Alternatives for Processing of Soapstock

J.B. WOERFEL, 141 McGuire Cove, Clarksdale, MS 38614

ABSTRACT

Soapstock is a valuable byproduct from the alkali refining of edible oils. Methods of processing at the refinery to make it suitable for use as an animal feed ingredient or for further industrial processing are discussed. Utilization as a feed fat and as an industrial raw material are reviewed.

Soapstock is the byproduct from the alkali refining of vegetable oil. It consists of soap, neutral oil, gums and extraneous material such as meal fines which are in the crude oil. The quantity and composition depend upon the type and quality of the crude oil and the refining conditions. The aim of an efficient refinery is quantitatively to remove the gums and free fatty acids with minimum loss of neutral oil. The amount of soapstock generated may be from 3 to 20% or more of the crude oil and contain from 10 to 40% total fatty acids (TFA).

Since soapstock constitutes a significant portion of the crude oil, it is necessary that it be recovered and utilized in the most cost effective manner. Any unrecovered material which is discharged into the plant waste water can add greatly to the cost of waste water treatment. This must be considered in the evaluation of any soapstock treatment system.

Raw soapstock, especially that from miscella refining, may be returned to meal in the desolventizer/toaster if the refinery is a part of an extraction plant. The feasibility of shipping raw soapstock to another location is limited by the high water content which increases freight cost and causes the soapstock to ferment quickly. As a result, the initial processing of soapstock is commonly done at the refinery, and the resulting product shipped as acidulated soapstock.

Raw soapstock is somewhat difficult to handle. When the TFA concentration is above 30%, it solidifies readily when cooled so it is necessary to have heated tanks and lines to maintain temperatures above 60 C. On standing in a tank, it may separate into two phases with an essentially water layer settling to the bottom. If heated to boiling, it has a pronounced tendency to foam, especially if from non-degummed oil high in phosphatides.

Traditionally, soapstock acidulation has been done in a batch process. Soapstock is charged to a corrosion resistant tank. Wooden tanks fitted with copper or bronze coils are still used, although more recent installations are likely to be monel metal, carpenter 20 CB stainless steel or fiberglass reinforced plastic (1,2). Typically, sulfuric acid diluted to ca. 10% is added in excess to the soapstock charge and the mass is boiled with sparge steam for 2-4 hr. The tank is then settled and the acid water layer drawn off. The acid oil is water washed by adding 25-50% water, boiling for a short time and settling thoroughly. After drawing off the water layer, the acidulated soapstock will be stored or shipped in steel tanks. Detailed practices may vary considerably from plant to plant and even from charge to charge.

The acid waste water is high in biochemical oxygen demand (BOD) and low in pH. However, when properly treated to adjust the pH and remove immiscible materials it is readily biodegradable, and does not present a problem in a properly designed treatment facility (3).

If the raw soapstock can be handled promptly it may be processed directly in a soap kettle where it is completely saponified and purified to make industrial soaps.

CONTINUOUS ACIDULATION

Several processes have been developed for continuous acidulation of soapstock. One such process (Fig. 1) which is currently being practiced on soapstock from degummed soybean oil has been patented by Bloomberg and Hutchins (4).

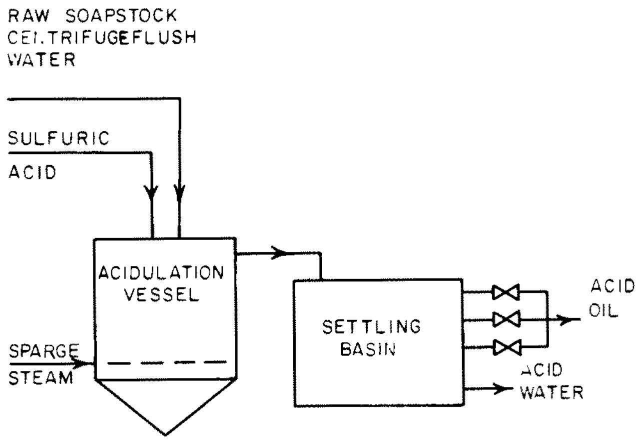

FIG. 1. Continuous acidulation of degummed soy oil soapstock.

