Jaocs news feature

Deodorizing system modification for heat recovery and steam refining of palm oil[1]

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With continuous deodorizers of the double shell type most of the steam normally used to preheat the feedstock in the deaerating section can be saved by a modification—the essential feature of which is the addition of a heat recovery section located between the final deodorizing section and the cooling section, by means of which heat is transferred from the hot deodorized oil to the feedstock. Consistent with the principles of the original design, no pumping or piping of hot oil outside the deodorizer is required. Continuous deodorizers of the stripping tray type can be modified for "steam refining" or "stripping" of high free fatty acid palm oil to reduce the free fatty acids to 0.03% max. This is accomplished by means of additional trays in the stripping sections of the deodorizer. The capacity, sparge steam, temperature, vacuum and retention time remain the same as with normal deodorization.

Heat recovery

The cost of deodorizing edible oils can be reduced by countercurrent heat exchange, which will reduce the amount of steam required for heating.

Modern deodorizing systems are designed to produce quality products by deaerating, heating, steam stripping and cooling the oil inside a vessel designed to prevent any air from contacting the oil during deodorization. A deodorizer modified for heat recovery must retain these basic design features.

Figure 1 illustrates a typical deodorizing system; feedstock at 120 F is pumped into the deaerating section, which consists of a series of passages formed by baffles and provided with pipe coils for steam heating and perforated pipe for steam agitation. While passing through this labyrinth, the oil is deaerated under vacuum and heated to 300 F.

The deaerated oil flows down to the heating section below which is also constructed with baffles to form a series of passages and is provided with pipe coils for Dowtherm heating and perforated pipe for steam agitation. While passing through this labyrinth the oil is heated to any desired temperature within the range of 400 to 525 F, at which it flows down to the prestripping section below.

The oil is deodorized by passing over a series of stripping trays countercurrent to the flow of stripping steam, which is injected in the bottom of the section.

After prestripping, the oil flows down to the holding section, which consists of a series of baffled passages with perforated pipe for steam agitation. This labyrinth effectively provides a definite retention period for the thermal treatment of all of the oil.

