Decolorization of Tallow by Liquid-Liquid Extraction With Propane


The application of liquid-liquid extraction to glycerides using propane as a solvent has recently become a commercial reality. A unit for the decolorization of crude tallow is now in successful operation at the Lever Brothers Company plant in Baltimore, Md. The unit was designed and erected by the M. W. Kellogg Company of New York City and has a capacity of over 200,000 pounds a day.

The present process is the outgrowth of earlier work in the petroleum industry dealing with the removal of asphalt from heavy oils. The process proved very useful in the solution of this problem. A logical sequence of this success was to find new applications for the process. The installation of the commercial tallow decolorization unit at Baltimore is a result of this effort. Experiments conducted in the M. W. Kellogg Company laboratory at Jersey City, N. J., demonstrated that a crude tallow having a color of 37-45 F.A.C. could be processed by liquid-liquid extraction in propane solution to yield a finished product having a color of about 7-11 on a 5-10 inch Lovibond column. In September 1946 experimental work was begun in the newly constructed pilot plant at Cambridge, Mass., under the supervision of the research department of Lever Brothers Company. Here many of the operational factors which influence the decolorization of tallow were studied.

Propane is an odorless gas at atmospheric pressure and room temperature. It is abundant in the gases liberated in the crude oil fields and in the gases produced during the process of refining petroleum. It is readily liquefied by compression. For use in the decolorization of tallow it is necessary that it be free of mercaptans and other odoriferous compounds which tend to concentrate in the decolorized tallow.

Pure propane boils at --44°F. under one atmosphere of pressure and has a critical pressure of 643 pounds absolute at 212.5°F. At 70°F. the gage pressure of saturated propane is 110 pounds while at 100°F. it is 174 pounds. The specific gravity of propane varies from 0.50 at 70°F. to 0.25 at 212°F. Surface tension and viscosity measurements decrease to nearly negligible values just below the critical temperature. As liquid propane approaches its critical temperature, it becomes highly compressible.

Gaseous propane is heavier than air. Its molecular weight of 44 corresponds to that of carbon dioxide. It is of course highly flammable and has an explosive range with air of 2.37-9.5% by volume. Because of these properties care must be exercised to prevent its accumulation in sumps, drains, and other depressions where it might collect and create a hazard. One property of liquid propane which can also be a hazard is its refrigerating ability. Care must be taken to avoid personal contact with liquid propane since its evaporation to a temperature of --44°F. can cause a "burn" similar to that caused by dry ice. Breathing propane vapors may result in dizziness if continued over a moderate length of time. Among its desirable qualities are its stability, non-corrosive nature, and low cost.

Plant

The major process equipment of the propane plant is located out-of-doors. The ground area around the tower and its accessory equipment is covered with a concrete mat. To the east of the tower is a building which houses the tallow storage tanks, the tallow and product pumps, the propane pump and propane compressor, and the control instrument room. To the west of the tower is the water cooling tower and the water circulating pump house. This latter building also houses the water chlorinator. Several hundred feet north of the tower and plant buildings is the 125-foot high blowdown stack to which propane gas may be vented in an emergency. At a nearly equally distant point in the same general direction is the unloading station for the propane and an 18,000-gallon propane storage tank. Liquid propane is normally pumped to this tank as received and is withdrawn to the working propane supply tank as required.

All equipment is grounded and sprinkler and gas detecting systems have been installed. Portable gas detectors are available for checking gas leaks or the presence of gas in supposedly gas-free vessels. Special automatic shut-off valves have been provided at the outlet of the working propane supply tank and at the top and bottom of the fractionating column. These valves will automatically shut off the flow if a major break occurs in the piping system in which they are installed. Flood and mist fire protection nozzles protect the tower and surrounding outside equipment. Grinnell “H.A.D.” heads located strategically about the plant actuate a trip valve located within the tallow tank room and, in the event of fire, flood the otherwise dry fire protection lines with water. Wet sprinkler heads of the conventional type are installed in the heated buildings. An emergency steam turbine-driven electric generator is located in the water pump room. This generator automatically trips on power failure and furnishes sufficient power to light important areas of the plant and operate the control instruments on the panel board so that an orderly shutdown may be effected, if required.

The practice of color-coding lines and equipment has been followed at this plant. Propane lines are orange; stock lines, dark green; steam, aluminum; fire protection, red; air, black; water, light green; and vacuum, white. Steam lines are banded with a stencil L.P. for low pressure and H.P. for high pressure. This coding of lines has been very helpful, particularly to new operators following the course of any particular line in the maze of piping which is encountered.

The process equipment utilizes a considerable proportion of type 316 stainless steel, either as stainless-clad for the tower, strippers, etc., or entirely stainless, such as piping for overheads. In general, all metal contacting decolorized tallow after leaving the tower is 316 stainless steel. Liquid and gaseous propane lines and vessels are carbon steel. The tal-
low feed tanks are carbon steel while the finished product tanks and lines are aluminum. Lines used for tallow, tallow bottoms, water, etc., have been rather heavily steam-traced, using copper tubing, to prevent freezing during winter conditions. It was necessary to steam-trace liquid gage glasses on the flash drums and strippers, etc., and insulate them well since the slight internal liquid movement proved insufficient to prevent solidification of the tallow in severe weather.

**Process**

The plant was originally designed to decolorize 300,000 pounds of crude tallow per stream day at a propane ratio of 10:1. The decolorized overheads product was to amount to 97% of the tallow charged to the unit while the remaining 3% was to be withdrawn as bottoms. The bottom fraction was to be rerun at a 50:1 propane ratio and 50% of the charge was to be recovered as overheads while the residue was to be withdrawn as final bottoms. The recovered overheads were to be blended with fresh crude stock and rerun.

Under present conditions of operation the primary bottoms are not rerun since it is uneconomical to do so. A propane-to-tallow ratio of 17:1 is employed rather than the 10:1 design figure. Finished product yields are approximately 98% of the crude feed.

Basically the process is very simple. It involves the pumping of the tallow and propane to a tower in the correct proportions and the subjecting of the mixture to the proper conditions of temperature and pressure, causing the color bodies to fall to the bottom while the tallow-propane solution rises in the tower. The bottoms phase containing the color bodies, or bottoms, as the tallow-propane solution rises in the tower, contains the bulk of the color bodies, water, dirt, and some glycerides heavy and is withdrawn from the column in such a manner as to fix the lowest temperature in the lower portion of the tower and a somewhat higher temperature at the top of the tower. If this temperature differential, or gradient as it is usually termed, is correctly chosen, there will be a precipitation of the color bodies, or bottoms, as the tallow-propane solution rises in the tower. The bottoms phase consisting of color bodies, water, dirt, and some glycerides is heavy and is withdrawn from the column in combination with approximately one volume of propane. The continuous phase, which is withdrawn from the top of the column, contains the bulk of the propane charged to the system and the decolorized overheads. The pressure in the tower is normally held at 465 psig. It is controlled by a Brown pressure recorder controller, which maintains the required air pressure on a control valve in the overheads line.

If for any reason the tower pressure becomes excessive, a high pressure alarm will sound a howler.