A mixture of soapstock and centrifuge flush water is delivered at a controlled rate into an acidulation vessel together with a metered stream of sulfuric acid to bring the pH to 1.5-2.0. The vessel is designed so that the contents are both mixed and heated with sparge steam to ca. 90 C. The mixture constantly overflows into a settling basin. In the settling basin the acid oil floats to the top and the acid water settles to the bottom. A series of valves at different levels are provided for drawing off the acid oil. The acid water overflows through a standpipe which maintains the level in the settling basin. This process has been in successful use for several years. It is limited to use on soapstock from oil which has been thoroughly degummed, since even small amounts of gums create emulsions which will not separate.

De Smet offers a process (Fig. 2) which is made continuous by providing three reactor tanks in parallel. Each tank is charged successively. The sequence of acidulation, water washing and decanting is performed in each vessel. The acid layer from one vessel may be mixed into the soapstock charged to the next vessel to economize on acid usage.

The continuous acidulation process (5) described by Braae (Fig. 3) removes the bulk of the acid water by decantation. Wash water is added to the acid oil and the water and solids removed by centrifugation in a self-cleaning separator. This also describes the use of a surfactant, 50-

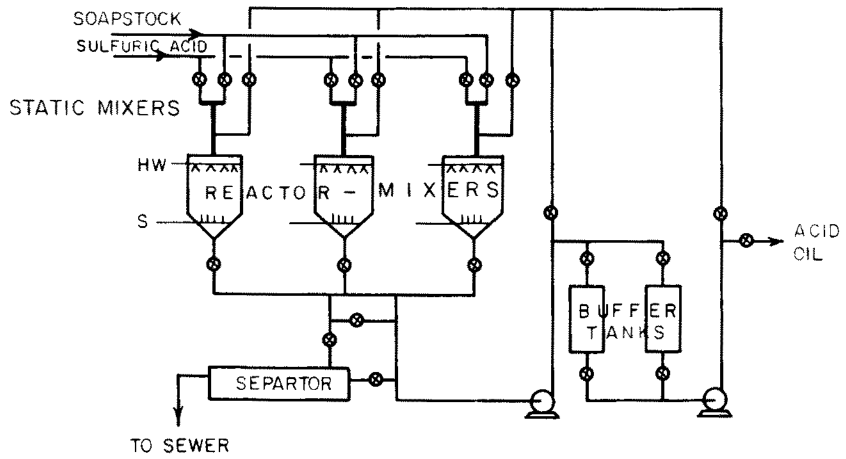

FIG. 2. Continuous soapstock acidulation (De Smet).

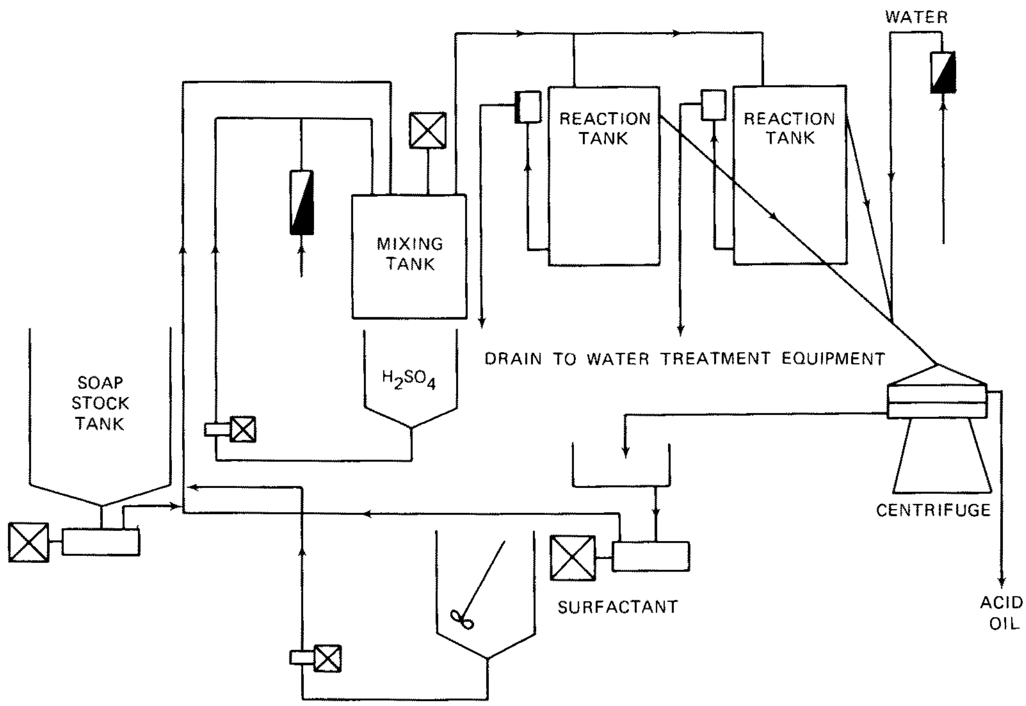

FIG. 3. Continuous acidulation (5).

