The rendering process applies heat, extracts moisture and separates fat to turn the by-products of the meat industry into useful ingredients

Essential recycling

The rendering industry performs an essential recycling service by taking animal by-products and turning them into ingredients for feed and other applications. OFI explains what is involved in the modern rendering process. *Serena Lim*

Around a third to half of each animal produced for meat, milk, eggs and fibre is not consumed by humans. These raw materials are subjected to rendering processes resulting in many useful products.

Meat and bone meal, meat meal, poultry meal, hydrolysed feather meal, blood meal, fish meal and animal fats are the primary products resulting from the rendering process. The most important and valuable use for these animal by-products is as feed ingredients for livestock, poultry, aquaculture and companion animals.

Without the continuing efforts of the rendering industry, the accumulation of unprocessed animal by-products would impede the meat industries and pose a serious potential hazard to animal and human health.

The rendering process

Rendering is a process of both physical and chemical transformation using a variety of equipment and processes. All of the rendering processes involve the application of heat, the extraction of moisture, and the separation of fat (*see Figure 1, following page*).

The temperature and length of the cooking process are critical and are the primary determinant of the quality of the finished product. The processes vary according to the raw material composition.

All rendering system technologies include the collection and sanitary transport of raw material to a facility where it is ground into a consistent particle size and conveyed to a cooking vessel, either continuous flow or batch configuration.

Cooking is generally accomplished with steam at temperatures of approximately 115°C-145°C for 40-90 minutes, depending on the type of system and materials.

Regardless of the type of cooking, the melted fat is separated from the protein and bone solids and a large portion of the moisture is removed. Most importantly, cooking inactivates bacteria, viruses, protozoa, and parasites. Alternative methods of raw material disposal such as burial, composting or landfill applications do not routinely inactivate micro-organisms.

Fat is separated from the cooked material via a screw press within a closed vessel. Following the cooking and fat separation, the “cracklings” or “crax” – which includes protein, minerals and some residual fat – are further processed by additional moisture removal and grinding, then transferred for storage or shipment.

The protein is stored either in feed bin structures or enclosed buildings. The fat is stored and transported in tanks.

Production and technology

Rendering processes and technology have changed over the years and continue to improve. Modern rendering facilities are constructed to separate raw material handling from the processing and storage areas. Process control is performed and monitored via computer technology so that time/temperature ▶

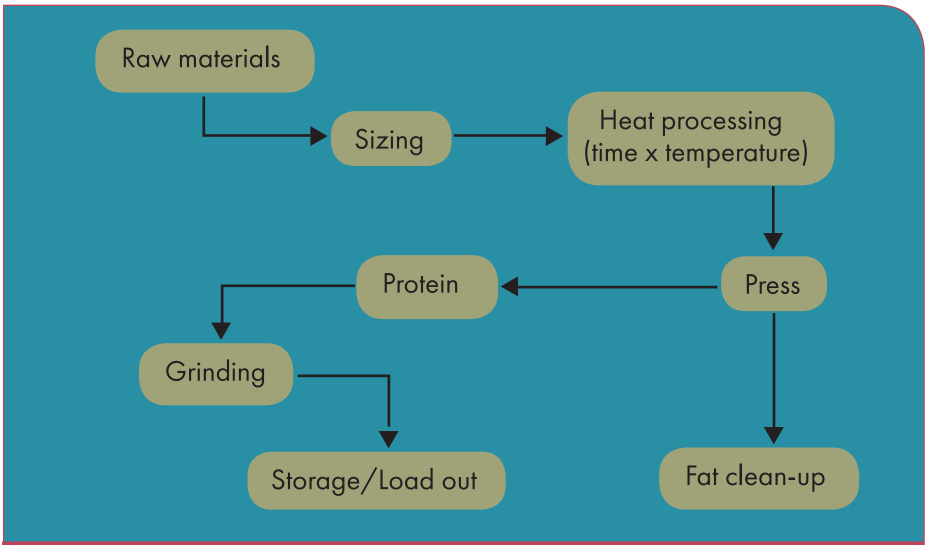

Figure 1: Basic production process of rendering

Source: Meeker & Hamilton

recordings for appropriate thermal kill values for specific micro-organisms are achieved. Temperatures far in excess of those needed to break cell walls and remove fat are avoided because they can lower nutritional values and digestibility. The cooking times and temperatures in rendering are far above the thermal kill times required for food safety.

Wet rendering

Wet rendering is a system that leaves a high amount of moisture in the product until, or if, it is dried. It is most commonly applied today in the rendering of edible fats and oils and in the production of items such as partially defatted chopped beef or condensed beef. The earliest wet rendering system was an open kettle fired with wood or coal. Fat rising to the top was skimmed off for use.

