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Modern Deodorizing Methods

Quality of Edible Oils Dependent Upon Design of Distilling Equipment

By JOHN P. HARRIS* and ALEXANDER B. McKECHNIE*

MANY of us have seen and can recall the original deodorizing tanks that were at the plant of the N. K. Fairbank Company at Chicago. (This plant is now dismantled.) If they were not actually the first treating tanks for vegetable oils in the United States, they were certainly among the first of their kind, and were typical of that early period. They were merely steel holding tanks in which neutralized oil was stored, and heated with pressure steam which passed through a closed coil.

Early History of Deodorizing

During the heating process, the oil was blown with steam, which carried away certain of the more volatile compounds, producing a decidedly beneficial effect upon the flavor and odor, as compared with the untreated oil. This process was far from perfection, but nevertheless was a step in the right direction. The entire layout and process would now be considered crude, to say the least, yet a number of years passed before any radical improvements were made.

It may interest and surprise some readers to learn that there are still a number of refineries throughout the country producing edible vegetable oils and lard compounds with equipment and methods as antiquated as in this first installation; yet in spite of this, and the great advancement made in this highly specialized field, they claim to produce choice products of the highest quality.

Introduction of Superheated Steam

One of the first great improvements was made when superheated steam was introduced for the blowing process.

Before this time, steam at 125 lbs. boiler pressure was ordinarily used. This pressure gave a final temperature in the oil of about 345°F., after many hours of heating.

When superheated steam was introduced for blowing, it not only proved to be a better medium for carrying away the distilled vapors, but it also produced a rise in the final temperature of the oil to approximately 390°F. This higher

* *Parks-Cramer Company.*

temperature shortened the deodorizing process to about five hours, and also caused the distillation of a higher percentage of the volatile compounds, which in turn made a further improvement in the flavor and odor of the finished oil. Up to this time, however, all of this work was carried on under atmospheric pressure, and the greatest gain in quality was still to come by the use of vacuum distillation.

Vacuum Deodorizing

As the demand for edible vegetable oil products increased, alert refiners began searching for new ways to further improve the quality, and it is natural that the distillation of the volatile bodies under vacuum should be the next step in a process of this kind.

Vacuum distillation, particularly in connection with vegetable oils, serves two major purposes—

First—It minimizes the damage caused by oxidation, which was all too prevalent when the oil was distilled under atmospheric pressure and exposed at its highest temperature to the open air.

It is a well known principle that a vegetable oil possesses a great affinity for oxygen, especially at temperatures above 140°F., and when exposed at this temperature to the air, it will absorb the oxygen therefrom. As the temperature of the oil increases above 140°F., its rate of oxygen absorption actually accelerates in proportion to the temperature increase.

Second—The use of a vacuum materially lowers the boiling or distilling point of the volatile compounds, just as the boiling point of water is lowered from 212°F., at atmospheric pressure to 32°F., when a perfect vacuum is attained. Consequently, an equivalent degree of heat applied to oil, under a high vacuum, produces an exceptionally better result than when applied at atmospheric pressure.

The attitude of certain manufacturers, when they persist in their policy of "We are getting by, why change?" is a strange commentary upon the tastes of the American public, and it is, indeed, puzzling to know that huge quantities of oil are still being deodorized, or supposed to be, without the use of the vacuum still.

Oxidation of vegetable oil is directly attributable to exposure to any source of oxygen absorption, and as this makes the oil incipiently rancid, its life, or keeping quality, is very short. Under such conditions, therefore, as open distillation with temperatures of only 345°F. in the oil, the undesirable flavors and odors cannot be entirely driven off, and yet this is the whole purpose of the deodorizing process.

It is true, of course, that a certain trade will buy an inferior product, if they can get it at a favorable price, and will even become accustomed to an off flavor, rating it as "quality."

Cases are known of refiners who boasted of "bland neutral flavor," which actually was merely a flat oxidized flavor, and still others mistook a soapy flavor for "sweet nutty flavor."

Modern practice, insofar as the deodorizer is concerned, is to use vessels of rugged construction sufficiently strong to withstand the highest vacuum that can be produced, and equipped with high vacuum pumps and condensers for distilling the vapors driven off. The high quality of oils which are produced in equipment of this kind, has placed this process on a highly scientific basis, and caused the refiners to seek still further means of improvement.