100 ppm ethylhydroxyethylcellulose, to break emulsions.

Another continuous acidulation process has been described by Crauer (6). In this process, continuous centrifugation is used to separate the acid water and acid oil. It is claimed that this reduces the fat content of the acid water to less than 0.4% and the acid water stream is improved over the batch process in higher pH, lower fat and BOD. A further process step to neutralize continuously with lime and clarify the acid water centrifugally is said to reduce the BOD 62-76%, remove 80-95% of invert sugars and all of the fat.

Morren describes continuous acidulation (7,8) as shown here (Fig. 4) using a Podbielniak centrifuge. Residual TFA in the acid water is reported as .03-.74 for different types of oils.

The use of centrifuges for separating acid oil and acid water in continuous soapstock systems has not been widely accepted in the USA. This is apparently due to the expense of the equipment and severe corrosion problems inherent in the process.

A particularly interesting development was described by Mag and coworkers (9) (Fig. 5). In this work, they have adopted a practice from petroleum oil/water separation technology. After decanting, the acid water is passed through a fiberglass bed coalescer, and then to a smaller decanter tank. Fatty material concentrations of the acid

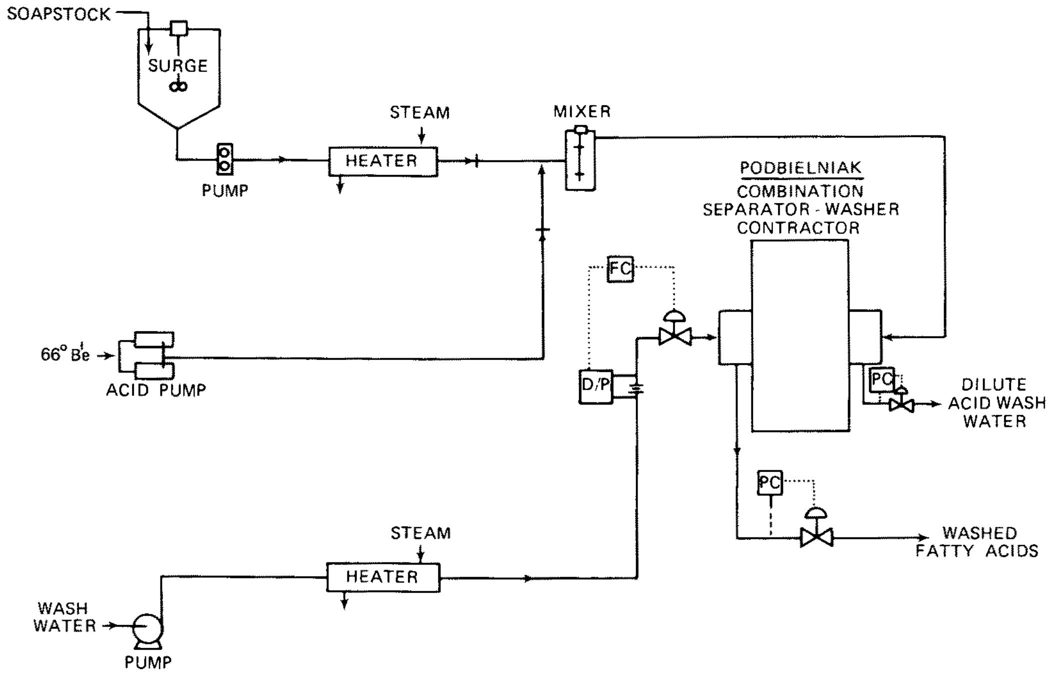

FIG. 4. Continuous acidulation using Podbielniak equipment (7,8).