Dry rendering

Dry rendering is done with or without an initial pressurisation stage (sterilisation) and it is the most common system used today. In the mid-1900s, the dry rendering batch cooker came to near universal use.

Before adequate pre-breaking or pre-crushing came into use, large pieces of animals or offal could be pressurised in a batch cooker prior to drying. This had the same effect as a home pressure cooker and would cause the bones to become more brittle, softer and easier to handle.

Particle size reduction technology eliminated the need for the pressure step for size reduction. However, this step was re-deployed in Europe as an extra reduction factor in bovine spongiform encephalopathy (BSE) control programmes.

Pressure is regularly used for hair and feathers to achieve protein digestibility and can be in a batch or continuous process.

Source: Douglas Anderson

Hammer mills are used to process raw material into a uniform size

Edible rendering

Edible fats and oils are designated as high temperature or low temperature, as is the resulting tissue. Tissue with enough meat processed at low temperature is beef or pork with meat-like definitions. A high temperature product that is not to be designated as "cooked" or "ready to eat" will generally wind up as meat and bone meal through another rendering system, or possibly go to pet food. Condensed beef is a newer term, and has certain production characteristics that are specialised.

Batch rendering

When a system is operating in a batch manner, it becomes a batch system.

Even a continuous cooker can be operated in a batch mode. A batch cooker is designed to be loaded, operated to the designated time and temperature under pressure, and then discharged for fat separation. It can function as a cooker, dryer, hydrolyser or processor, yet it is still the same piece of equipment.

With minor modifications, and with or without internal pressurisation, a batch cooker can be used for each purpose. It can have a heated shaft as well as a shell, increasing the heating surface and efficiency of heat transfer. When used as a sterilisation step, the heated shaft can minimise the time required to attain temperature and pressure parameters.

Continuous rendering

Generally defined as continuous in-feed and continuous out-feed, there have been a number of continuous systems employed in the past. One of the first was the Anco Strata-Flow system. By connecting a series of modified batch cookers in a unique fashion, this became the first real continuous system.

Carver-Greenfield systems came on the scene at about the same time that Dupps, along with Keith Engineering, created the DUKE system. Today known as Equacookers, they are the most commonly employed units in North America. The ease of operation before sophisticated computer controls was a major factor in their success.

Companies such as Atlas and Stord-Bartz brought their fish meal know-how to North America in the late 1970s, and became well-known in the 1980s. By using their unique disc dryer/cookers, waste heat evaporators, mechanical vapour recompression, and improving on the original Carver-Greenfield design, they developed a large market share in the poultry and red meat industries.

Consolidation has occurred in equipment supply as with the rendering industry as a whole. Dupps, and now Haarslev (consolidating Haarslev, Svaertek, Stord Bartz and Atlas-Stord), along with Anco-Eaglin (the modern ANCO), are the major providers of equipment to the North American market. Several other companies provide specialised equipment, rebuilding and repair services, centrifuges, and other options for the industry. With nearly round-the-clock operations, it is essential to have a plant and system that remains in an operating condition, with low downtime and energy efficiency.

Material to be rendered is received for temporary storage in raw material bins. Raw material is conveyed from the bins by a raw material conveyor and discharged across a magnet to remove ferrous metal contaminants. A raw material grinder then reduces the raw material to a uniform particle size for material handling and improved heat transfer in the cooking step. The ground raw material is fed at a controlled rate from a metering bin into a continuous cooker.

The continuous cooker is an agitated vessel generally heated by boiler steam. It brings the raw material to a temperature between approximately 115°C-145°C, evaporating moisture and freeing fat from protein and bone. A dehydrated slurry of fat and solids is discharged from the continuous cooker at a controlled rate.

The discharged slurry is transported to a drainer conveyor. The drainer conveyor separates liquid fat from the solids, which are then conveyed from the drainer conveyor by a discharge conveyor. In the discharge conveyor, solids from the drainer conveyor are combined with the solids discharge from the settling tank and from the decanter-type centrifuge. The solids from the discharge conveyor go to screw presses, which reduce the solids' fat content to about 10-12%. Solids that bypass the screw presses are recycled back to the cooker. Solids discharged from the screw presses in the form of pressed cake go to the pressed cake conveyor for further processing into meal.

The fat removed in the screw presses goes to the press fat conveyor, which separates large particles from the liquid fat and returns them to the discharge conveyor. The fat from the press fat conveyor is pumped to the settling tank. Fat discharged from the drainer conveyor goes into the settling tank.

In the settling tank, the heavier bone and protein particles settle to the bottom, where they are discharged by a screw conveyor into the discharge conveyor. Liquid fat from the settling tank is pumped to the centrifuge, which removes residual solid impurities from the fat. The solids from the centrifuge go to the discharge conveyor. The clarified fat is transported for further processing or to storage as finished fat.

