New Concept for Edible Oil Deodorizers[1]

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ABSTRACT

For many years the double shell deodorizer has been the preferred design, and quality minded refiners have paid a premium price for this type of deodorizer. Double shell deodorizers generally are supplied for capacities of 150-600 metric tons/24 hr. Our objective was to design a deodorizer for capacities of 25-150 metric tons/24 hr with all the process advantages of the double shell deodorizer at a lower capital cost.

INTRODUCTION

Crude vegetable oils produced by screw presses or solvent extraction contain variable amounts of nonglyceride impurities. The accepted practice of processing crude vegetable oils into edible products, such as cooking oil, salad oil, margarine, and shortening, includes the processes of caustic refining, vacuum bleaching, winterizing or hydrogenation, and deodorization.

Deodorization, which is the final step in the processing system, is required to produce an odorless, tasteless product with a low free fatty acid content, light color, and stability against oxidation.

Deodorization is essentially a process of steam distillation, whereby odoriferous, flavored substances are stripped from the relatively nonvolatile oil. The operation is carried out at high temperature to increase the volatility of the odoriferous components. The application of reduced pressure during the operation protects the hot oil from atmospheric oxidation, prevents undue hydrolysis of the oil by the steam, and greatly reduces the quantity of steam required.

Flavor and odor removal generally parallels free fatty acid removal; if an oil has an initial free fatty acid content of 0.10%, the disappearance of noticeable flavor and odor usually will correspond to a reduction of the free fatty acid content to 0.02-0.04% (1).

Operating variables, such as temperature, pressure, amount and time of steaming, and deodorizer design affect the quality of the finished product. The temperature of deodorization affects the steaming rate and time. The amount of steam required is proportional to the absolute pressure. The time required for efficient deodorization depends upon the rate at which steam can be passed through the oil and is limited by the point at which appreciable mechanical entrainment occurs. The mechanical design of the deodorizer should permit contact of stripping steam with oil in a shallow layer, at minimum pressure to minimize hydrolysis, and obtain a free fatty acid content in the product of 0.03% or less.

Figure 1 is a schematic diagram of a double shell deodorizer available in capacities of 150-600 tons/24 hr. The deodorization is conducted in a series of six stainless steel vessels all mounted inside, but separate from, a carbon steel outer shell which is maintained under high vacuum. The deaerating and heating tanks, stripping towers, and holding and cooling tanks have been described previously in detail (2).

The steam used in sparging and stripping, along with the volatile impurities, passes from each vessel into the outer shell space and is removed through a single connection to the vacuum system. Wire mesh type entrainment separators

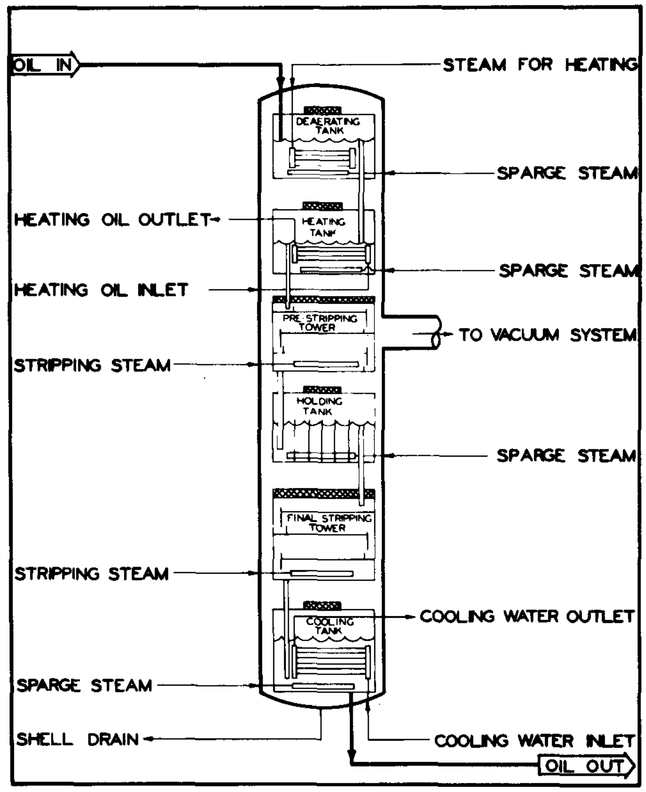

FIG. 1. Schematic diagram of double shell deodorizer.

are provided in the covers of the tanks and above the top tray in the stripping towers to remove entrained oil from the sparging steam. Any entrained oil not removed, together with any volatile materials that condense on the outer shell surfaces, drains to the bottom of the outer shell and is removed periodically.

This double shell deodorizer design has received widespread acceptance in the U.S. and Europe. However, it is not economical to fabricate this double shell design for refineries operating at 25 to 150 tons per 24 hours.

NEW DESIGN

In 1968, we decided to design a deodorizer for capacities of 25-150 tons/24 hrs that would have all the process advantages of the double shell deodorizer at a lower capital cost.

Figure 2 is a schematic diagram of our single shell deodorizer. We found it was less expensive to use Dowtherm for all of the heating instead of the steam-Dowtherm heating combination used in the double shell design. The single shell deodorizer consists of a stainless steel tower containing the same process elements as the double shell deodorizer. The carbon steel shell is eliminated and replaced with a carbon steel pipe mounted alongside, with several connections to the stainless steel deodorizer tower.

The feedstock is sprayed into the top section of the deodorizer where it is deaerated and then heated to the deodorizing temperature. The top section contains an integral U-tube type heating coil for use with Dowtherm, a series of passages and baffles for directing oil flow, and a perforated pipe for steam sparging to aid in heat transfer.