It was immediately apparent that steam, under the pressures ordinarily available, did not offer a medium for heating which was conducive to efficiency, inasmuch as about five hours were required to raise the temperature to 380°F.-390°F. When 200 deg. superheat was used above the boiler pressure steam, the effect produced in the early hours of deodorizing was very slight, and it was found that a maximum of 380°F.-390°F. was not sufficient, in view of the fact that temperatures considerably higher than 400°F. (and under high vacuum), are necessary, in order to distill off the aromatic aldehydes and ketones commercially.

Heating by Direct Fire

The obvious method for correcting these inefficiencies was to heat the oil directly by the use of a tubular heater, or pipe still.

This consisted of a large coil through which the vegetable oil was circulated for heating, the whole being mounted above a direct fired furnace setting. This oil was kept in constant circulation by a pump which forced it from the deodorizer through the tubes of the heater and then returned it to the deodorizing tank.

A number of these direct fired heaters have been installed, and doubtless some of them are in successful operation. The design of such a heater requires the utmost engineering skill of a trained specialist, and even when perfectly designed and constructed, vagaries of operation will lessen or greatly depreciate the uniformity and value of the product being treated.

The oil comes in direct contact with the tubes which are exposed to the fire, and as all the heat for the body of the oil must pass through the film in contact with the heating surface, it is obvious that this film must necessarily be raised to a temperature higher than is required in the batch. Such overheating must have only one effect, and that is, to burn or scorch the oil, considerably darkening its color and affecting its taste unfavorably.

With this type of pump-over system, there is the ever present danger of ruining an entire batch of oil in the event of a shutdown of the circulating pump either for mechanical reasons, or because of an interruption in the current supply to the electric motors. Under such conditions, it is also probable that considerable damage would result to the heater.

With this method of heating, there is further, difficulty in maintaining the desirable high vacuum on the equipment, as it is almost impossible to secure permanent tightness through a multiplicity of pipe joints, valve stems, pump stuffing boxes, etc.

The losses sustained through the use of this direct fired heating method have been so great that many such installations have been abandoned, and the plant converted back to the older method of heating with superheated pressure steam with a lower resultant temperature in the vegetable oil.

It was only natural, therefore, that the refinery operators should continue in their search for a method of heating that would combine both the good qualities of the high temperature of the direct fired system, and the freedom from overheating of the steam system, without having the disadvantages of either.

The result of this search has led to the use of the well-known system of "Industrial Heating by Oil

Circulation." This system uses a high flash mineral oil to convey the heat to the deodorizers, and was primarily designed for furnishing heat at high temperatures and low pressure for work beyond the range of steam, for delicate reactions and sensitive compounds, which, of course, include vegetable oil deodorizing.

Indirect Heating

This system was perfected about 12 years ago, and is best described as being similar to the ordinary hot water heating system, with the exception, of course, that a high flash point mineral oil is used as the transmitter of heat instead of water. This mineral oil is kept in rapid and positive circulation by means of a pump, instead of depending upon thermal circulation, as is the case with water.

This equipment is the result of many years of experience on the part of trained engineers, skilled in high temperature heating work. The absorber, pumps, pipe lines, etc., must be all of the most rugged construction in order that proper provision be made for temperature and expansion strains.

Design of Indirect Heating System

The absorber or mineral oil heater, like any high grade exchanger, is designed for maximum efficiency insofar as that is consistent with long operating life and low upkeep cost.

The furnace setting is well insulated to minimize losses by radiation. The length and size of the tubes and the velocity of the mineral circulating oil is such that the life of all these parts is indefinitely long.

The circulating pump is of sufficient capacity to maintain the proper tube velocity, and is the positive *displacement*, rotary type. This insures a uniform and nonpulsating flow.

The system is a closed type of circulating oil system, which is the correct principle for the handling of high temperature oxidizable oils, in that it is not permitted to come in contact with the atmosphere. A mineral oil has an affinity for oxygen, similar to that of vegetable oils, and must be also protected from the atmosphere by being entirely enclosed.