Water vapour exits the continuous cooker through a vapour duct system that generally includes an entrainment trap to separate and return entrained particles to the continuous cooker. The vapour duct system transports the vapour stream to a vapour condenser. Non-condensable gases are removed from the condenser by a non-condensable fan. Odorous gases generated at various points in the process are collected by a ductwork system and are transported along with the non-condensable gases from the condenser to

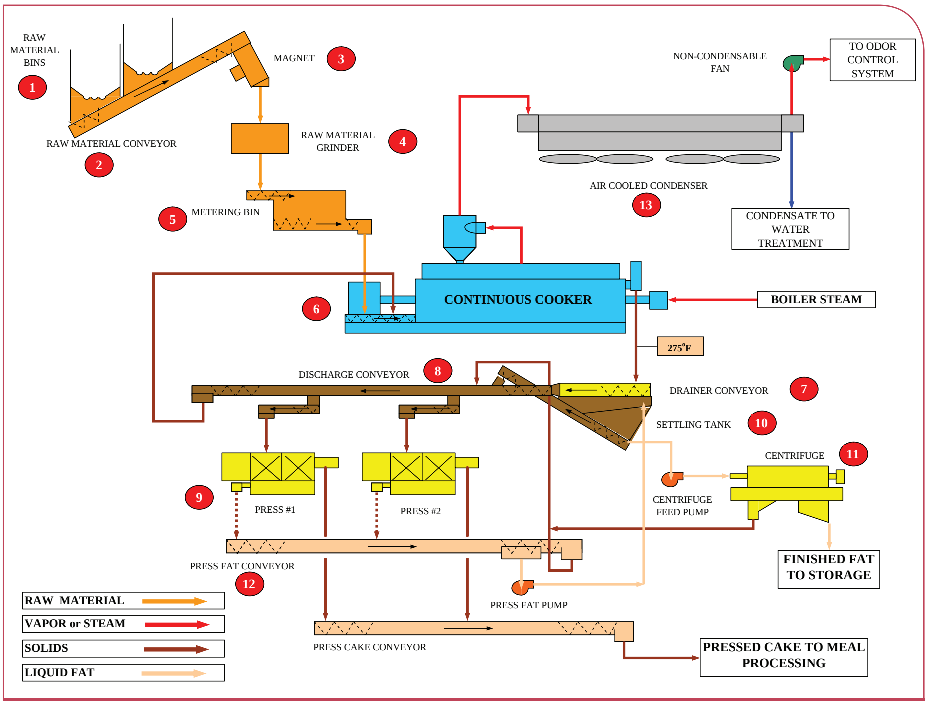

Figure 2: Continuous dry rendering process

Source: Dupps Company

an odour control system for neutralisation of odorous components.

Waste heat evaporation

Employing an evaporator with a continuous cooker offers energy savings that will continue to be very important as the global energy balance continues to shift. Some waste heat systems installed in the early 1980s are still operating efficiently. Waste heat is very important for the meat processing industry to generate hot water – plants that do not employ waste heat to generate their hot water face rising energy costs.

Low temperature separation, originally used in fish meal production, allowed many of these waste heat systems to achieve very low energy consumption numbers, especially with materials with high water content. Finished product fat quality is also enhanced in any low temperature system. However, care must be taken to prevent rancidity in this fat. Generally, heating the dry fat past 121°C, once, will accomplish this. It also serves to dry the fat to a lower moisture level.

Waste heat recovery evaporators can be falling film, rising film, or forced flash designs. All have advantages and disadvantages, and selection for the characteristics of the liquid is critical.

Pre-heating the feed liquid may be required for coagulation of the soluble protein generated in the preheating process, and a glue breaking step may have to be added to allow the easy use of the concentrate in a dryer or cooker. Fish and porcine materials typically have more issues with glue due to the temperatures at which they are released from the material.

Continuous slurry systems

There have been various continuous slurry systems, such as Carver-Greenfield, with changes and improvements introduced by a number of manufacturers.

Designs by Dupps, Atlas-Stord and other firms created slurry evaporators that have been supplied successfully. These high capacity systems produce a meal with very good digestibility, as well as good fat quality. They are highly energy efficient.

Fish meal systems

Although not employed in a large number of plants, the predominantly mechanical fish meal system is extremely energy efficient and, without doubt, produces the highest quality fats and oils from any raw material that is possible to obtain.

Capable of large capacity throughput and energy efficiency, their use may increase in the North American market in the future.

Low temperature separation is utilised for high product quality in finished meals and fat. The meals are still subjected to a long drying process, but the low temperature enhances the quality of fats due to a lower thermal stress. ●

This article is based on the papers, 'Rendering Operations', by Douglas Anderson of Smithfield Foods; and 'An Overview of the Rendering Industry', by David Meeker of the National Renderers Association, and C R Hamilton of Darling International