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The oil flows by gravity into the second section of the deodorizer, the prestripping section, which has the same process design as the prestripping tower in the double shell deodorizer.

The oil then flows by gravity into a holding section, sparged by steam, then into a final stripping section, again with the same process design as the double shell deodorizer.

The oil discharging from the final stripping section enters the cooling section which contains an integral U-tube coil for use with water to cool the oil to 65 C. The cooled oil then is pumped from the deodorizer.

The carbon steel pipe connections to the stainless steel tower are located so that steam used in sparging and stripping, along with the volatile impurities, pass from each section into the vapor take-off pipe and are removed through a single connection to the vacuum system.

Wire mesh-type entrainment separators are provided in the top of each section. Manholes, which are required to permit removal of the mist eliminators for cleaning, are mounted on the vapor take-off pipe in such a manner that any air leakage will pass out through the vaccuum system making it impossible for air leakage to contact the hot oil in process.

DESIGN FACTORS

The principle factors to be considered in the design of any deodorizer are: pressure, temperature, stripping steam rate, materials of construction, thermal treatment, and protection of the hot oil from contact with air. In both single and double shell deodorizers, these factors are considered.

Pressure: Since the outer shell or the vapor take-off pipe is evacuated, all the deodorizing operations are conducted at the same low absolute pressure.

Temperature: The temperature of the Dowtherm flowing to the coils in the heating section can be controlled to maintain the desired deodorizing temperature. The oil is sparged with steam to obtain a high rate of heat transfer.

Steam rate: The steam rate to each section is metered and controlled individually. Fresh steam is used in each stripping tower.

Materials of construction: All metal in contact with the oil in process is stainless steel.

Thermal treatment: The holding tank provides the necessary retention time to obtain heat bleaching and thermal decomposition of odoriferous compounds which later are removed in the final stripping section.

Protection from air: The deaerating section acts to remove dissolved and entrained air before the oil is heated to deodorizing temperature. In addition, any air leakage will pass out the vacuum system without contracting the hot oil.

The single shell deodorizer design has been proven in operation in various parts of the world for 5 years and has been used to deodorize all varieties of animal fats and vegetable oils.

Both the single and double shell deodorizers are supplied with the same process guarantee: they will produce deodorized oil with a bland flavor, a maximum free fatty acid content of 0.03%, and a zero peroxide.

The deodorizer can be provided with the necessary components to change feedstock without intermixing, when required.

Optional equipment, such as deodorizer distillate recovery and antioxidant addition systems, are available for the single shell deodorizers.

The deodorizer can be modified to provide heat recovery by the addition of an external deaerator and a heat recovery section located between the final deodorizing section and the cooling section, which transfers heat from the hot deodorized oil to the feedstock (2).

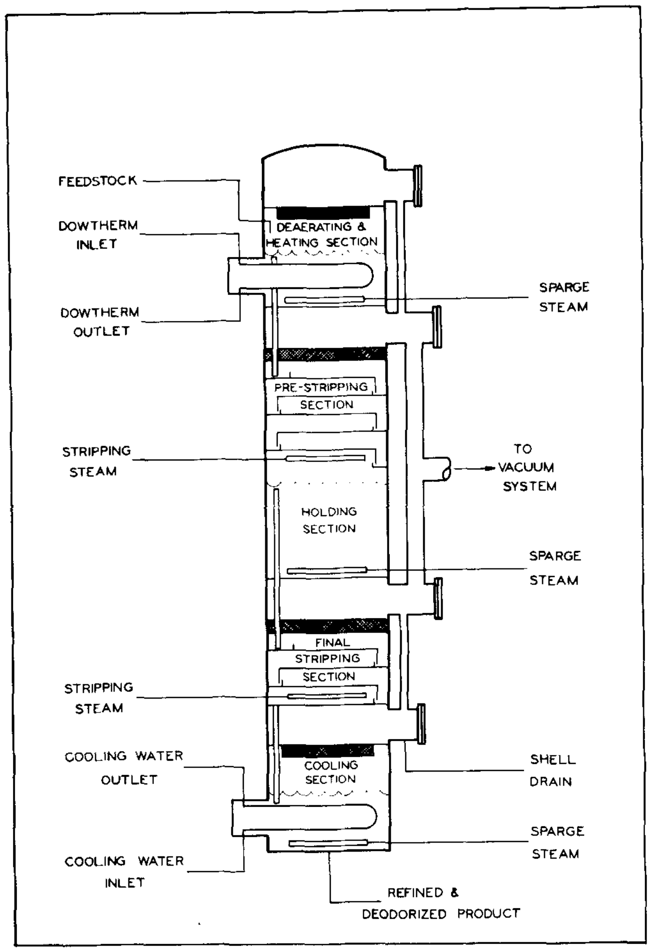

FIG. 2. Schematic diagram of single shell deodorizer.

The single shell deodorizer can be modified for use as a steam refiner-deodorizer for high free fatty acid oils, such as coconut, palm, palm kernel, and animal fats (2). The required amount of sparge steam and motive steam for the vacuum system is kept at a minimum by designing the steam refining-deodorizer to use the same ratio of sparge steam to oil as used in the standard deodorizer. With the same sparge steam ratio, free fatty acid levels as high as 5-6% can be removed by increasing the number of stages or stripping trays in each stripping section of the deodorizer. The refining deodorizer uses only 50 lb steam/1000 lb oil, more than the standard deodorizer. This 50 lb is the additional motive steam required for the vacuum system to remove the higher load of free fatty acids.

This deodorizer design permits the refiner of high free fatty acid oils to steam refine and produce a fully deodorized oil at full design capacity and to use the same deodorizer for other oils without the penalty of high steam requirements.

REFERENCES

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