Provision is made for the expansion of the circulating oil, which has approximately a 25% volumetric increase in a 500°F. rise. An expansion tank, located on the end of a dead, or stagnant line, attached at the proper place in the system takes care of this expansion satisfactorily and acts as a liquid seal, thus insuring the exclusion of air. This tank is vented to the atmosphere, and does not permit the building up of high pressure. Tests have shown that the oil in the tank is several hundred degrees lower in temperature during operation than the oil in circulation.

The circulating oil is a highly refined derivative of mineral crude. Its flash and fire points, viscosity and specific heat, are all carefully regulated or determined for use in work of this kind.

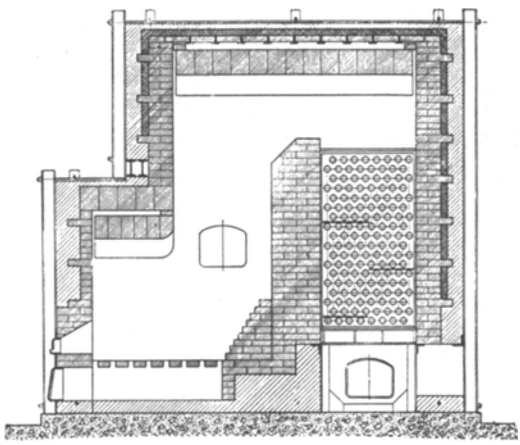
The piping used for circulating the mineral oil from the heater to the deodorizer is laid out to properly provide for its expansion of 1/32" per foot.

The piping is of standard weight, but all valves and fittings used are of extra heavy construction, and all flanges are forged steel, screwed and welded to the pipe. This heavy construction is employed in order to insure absolute tightness at all joints.

Such systems are built in standard sizes, ranging up to 2,800,000 B.t.u. per hour in individual units, and two or more units may be connected in a battery when greater quantities of heat are required than that contained in the largest system.

In vegetable oil work there are installations in which the deodorizers vary in size from 5,000 lbs. to 30,000 lbs. each, and are arranged in batteries of two, three, or more.

In addition to the vegetable oil industry, this method of heating has been successfully applied in chemical plants for high temperature heating, distilling, etc; in the manufacture of electrical equipment, such as transformer or dynamo coil impregnating, also molded electrical products; saturated asphalt roofing, shingles and asphalt coated paper; rosin and wax compounds, battery boxes, etc.



Typical furnace and coil cross-section for indirect heat deodorizing system

Advantages to the Vegetable Oil Industry

Through the use of circulating mineral oil, the application of heat to the vegetable oil is at a uniform rate, and at all times under perfect control. With thermostatic equipment at the heater, the mineral oil is easily held within a few degrees Fahrenheit of any pre-determined temperature, and individual control is further provided at each of the deodorizers by installing a three-way valve in the deodorizer branches.

The deodorizer can be either a jacketed vessel or a vessel of single shell type, with a coil of the proper heating surface installed therein.

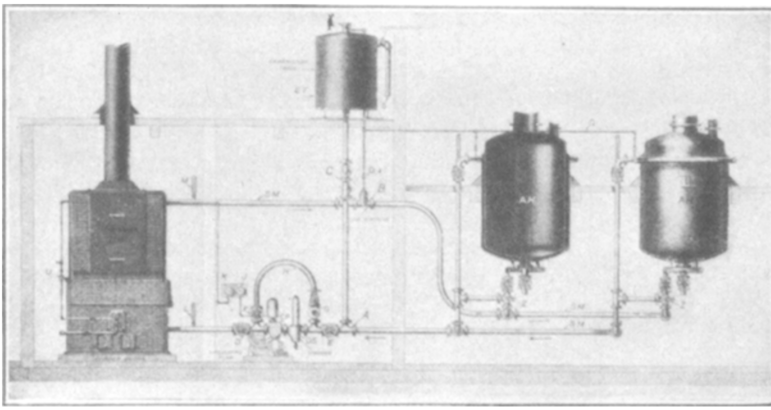
It must be apparent to the reader that in the old method of slow steam heating, the live steam which is added for the purpose of assisting in the distillation of the objectionable volatile bodies, etc., is largely wasted during the major part of the operation until such time as the temperature considerably exceeds 300 degrees F., which usually takes several hours; or at best it merely serves to agitate the oil during that period to keep it from burning, and achieves very little in the way of real deodorization. In fact temperatures high enough for proper distillation are never achieved, even with 200 degrees of superheat plus 125 pounds boiler pressure in the heating coil.