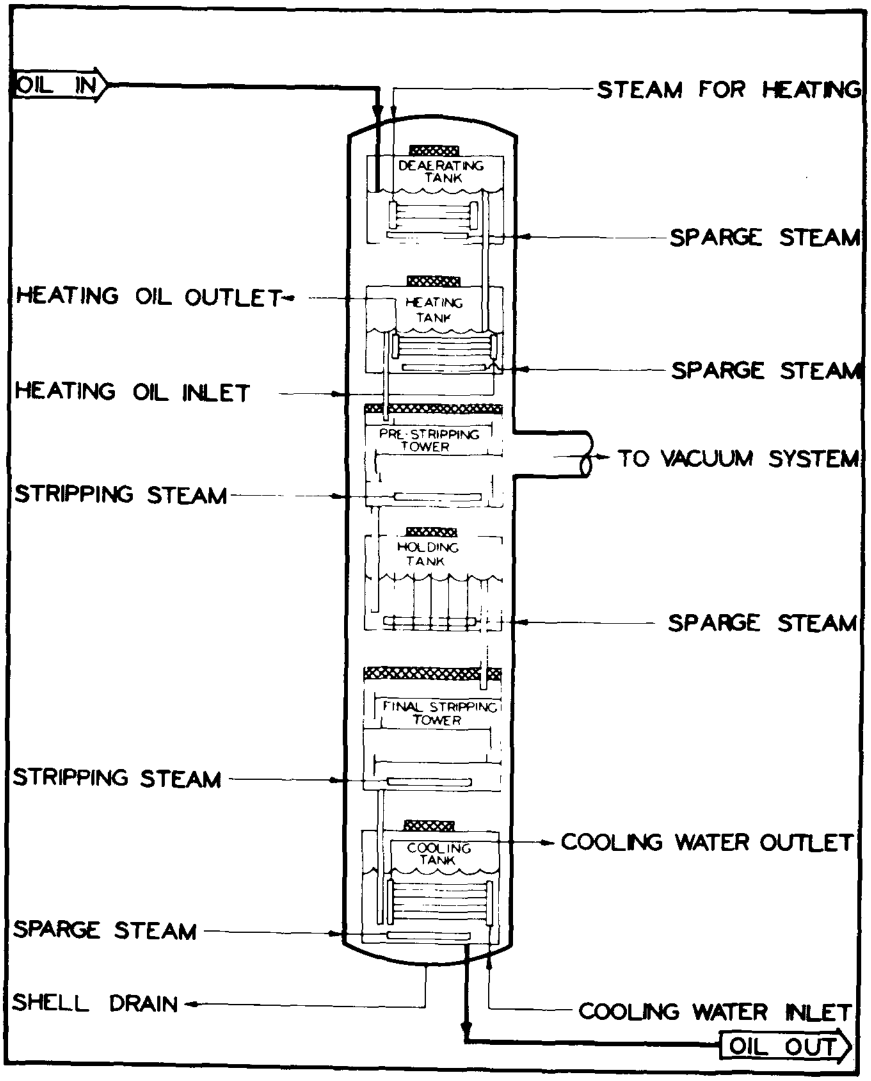


FIG. 1. Continuous deodorizer schematic.

[1]Presented at the JOCS-AOCS Joint Meeting, New Orleans, April 1973.

