Rendering

H. C. DORMITZER, Wilson and Company, Chicago, Illinois

THE TERM "RENDERING" is understood to refer to the extraction of fat or oil by heat. Nearly all animal fats are recovered by rendering, while vegetable fats and oils are obtained by crushing, or by solvent extraction, or by both. A perfect rendering process should have the following characteristics.

1. It should be able to process all kinds of material available.
2. It should produce a mild-flavored fat similar to fat in the cells without increase of free fatty acid, darkening of color, or loss of bleachability.
3. It should produce a protein residue with no deterioration of the protein for nutrition and with no loss of vitamins or growth factors.
4. It should have a wide range of capacity and work as efficiently with small loads as with large.
5. It should give high efficiency and yields at a minimum of cost.

At the present time we do not have a perfect rendering system, but we are always looking forward hopefully.

H. C. Dormitzer

Broadly, there are two general methods of rendering tissues: wet rendering and dry rendering. In wet rendering the fat cell walls are hydrolyzed by steam under pressure until they are partially liquefied and the released fat floats on the surface of the water. In dry rendering the tissues are dehydrated until brittle, and the fat cells break and release the fat. Final recovery is completed by pressing either in hydraulic or continuous screw presses.

In general, wet rendering is used for edible products where color, flavor, and keeping qualities are of prime importance and the relative percentage of residue is small. Dry rendering is preferred for inedible products where flavor and odor are secondary and the production of larger amounts of high quality residue is important.

The wet rendering process is carried out in vertical tanks holding anywhere from 5,000 to 25,000 lbs. Means are provided for drawing off the fat just above the interface. When the interface is not in line with the draw-off outlet, it is raised or lowered by admitting or drawing off water at the bottom of the tank. In practice, after the tank is filled, the head is fastened on and the steam is admitted to the bottom of the tank. Thus it serves for both heating and agitation. The steam outlet at the top of the tank is left open until all air has been displaced. It is then closed, leaving a small by-pass open so that steam will continually feed in at the bottom and provide agitation during the cooking period. The pressure used may be from 40 to 75 lbs. of internal pressure.

The latest practice is towards the higher pressures to cut down on the time. This reduces hydrolysis of the fat and maintains a lower free fatty acid. Cooking usually takes from three to five hours, depending on the material rendered, the size of the tank, the size of the load, and the steam pressure. After the material has settled, a small amount of cold water is introduced at the bottom of the tank to cool the water solution in the lower part of the tank under the liquid fat. This is done to prevent flashing while the fat is being drawn off and the pressure on the liquid is reduced.

After the fat is removed, the residue, consisting of a liquid containing hydrolyzed protein, and the solids are dropped from the tank and the solids are separated from the liquid. The liquid portion is usually evaporated to a concentration of 50 to 60% of solids in a double-effect evaporator, recombined with the solid portion, and dried in a steam-jacketed drier.

Several modifications of the above process have been introduced. In one the liquid and solid material, after dropping from the tank, are agitated and conveyed or pumped to a hammer mill, which disintegrates the material and discharges it into a jacketed tank equipped with an agitator. After heating to 180–200°F. it is pumped through a horizontal solid bowl centrifuge for the continuous separation of solids from liquids. The liquids are screened, reheated, and again centrifuged through a clarifying centrifuge that discharges solids to recover the grease. The liquid and solids are then handled as previously outlined. This process can be used on edible or inedible products.

Another modification is used for edible product only but is somewhat related to this. The fats are ground or hashed before loading in the tank, and cooking takes place under pressure for about an hour. The liquid and solids are drawn off at the bottom of the tank until the liquid fat is reached. The fat is then drawn off, cooled, and settled or filtered. The liquid and solids are filtered or centrifuged as described above. This process has the advantage of cutting down the time, increasing the capacity of the tank, and producing a milder lard of low free fatty acid.

Dry rendering is normally carried out in horizontal steam-jacketed tanks with a large charging opening in the center of the top and equipped with an agitator. The tanks hold from 5,000 to 10,000 lbs. per charge. The agitator has paddles attached by arms to a horizontal shaft. The steam pressure in the jacket is from 50 to 75 lbs. p.s.i. The operation is carried out by charging the tank and by continuing the agitation of the contents until the product is dried down to the right consistency. The entire contents are then discharged into a steel box equipped with a perforated liner, and all possible free liquid is drained off. The residue is pressed, and the pressed liquid fat is combined with the drained fat. After settling, centrifuging, or filtering, it is ready for marketing. The residue is ground as a protein supplement for animal and poultry feed.