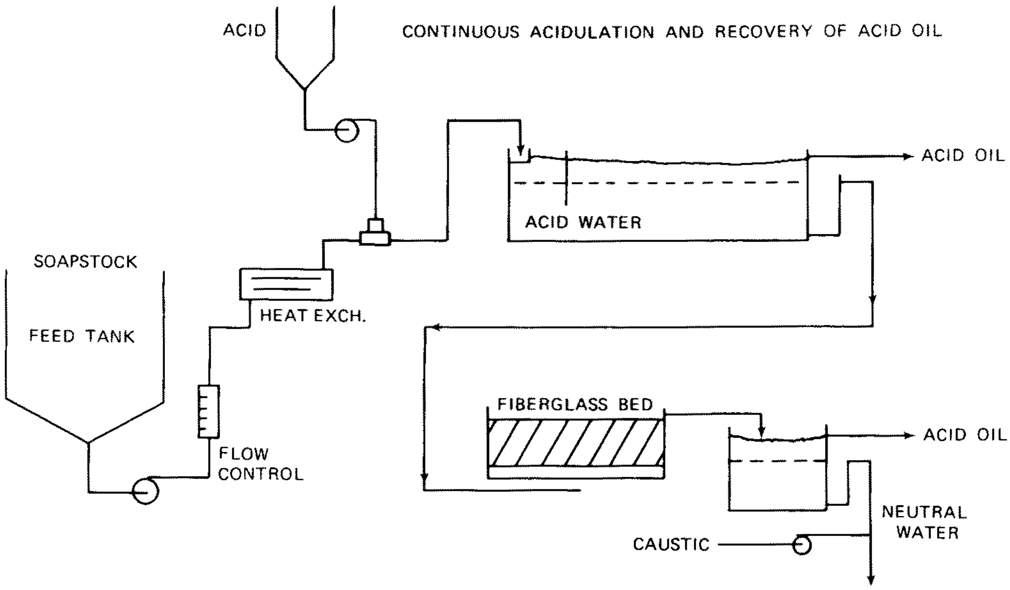

FIG. 5. Continuous acidulation and recovery of acid oil (9).

water of less than 150 ppm can be achieved. The acid water is then neutralized for discharge to municipal sewers.

DRYING OF SOAPSTOCK

While the acidulation of soapstock by the various processes described offers a feasible means of recovering acid oil, even under the best circumstances the acid water requires considerable treatment to reduce fat and BOD to acceptable levels. Although this effluent is readily biodegradable, treatment facilities are expensive to construct and operate. In an effort to eliminate the waste stream completely the drying of soapstock has been developed.

Patents (10,11) for drum drying of soapstock for addition to poultry feed were issued to workers at Central Soya. It has been reported that the product was dusty, hard to handle and hygroscopic.

More recent work has been done by the USDA and was reported at the 2nd ASA Symposium on Soybean Processing in June 1981 (12). Soybean soapstock was neutralized with sulfuric acid and dried under vacuum in either a natural circulation-evaporator or a scraped film evaporator. The product was a wax-like solid at room temperature and contained between 54 and 71% TFA. When made from nondegummed soybean oil, a high level of carotene and xanthophyll was retained.

This neutralized dried soapstock (NDSS) was tested in feeding studies with both broilers and laying hens using animal-vegetable commercial feed fat as a control. In the broiler study, there were no significant differences in body weight or feed conversion between the NDSS and the control, but the shank pigmentation score of the broilers fed NDSS was significantly greater. In the tests with layers there was no significant difference between treatments in body weight, egg production, feed per dozen eggs, feed consumed, cholesterol level of serum or yolk or lipoprotein level. However, egg yolks from the NDSS diet were significantly deeper yellow and higher in xanthophyll than from the controls.

Since pigmentation of broilers and egg yolks is considered desirable in many markets, and feed ingredients are specifically added to the diet to achieve pigmentation, the NDSS may have enhanced value.

Cattle feeding tests indicated that it would be a suitable feed ingredient for steers and dairy cattle.

It has been reported that two US refiners are processing soapstock by neutralization and drying. A commercial NDSS process is being offered using a Votator turbofilm process as illustrated in Figure 6.

Soapstock is neutralized to pH 7.0 and moisture is evaporated at 190 mm Hg absolute in a swept surface evaporator. It is stated that foaming can be controlled by close pH monitoring proper operating pressure and adjustment of heat exchange conditions.

Another process designed for desolventizing miscella soapstock is shown in Figure 7. The soapstock is heated and neutralized with sulfuric acid. It is then fed to a multipass forced-circulation evaporator. Water and hexane are removed as a vapor while the soap mass is recirculated through the evaporator at a high flow rate. Finished soapstock contains 2.5% water and a maximum of .5% hexane, and is readily pumpable at 60 C. Water and hexane vapors are condensed, separated by decanting and the hexane returned to the plant system.