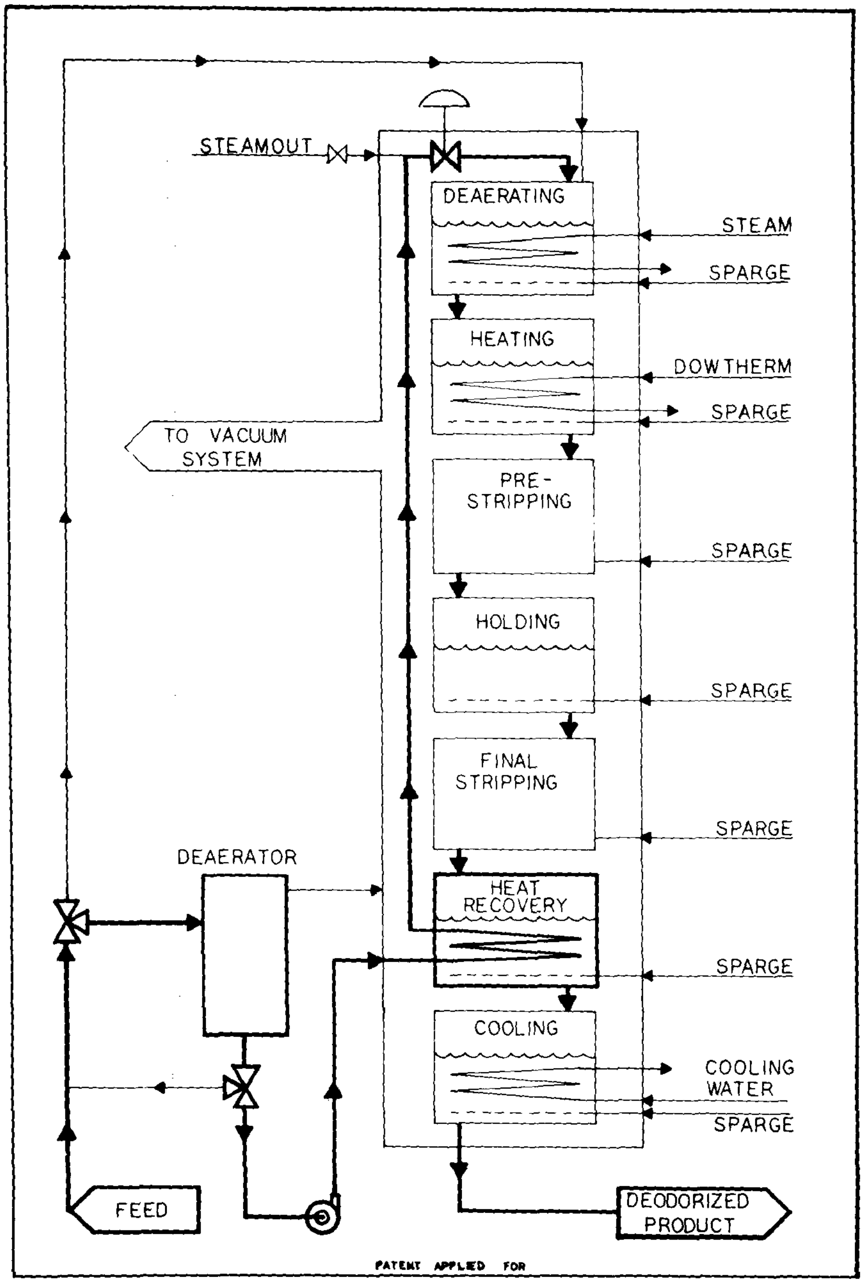


FIG. 2. Deodorizer modification required for heat recovery.

The oil from the holding section is again deodorized in another series of stripping trays, in order to remove any additional odoriferous materials released during the holding period.

The completely deodorized oil flows down to the cooling section, which consists of a series of passages formed by baffles and provided with pipe coils for water cooling and perforated pipe for steam agitation.

The completely deodorized oil discharges from the deodorizing vessel at a maximum temperature of 150 F.

All of the required functions for the deodorization of edible oils take place in stainless steel vessels supported inside a carbon steel vessel designed for an absolute pressure of 6 mm or less. This double shell design makes it impossible for any air to contact the oil during deodorization.

Figure 2 illustrates the deodorizer modification required for heat recovery, which reduces the amount of steam required for deodorization. The steam savings are obtained by means of an additional tank located between the discharge of the final stripping tower and the entrance to the cooling section. The heat recovery tank is fabricated of stainless steel. It contains a series of passages formed by baffles and is provided with pipe coils and perforated pipe for steam agitation to insure maximum heat transfer.

Feedstock at 120 F is pumped into the external deaerating vessel, which is maintained under the same vacuum as the deodorizer to accomplish deaeration of the feedstock. The deaerated feedstock flow is regulated by the liquid level controller and pumped into the heat recovery tank where it flows through the coils and is heated by the hot oil surrounding the coils. The heated, deaerated oil then flows to the top section in the deodorizer and proceeds through the customary deodorizer processing steps.

For normal flow, there will be no steam requirements in the top section of the deodorizer. The usual steam-heated pipe coils are provided for heating the oil at start-up or when changing feedstock.

Supplemental piping is also provided to permit change of feedstock through the heat recovery system without intermixing. When it is necessary to change feedstock the feed pump is stopped and oil in the deaerator is pumped through the heat recovery tank into the top section of the deodorizer. The flow is then reversed and oil remaining in the pipe line and pipe coil is blown with steam into the top section of the deodorizer, thus completely emptying the system.