The cooking or drying operation may be conducted either under internal pressure, atmospheric pressure, or under vacuum. If no grinder is available for the bones, internal pressure is necessary. The best yields are produced under vacuum, but most plants operate at atmospheric pressure. The finish of the cooking operation has been determined by experienced operators feeling a small sample of the product withdrawn from the cooker. In recent years this has been replaced by an end-point controller, an electronic device for controlling the cooking. The end-point controller has a feeler tube installed in the cooker, flush with the inside cooking surface, and measures the conductivity of the product. As the product dries, the conductivity decreases and when a selected end-point is reached, an alarm is sounded. These devices are accurate and sensitive. On repeated tests they have been found to be more reliable than experienced operators.

While cookers in dry rendering have been in use for approximately 35 years, it is only comparatively recently that real improvements have been made. For years the agitators have been designed with an r.p.m. of 15 to 20, and this was considered normal. Within the last few years this has been increased to from 34 to 40 r.p.m., with a decrease in cooking time of about 25%. Recently r.p.m.'s as high as 50 to 60 have been tried with even better results.

The cookers also were mounted on a heavy steel frame, which was extended to support the motor and speed reducer. This has now been discarded, and the cooker supports are mounted directly on the concrete foundations while the motor and reducer are bolted directly on the end of the cooker shell, thus saving about three feet of length.

There are several modifications of continuous wet-rendering operations in which attempts are made to obtain a better product and a better protein residue than the usual pressure tank produces. A considerable amount of beef fat at the present time is rendered at moderate temperatures (160–170°F.) in open agitated tanks to make oleo stock and oleo oil. However, to handle it satisfactorily, the fat must be first chilled and then hashed to crush the cell walls so that the rendering process is largely one of melting. The newer modifications have been designed to eliminate chilling and still obtain maximum yields.

The Titan Process. This method of rendering originated in Denmark and is used largely for the production of lard. In South America it has found favor for the production of oleo stock from beef fats.

The equipment is designed to fit the job. The fat is fed through a hopper into a cutter and discharged into a preheater. Hot water is added, and the temperature is raised to 180°F. From the preheater the fat is pumped into a vertical boiler, where with live steam the temperature is raised momentarily to about 240°F. The product is then discharged through a reducing valve to atmospheric pressure, which causes the final rupture of the fat cells. It is then screened, and the screenings are pressed in a continuous press. The fat, water, and fine scrap are put through a centrifuge which separates the fat from the water and solids and discharges the solids periodically. The fat is finally polished through a high-speed centrifuge. Passage through the unit takes about 10 min. and it is continuous. The capacity is rated from 2,200 lbs. to 2,800 lbs. of raw fat per hour.

Some of the objections to the use of this equipment in this country have been its high first cost and limited capacity. Also, although hashing of fats would seem to be an easy operation, in practice there are many edible fats, especially with skins on, that the normal hasher will not handle. Work is being done now to develop better machines for this purpose.

The Kingan Continuous Rendering System. This is an interesting development in that it has been one of the first successful continuous wet-rendering systems. It is a system that was originally devised to handle beef fats for oleo stock without chilling but has been expanded to handle pork fats for lard. It has the advantage of simplicity and can handle either hot or chilled fats.

The process on beef fats is as follows: The fat is ground through a hasher with a 5/8-in. plate into a holding tank and pumped through a tubular heater or Votator heat exchanger, where the temperature is raised to approximately 180°F., or high enough to melt the fat. It then passes through a comminutor to break up any unrendered fat cells. From the comminutor it is discharged through a surge tank into a Nozljector centrifuge, where the fat is separated from the water and scrap. The fat has a bland flavor, and because of the short rendering time and low temperatures there is little or no increase in the fatty acid. A Nozljector is a trade name for a centrifuge that continuously discharges solids. It is used for the separation of fats from solids and water when the percentage of solids is relatively high. Similar machines are made by other centrifuge manufacturers.

The process has been somewhat modified for the production of lard. The fat is first put through a pre-breaker, which is a horizontal machine with strong short paddles turned so as to break the material and convey it along at the same time. It is then put through a comminutor with a 3/4-in. screen, giving it a coarse grind, and then discharged into a surge tank. From the tank it is pumped with a Moyno pump through a Votator heat exchanger, and the temperature is raised to about 200°F. After leaving the heat exchanger, it is put through a fine comminutor to another surge tank. Finally it is passed through the centrifuge, and the lard is separated from the water and scrap. This process has the advantage of short put-through time and should produce a bland lard of low free fatty acid, good color, and good odor. It should produce a fat with the advantages of wet-rendered product without the disadvantages of the regular system. However there is some loss of protein material.