REFERENCES

1. Rice, E.E., JAOCS 65:754A (1979).
2. Duff, A.J., Ibid. 53:370 (1976).
3. Watson, K.S., and C.H. Meierhoff, Ibid. 53:437 (1976).
4. Bloomberg, F.M., and T.W. Hutchins, U.S. Patent 3,425,938 (1969).
5. Braae, B., JAOCS 53:353 (1976).
6. Crauer, L.S., Ibid. 47:210A (1970).
7. Todd, D.B., and J.E. Morren, Ibid. 42:172A (1964).
8. Morren, J.E., U.S. Patent 3,428,660 (1981).
9. Mag, T.K., D.H. Green and A.T. Kwong, Presentation at the 73rd AOCS annual meeting, Toronto, 1982.
10. Witte, N.H., and E. Sipos, U.S. Patent 2,929,714 (1958).
11. Kruse, N.F., and W.W. Cravens, U.S. Patent 2,929,525 (1960).
12. Beal, R., Presentation at the 2nd ASA Symposium on Soybean Processing, 1981.

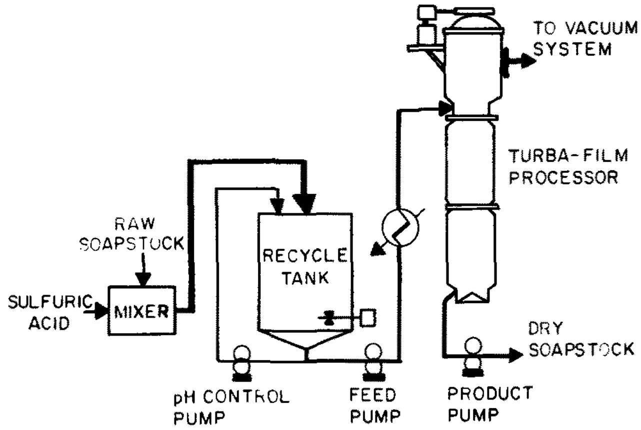

FIG. 6. Soapstock drying Votator.

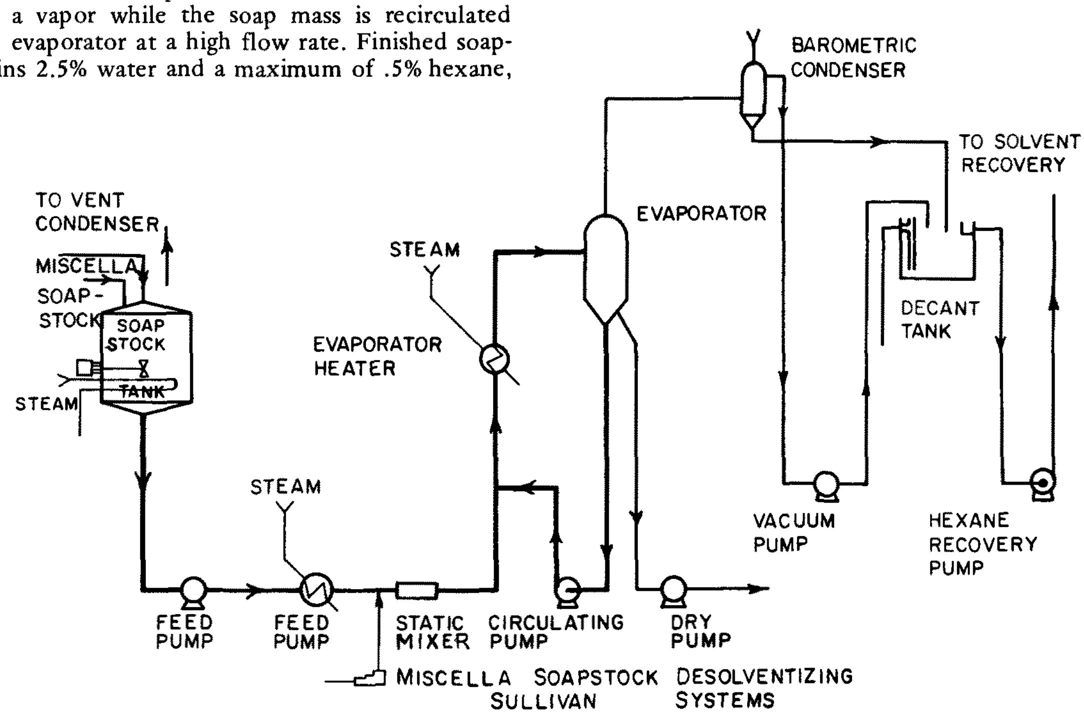

FIG. 7. Desolventizing miscella soapstock.