. Copper and its alloys should be completely avoided if color and odor stability are desired.

Light weight type 304 stainless steel piping is satisfactory for transfer lines, but type 316 is recommended for high temperature (above 250°F) process lines. Connections are best made by welding or flanging, but threaded joints give satisfactory service at ordinary temperatures and pressure. The use of Schedule 5 or Schedule 10 stainless steel pipe and fittings can cut the cost of stainless piping installation appreciably. Stainless steel tubing is also successfully employed. Aluminum (alloy 3003) pipe may also be used, but care should be taken to use welded or flanged joints. Screwed joints are not satisfactory with aluminum piping because of the relative softness of this metal. Steel or copper transmission lines are definitely not recommended except in those cases where metal contamination is not a factor.

Pumping lines should be equipped with steam tracers or electrical resistance tape to avoid solidification of fatty acids in the line. Steam tracing is usually accomplished by wrapping copper tubing around the line. Electrical heating is done with resistance tape either wrapped around the line or run parallel to and adjacent to it. This latter method of heating is relatively new and has the advantage of supplying a uniform and controllable amount of heat throughout the line. Installations can be made using 120 to 480 volts. Cost is approximately $1.50 per foot for ordinary lines. For best performance, steam traced or electrically heated lines should be insulated, particularly for outside use.

Lines should be cleared with steam or compressed inert gas or air upon completion of every pumping. Steaming will, of course, cause some water to get into the fatty acids and it is therefore advisable to provide separate facilities for holding the "blow-out" stock. Aluminum tanks are not recommended for "blow-out" stock because of free moisture present.

Pumps. Centrifugal pumps of type 316 stainless steel, or of such trade alloys as "Worthite" (Worthington Pump and Machinery Company), "Duramet 20" (Duriron Company) or "Ircomet" (Ingersoll-Rand) are recommended. Bronze or monel pumps may be used where metal contamination is not objectionable. Positive displacement pumps such as gear pumps can be used, but should be selected with care because of the tendency of stainless steel to gall where there is metal to metal contact.

When pumping out of a tank car or storage tank, it is desirable to install a strainer ahead of the pump.

Pumps with mechanical seals generally give much better performance in fatty acid service than those with packings. If possible, a positive head should be maintained on the suction side of the pump. Otherwise, the use of two types of stainless, one softer than the other, may be necessary to prevent galling.

Since pumps have a way of being transferred from one service to some other service, it is usually good practice when purchasing a centrifugal pump to buy the motor that is termed non-overloading, i.e., a motor with sufficient horsepower to handle the load imposed on the pump when it is pumping maximum capacity at minimum head. This motor will usually be found within one or two sizes of the motor required for the job. The additional cost is well worth the versatility obtained.

Valves. "Ni-Resist" (International Nickel Company) and "Causul" Metal (Lunkenheimer Company) valves with stainless steel trim are very satisfactory for handling fatty acids at ordinary temperatures (up to 250°F). For high temperature applications, valves should be of type 316 stainless steel, "Worthite," etc.