The Sharples Rendering System. This system is also a continuous wet-rendering process, where the fats are separated from the protein material before high temperatures are applied. It operates at a capacity of about 8,000 lbs. per hour, and the put-through time is also about five minutes. Its aim is to render the fat and free it from the protein residue without high temperatures and at the same time to avoid the formation of an emulsion layer that limits the capacity of systems using clarifying centrifuges.

The fat is first ground through a grinder with about a 1/2-in. plate. It is then heated to 180°F in a jacketed tank provided with an agitator or a heat exchanger. From the heater it passes through a horizontal solid bowl centrifuge built for the continuous separation of solids and liquids. It is designed for slurries with large amounts of solids. The solids, which are deposited against the wall by centrifugal force, are moved by a screw conveyor to solids discharge ports located at one end of the unit. The solids consist of approximately 61% water, 26% protein, and 13% fat. The liquid fat, with some unrendered material, is then run through a comminutor to complete the rupture of the fat cells and insure satisfactory operation of the centrifuge valves on the subsequent clarification. The comminuted fat is heated to 195–200°F. and pumped to an auto-jector clarifier centrifuge. This is a centrifuge which is equipped with a series of automatically operated valves located around the periphery of the bowl to discharge solids automatically. The accumulation of solids in the bowl causes the valves to open. When the solids have discharged through the open ports, the valves close. The water and protein are removed from the fat, and the fat is discharged to storage. The solids accumulated from both centrifuges may be collected and dry-rendered for final recovery of fat and protein.

There are a few other methods of rendering, such as open kettle and various modifications, but they are not important, and to cover them would be largely looking backward.

There are still numerous problems to be solved in both wet and dry rendering, but the last few years have been encouraging in that definite attempts have been made to solve some of them with a moderate degree of success. It is hoped that with a wider understanding of the rendering processes, more progress will be made.

Vegetable Oil Refining

FRED H. SMITH, The Sharples Corporation, Philadelphia, Pennsylvania

I would like to quote from a paper presented before the North Central Section of the American Oil Chemists' Society in Chicago about 18 months ago. "Within the memory of most of this audience tonight, refining of vegetable oils was accomplished by kettle refining or a single version of caustic centrifugal refining. Each in its own way was an art, and profits depended on that art centered in an experienced refiner who tasted oils, rubbed soapstock in his hands, and blamed the crude mills for a poor extraction."

F. H. Smith

It was pointed out that today no processor can afford this luxury. To survive he must critically analyze some seven different refining methods in terms of his own unique requirements and operate a plant best suited to solve his problems of particular crude oils available, oil quality specifications, water supply, sewage disposal, and utilization of gums and soapstock.

Now however this list of possible process selections has grown to nine. How many more will be introduced depends on how many experimenters can and will spend the time and money required fully to develop new systems and to present an account of the completed research to the industry. The problem has become quite complex and may be expected to become more so.

The purpose of this paper will be to assist in completely understanding each new process as it develops and to analyze some of the existing systems in terms of the information available. This discussion will not deal with specific equipment selection but will bear on the following points: classification of contaminating components—how refining losses and oil quality are affected by removal of these components; classification of seven process concepts in terms of refining losses and quality; the physical chemistry of refining as applied to the process concepts; and examples of refining results selected from United States and Mexico.

Contaminating Components

The contaminating components in a crude oil are phosphatides or gums, free fatty acids, color, moisture, and meal and dirt.

Gums represent the natural phosphatidic materials contained in the crude oils. Some oils, such as palm or coconut, have so little of this contaminant that conditioning or removal need not be seriously considered. On the other hand, the American oils, such as cottonseed and soya, contain from 1 to 2% gums which must be removed to produce a refined edible or technical oil.

To a large extent, the gums are soluble in dry crude oils but may be precipitated as a non-oil soluble sludge by hydrating with water. The precipitate is a gelatinous mass wherein oil is dissolved in the gums. They are easily separated from the oil by centrifugal or gravity means, but in so doing the dissolved oil of the gums cannot be reduced. The percentage of oil in the gum phase seems to be a strong function of the water treat used, which is important for other reasons to the producer of technical oils. In general, a low water treat of 1% or less will produce gums which dissolve no more than 15 to 25% oil, giving gums of 75 to 85% acetone-insoluble rating. Higher water treats will increase the ability of the gums to dissolve oil but at the same time will do a better job of removing the last traces of gums from the oil. For the technical oil producer the right compromise between loss and gum removal becomes the basis for his profits.

However for the producer of fully refined technical oils or edible oils, percentage of treat is usually selected for other reasons. Gums must be fully removed to protect taste and flavor, but they need not be removed separately.

The following generalities emerge as important to developing a refining process. Gums dissolve oil,