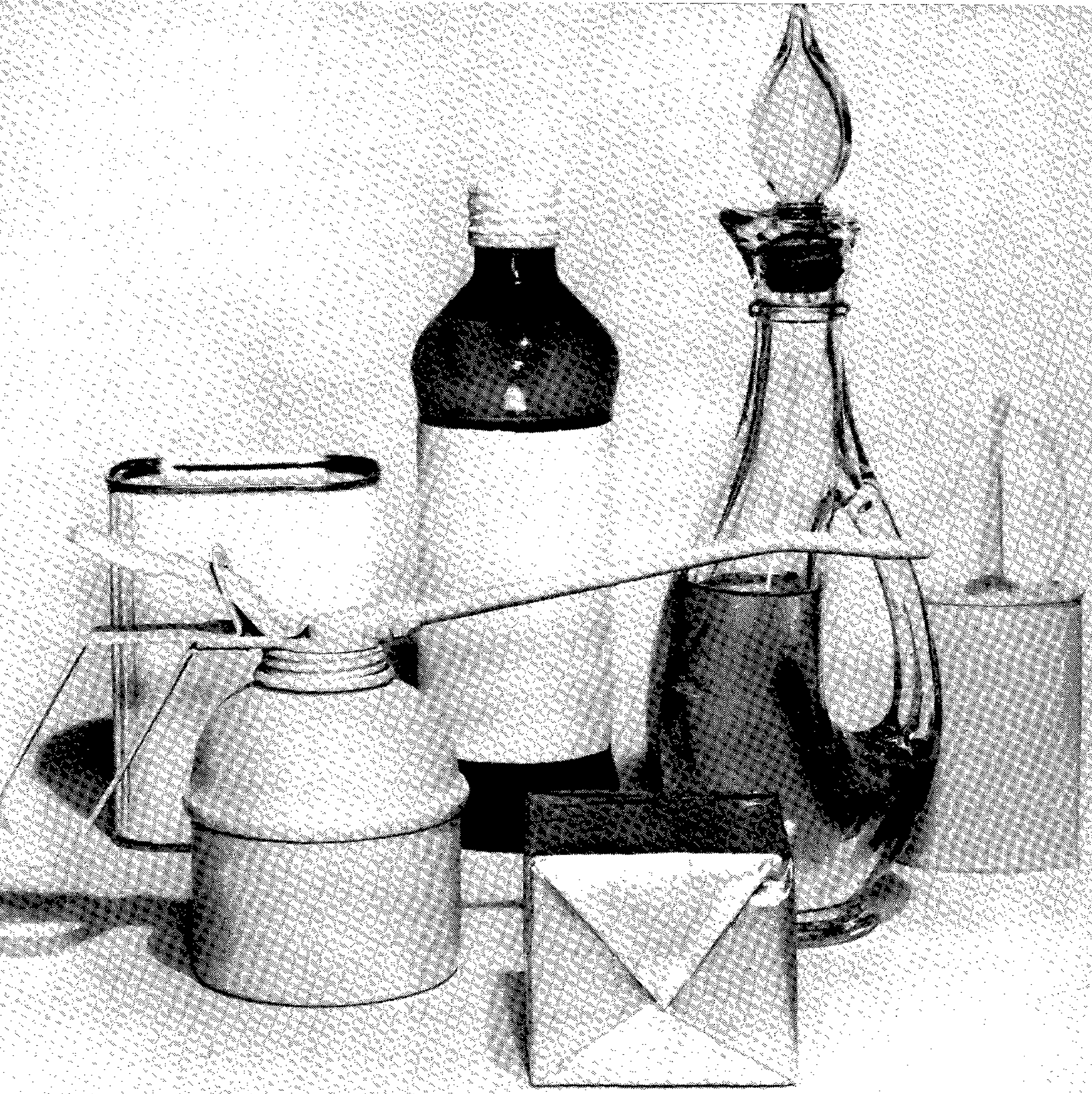
This heat recovery system will save 125 lb steam per 1000 lb oil deodorized and is consistent with the principles of the original design, as hot oil is not piped or pumped outside the deodorizer vessel.

Steam refining

The term "steam refining" refers to the removal of the free fatty acids (FFA) from oil by a distillation process instead of by reaction with an alkali. It has potential application to oils, such as palm, from which all of the nonvolatile impurities can be removed by degumming, clay treating or other means, so that only the FFA and other volatile impurities remain to be removed by steam refining. If such oils have a high FFA, steam refining has potentially lower losses and operating costs than alkali refining, particularly if it is combined with deodorizing. It also affords the possibility of recovering the FFA in good quality and without additional processing, as required by the soapstock resulting from alkali refining.

In order to achieve the full potential of the steam refining process, the system should be designed with the following objectives: (a) reduction of the FFA from the area of 5% to 0.03%, or less; (b) production of a fully deodorized product; (c) operation without substantially higher utilities consumption than a normal deodorizer; and (d) recovery of the FFA from the sparge steam. A fifth objective, implicit in the preceding, is that the refining deodorizer should also be suitable for normal deodorization of the usual salad oils, shortening stocks and margarine oils without sacrifice of product quality or operating efficiency.