Thus the mineral oil heating system in raising the temperature within approximately 30 minutes above 300 degrees F. and within an hour and a half or less, above the boiling or distilling point of the objectionable aldehydes, puts the live steam used in distillation to work almost immediately, shortens the time of processing, and reduces the amount of live steam to be used in processing very materially (some users have reported a reduction in total steam consumed of as much as one-half pound of steam per pound of oil treated).

The personal element in judging when an oil is properly deodorized, however, is so deceptive that it is difficult to foretell just how much of a reduction in point of time and in volume of steam will be possible. Actually it is far more positive to predict an increase in quality, due to ability to go to those temperatures at which distillation is properly carried out, than it is to predict the exact amount of saving.

However, it is safe to predict a very material reduction in steam and time of processing in addition to the better quality produced.

The temperature of the mineral oil is high enough to perform the work, namely, to give 400°F.-500°F. in the vegetable oil, but its temperature is not high enough to be damaging to the product.



Indirect heat deodorizing layout, showing absorber, pump, expansion tank and two deodorizers, also mineral oil circulation lines

The mineral oil being distributed over the entire area of a jacket or heating coil comes in contact with all parts of the vegetable oil, and therefore, no one part of the vegetable oil is over-heated and scorched by transmitting heat through it to any other part. The vegetable oil (properly blown with steam from an independent, separately fired superheater), remains in the deodorizer, thereby simplifying the process and the maintenance of high vacuum. All air is thus excluded from the deodorizer, and there is no chance for outside air to enter.

The pressure on the mineral circulating oil, instead of being high, as when pressure steam is used, is almost negligible, as it is made up of merely the pipe friction, plus the static head from the expansion tank.

Fire hazard can be minimized by installing the entire heating plant in a separate room or building, set any reasonable distance from the deodorizers.

The entire system operates at a comparatively high thermal efficiency, and through the natural preservative qualities of the mineral oil for all metallic parts, the annual upkeep cost is low.

Oxidation, the Greatest Danger in Deodorizing

In conclusion, it is well to repeat that when edible vegetable oil is raised to the high temperatures necessary to effect distillation of the undesirable aromatic components, it has a great affinity for oxygen, so that the operator or engineer shall be ever alert to remove possibilities of contact with the oxygen of the air or from any other source.

As already related, the best method of guarding against oxidation is the use of a vacuum in the deodorizing vessel.

Many operators appear to have too little appreciation of the necessity of keeping this equipment absolutely tight. No half-way measures will do, for if there are any leaks in the deodorizing vessel, the vacuum pump will pull air through the hot oil, damaging the oil much more than the vacuum helps.

There is, of course, always some danger of effecting a certain degree of oxidation from the steam itself, for some little air is commonly drawn into the steam through the boiler feed water as it is being evaporated.

Some operators, especially in Europe, have gone to the length of providing special boiler facilities to produce steam which will be absolutely free from air.

Other operators have attempted to use inert gases, such as hydrogen, nitrogen, carbon dioxide, etc., in the place of steam. Sometimes these gases, particularly hydrogen, are used to finish off the batch after the initial treatment with steam.

But of all methods commonly and successfully used to date, the safe indirect heat method has given the best quality result together with the highest efficiency in operation.

Surface Characteristics of Soap Solutions

In opposition to the generally favored hypothesis that the surface of aqueous soap solutions is made up of soap molecules, a theory is presented which consists in the main of the idea that the surface is built up of fatty acid molecules, which "verifies" the theory of Harkins and Langmuir to this effect. It follows from this hypothesis that a parallelism must exist between the surface phenomena of aqueous soap solutions and aqueous fatty acid solutions, a relationship which generally does exist.—J. F. Carrière (Chemische Umschau. No. 5. pp. 57-67. 1927).

Prominent Norwegian Oil Merchant Visits U. S.

Mr. Johan Isdahl, Jr., of Isdahl and Company, Cod Liver Oil Merchants, Bergen, Norway, has been visiting the United States on a business trip. Mr. Isdahl's firm is one of the world's large handlers of Cod Liver Oil.