Since deodorization is among the



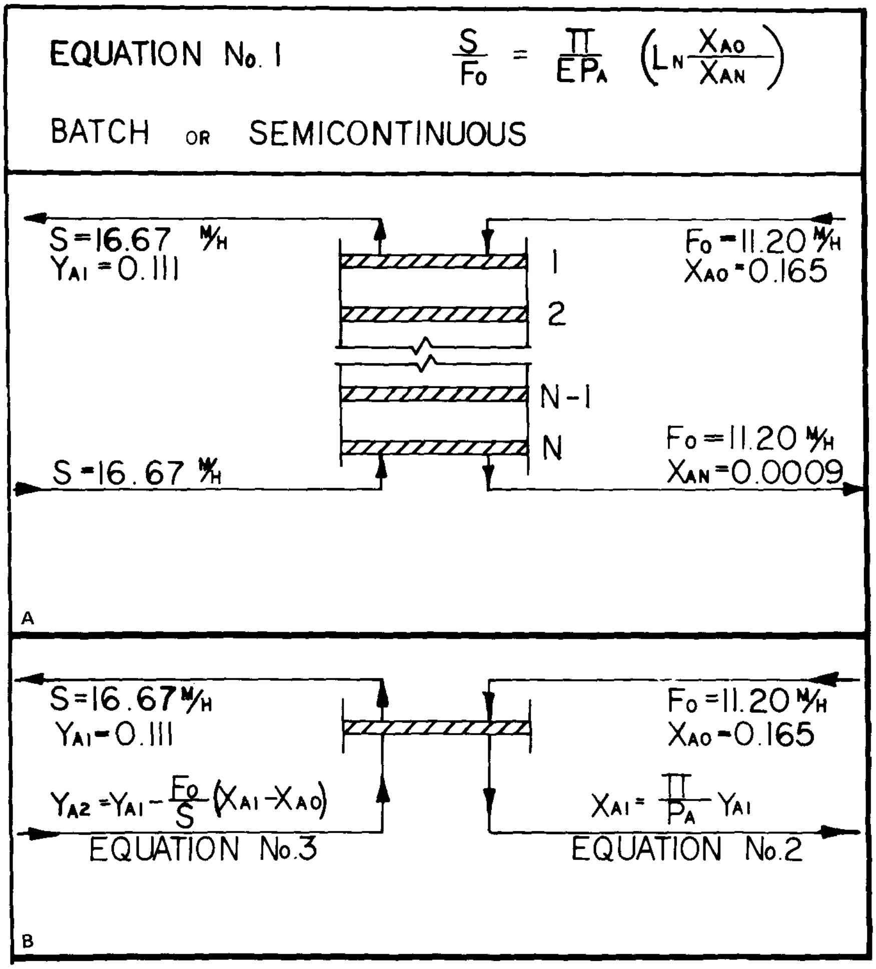


FIG. 3. Fo = oil; S = steam; Π = system pres.; Pa = FA vapor pres.; X = FFA in oil; Y = FA in vapor. A. Continuous tower material balance. B. First stage of continuous tower.

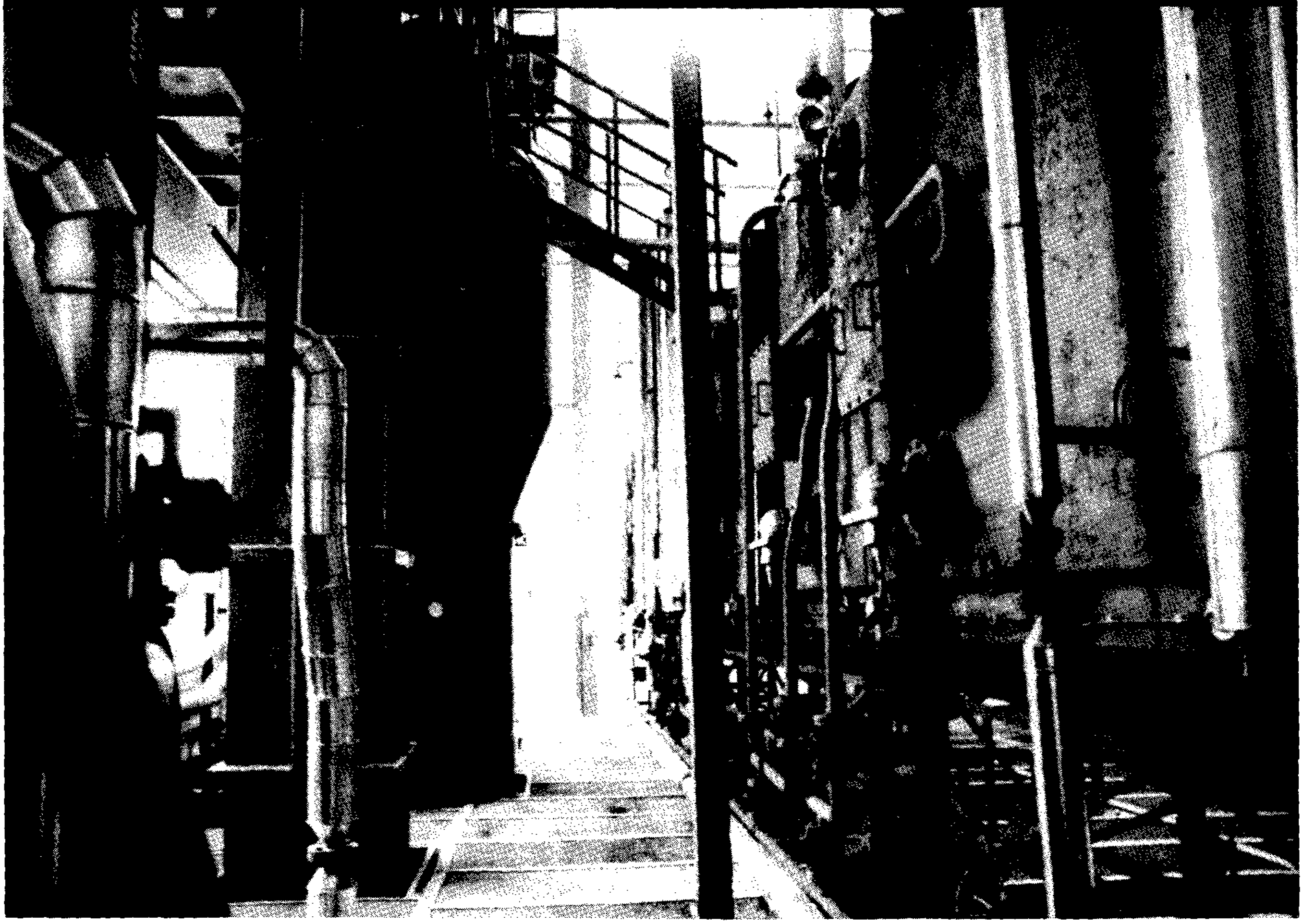
objectives of the design of a steam refining system, one approach would be to start with a well established deodorizing system and modify it as required to produce a refining deodorizer.

If a simple batch type or an automated batch, such as a "semicontinuous," is considered, its modification will be governed by the fundamental principle of equation 1. Assume that the absolute pressure (pi) already is as low as can be economically justified, the sparging efficiency (E) is as high as the designer knows how to make it, the temperature and hence the vapor pressure of the FFA (Pa) is as high as possible without damaging the oil; then, according to equation 1, higher FFA in the feed stock (Xao) will require a higher ratio of sparge steam (S) to oil (Fo). This could be accomplished by sparging at a higher rate for the same period of time as required for deodorizing or by sparging at the deodorizing rate for a longer period of time; but, in either case, the total amount of sparge steam used must be increased in order to remove the higher FFA.

If a continuous staged type, such as a tray tower, is considered, sparging may be fixed at the deodorizing rate and the number of stages increased in order to remove the higher FFA. Figure 3A is an overall material balance. The oil (Fo) enters the top of the tower with an FFA concentration of Xao and leaves the bottom with an FFA of Xan. The sparge steam (S) enters the bottom of the tower and leaves the top with an FFA concentration of Ya1. The problem is to determine the number of equilibrium stages required.

Figure 3B is the first stage in the top of the tower. The oil entering and the vapor leaving are known from Figure 3A. The FFA concentration (Xal) in the oil leaving this stage is determined from equation 2, and the FFA concentration (Ya2) in the vapor entering from equation 3. This procedure is repeated for successive stages and the final stage is that from which the oil leaving has an FFA concentration equal or less than Xan. The equivalent number of actual trays is determined by dividing the number of equilibrium stages by the tray efficiency, which is known from deodorizer experience.

Process description: Figure 4 is a simplified flowsheet of a well established deodorizing system that has been modified for steam refining by means of additional stripping trays and without increasing the amount of sparge steam. The process comprises the following operations: (a) Deaerating-heating–The oil is fed continuously at a controlled rate into the deaerating-heating section, which consists of passages formed by baffles and provided with a tube bundle for heating with Dowtherm or thermal oil and a perforated pipe for steam sparging. While passing through this section the oil is deaerated under high vacuum and then heated to the temperature required for distillation and deodorization, after which it continuously flows down to the steam refining section. (b) Steam refining–The free fatty acids are distilled from the oil by passing over a series of stripping trays countercurrent to the flow of sparge steam, which is injected in the bottom of the section. This section is maintained under the same high vacuum that applies to all sections in the refiner-deodorizer, since it is connected directly to the high vacuum system by means of a vapor pipe manifold that bypasses the other sections. Thus the highest temperature and highest vacuum are applied at the most advantageous stage of the process and the low pressure drop-high efficiency stripping tray design assures maximum utilization of these optimum conditions. (c) Holding–After steam refining, the oil continuously flows down to the holding section, which consists of baffled passages with a perforated pipe for steam sparging. This section effectively provides a definite retention period for the thermal treatment and heat bleaching of the oil, after which it flows down to the deodorizing section. (d) Deodorizing–The oil from the holding section is deodorized by passing over another series of stripping trays countercurrent to the flow of sparge steam, which is injected in the bottom of the section. Full vacuum is maintained on the deodorizing section by direct connection to the vacuum system by means of the vapor pipe manifold. (e) Cooling–The completely deodorized oil continuously flows down to the cooling section, which consists of passages formed by baffles and provided with a tube bundle for water cooling and perforated pipe for steam sparging. While passing through this section the oil is cooled to 65 C, at which temperature it is continuously discharged. (f) Distillate recovery–The distilled fatty acid vapors and sparge steam from the refining deodorizer pass into the bottom of the distillate recovery tower and rise countercurrent to descending films and droplets of cooled liquid distillate. This intimate contact cools the vapor and condenses the fatty acids, which, together with



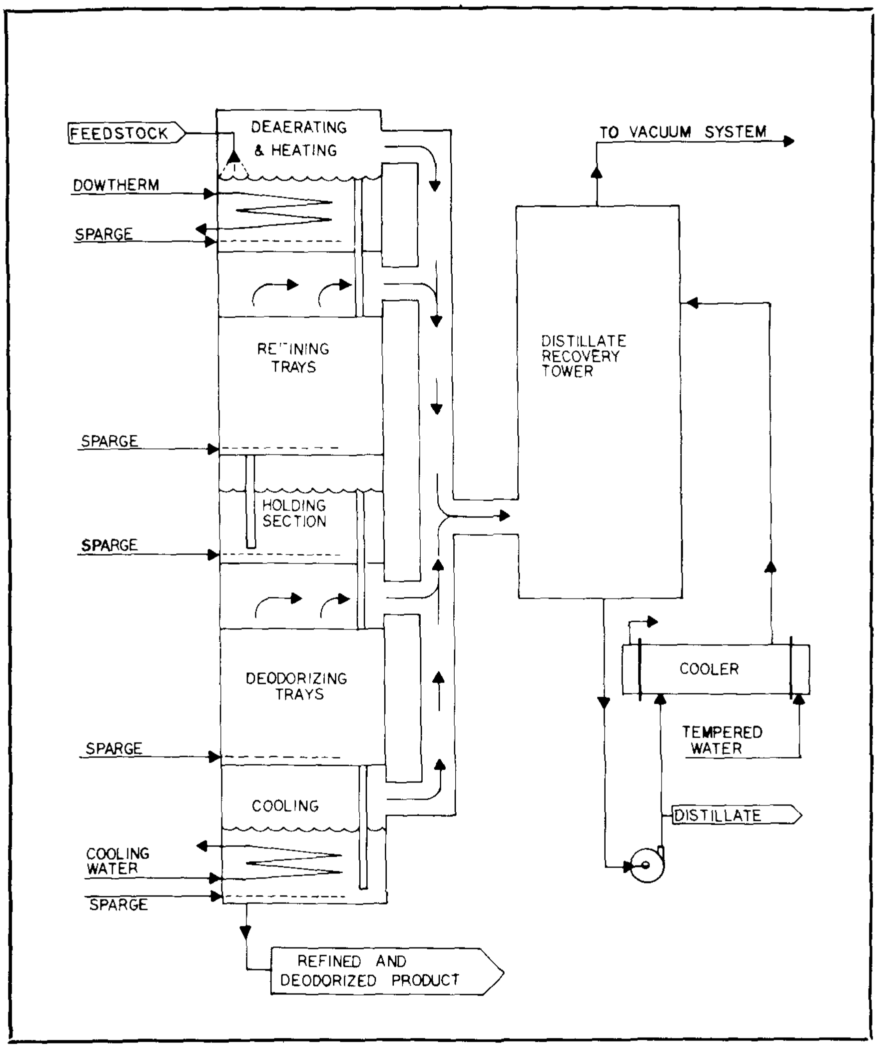


FIG. 4. Steam refining deodorizer.

Utilities Requirements per 1000 lb Feedstock

Deodorizer	Refining	Normal
Steam, 150 psig	300 lb	250 lb
Water, 85 F	4500 gal	3800 gal
Fuel gas, 1000 BTU/SCF	380 scf	380 scf
Electrical power	1.5 kwh	1.5 kwh

the liquid distillate, flow out the bottom of the tower, and are pumped through a water-cooled heat exchanger and recirculated back to a spray in the top of the tower. Since the sparge steam will not condense at the temperature and pressure in the tower, it passes out the top of the tower and is condensed in the vacuum equipment. Accumulations of fatty acids are automatically discharged to storage by means of a level control in the bottom of the tower.

The cooling water for the heat exchanger is "tempered" by recirculation so that all of the water in the exchanger is always at a temperature somewhat higher than the freezing point of the fatty acids.

In the table of utilities requirements in the caption of Figure 4, it can be seen that the refining deodorizer uses only ca. 20% more steam and water than the normal deodorizer. This somewhat higher consumption is caused by the distillate recovery system, which must handle ca. 50 times more distillate than from a normal deodorizer.

This refining deodorizer design achieves the objectives originally set forth: (a) It removes the FFA from high acid oils by means of additional stripping trays without increasing sparge steam, in accordance with well-known and proven design principles. (b) It produces a fully deodorized product and is also suitable for the deodorization of normal feedstocks because it is based on a deodorizer of proven performance to begin with. (c) It operates with only a moderate increase in utilities consumption. (d) It recovers the distillate without further processing.

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de Figueiredo named director of research and development

Mario P. deFigueiredo has been appointed director of research and development, National Portion Control, Inc., a Hershey Foods Company. He also will serve as a member of the NPC Executive Committee.

As director of research and development, deFigueiredo will be responsible for implementing all new product formulations, pilot production, and packaging development. In addition, he assumes the responsibilities of the NPC Quality Assurance Program and for NPC laboratory facilities. He joined NPC in 1973 as a consultant and head of the New Product Development Group.

deFigueiredo obtained his Ph.D. in food science and technology in 1962 from the Massachusetts Institute of Technology, and he also holds a S.B. degree in chemistry and an S.M. degree in food technology from the same institution. In addition, he has an M.B.A. from the University of Chicago. ■

Szuhaj promoted by Central Soya

Bernard F. Szuhaj, a member of the AOCS Finance Committee and currently vice president for the North Central Section, has been promoted to fats and oils research director in the Food and Chemical Research department of Central Soya Company, Inc. He joined Central Soya in 1968 as a scientist.

He holds M.S. and Ph.D. degrees in biochemistry from The Pennsylvania State University where his major areas of interest were in lipid chemistry and bioanalytical techniques.

Szuhaj is a member of the American Chemical Society, Phi Sigma Society, Sigma Xi, and American Association for the Advancement of Science. ■