Meat technology – information sheet

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Rendering Systems

Dry rendering systems are used at more than 100 of the 115 rendering establishments in Australia. The remaining plants rely on some form of wet rendering, with some plants using both dry and wet rendering systems.

Dry and wet rendering systems differ by the condition of the rendered material when the tallow is separated from the solids. In dry rendering, raw materials are boiled in their own juices until most of the water has evaporated. Heating continues but the solids are fried in tallow and more moisture evaporates. Finally, when the solids contain about 10% moisture, the tallow and dried solids are separated.

Solids and tallow are in contact until the total material is dried. Hence the term “dry rendering”. Dry rendering can be a batch or continuous process.

In wet rendering, raw materials are heated in their own juices, with or without steam injection. While the temperature could range from 60°C to 100°C, the temperature range under Australian conditions is usually 95°C to 100°C.

Water is not evaporated from the materials in the wet rendering process. After heating, centrifugal force or pressing is used to separate liquid including tallow and free water from the wet solids. The wet solids are then dried separately from the tallow.

Wet rendering is the term used because tallow and solids are separated while the total material is still wet. Wet rendering processes used in Australia are continuous processes.

Batch Dry Rendering

About half of Australian renderers use a batch dry rendering system.

In batch dry rendering, raw materials are usually pre-broken into 50 mm pieces. In some cases, materials are not pre-broken and can be processed whole, for example, whole heads.

Cookers are either loaded by blowing full charges into the cooker or loaded by screw conveyor direct to the open charge door or via over-cooker bins which can drop a single charge into the cooker.

Although batch cookers can vary in size, a typical cooker is 4.0 m x 1.6 m with a capacity for 2.5 tonnes of raw material. Batch cookers have steam-heated jackets which should be insulated on the outside.

Inside the cooker is a central shaft with beater arms attached. The central shaft may also be steam heated to provide extra heat transfer surface area. The central shaft rotates at up to 35 rpm, with the beaters stirring the mixture to improve heat transfer

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and to prevent material burning on the heated surfaces of the cooker. The beaters also help empty the cooker by pushing material to the exit door.

Material in the cooker is stirred and indirectly heated by steam in the jacket and the shaft. Typically, the material boils at about 100°C for about one hour. At some point during the cook, the liquid phase changes from mostly water to mostly fat, and the temperature increases from 100°C to about 135°C over 30 minutes.

Total cooking time for mixed raw material can be 70-140 minutes, with an end point temperature of 115°C to 140°C.

Figure 1 shows the typical temperature during a cook of mixed raw material with an initial 60% water content. Raw materials consisting of fat and bone contain less water and can be cooked in 55-90 minutes with a final temperature of 105°C to 125°C.

Total cooking time, which depends on the amount of water in the raw material, is affected by heat transfer from the jacket or shaft to the material.

The heat transfer can be improved and cooking times reduced by having a full flow of steam at 5-6 bar pressure in the jacket. The jacket temperature and heat transfer are reduced if air is trapped in the jacket, if steam flow is blocked by condensation in the jacket or shaft or if steam pressure is low.

Although rapid agitation improves heat transfer, excessive agitation will generate fines. Heat transfer is also affected by the fluid content of the cooker.

Most raw materials contain enough water to provide uniform heat transfer through the cooker contents in the early part of the cook. In the later part of the cook, heat transfer may be poor if the tallow content is low and it may be necessary to add tallow to the cook to improve heat transfer by cooking materials in a tallow bath.

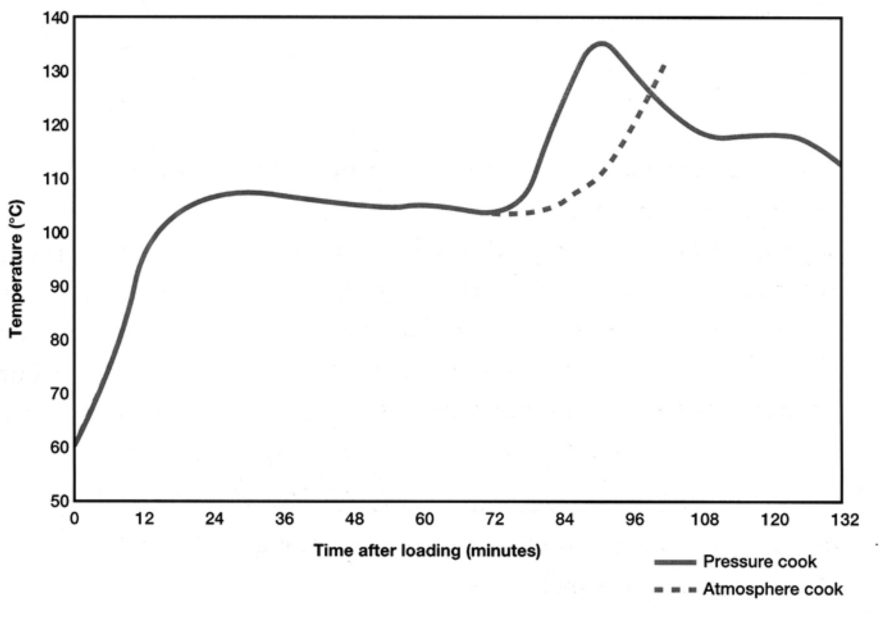
Although cooking times are generally shorter with smaller particle size, fines will be generated if the raw material is too small and it will also be more difficult to express tallow from the cooked material.

Other factors that may extend cooking time are scale build-up on the jacket shell, burnt material on the inside of the cooker shell and back pressure in the vent line to the vapour condenser.

Pressure can be applied during the cook by closing the steam vent.

Pressure cycles are used to hydrolyse wool or feathers, break down large bone particles and improve the prospects of sterilising the

Figure 1 Temperature profile in pressurised and non-pressurised batch cooks



solids. A pressure cycle adds about 30-40 minutes to the total cooking time.

Figure 1 also shows the temperature profile in a pressurised cook with the pressure applied when the water content is about 40%.

Rendering is complete either when the chosen end-point temperature is reached, when the when the chosen water content is achieved - as determined by a conductivity meter - or when the end-point is determined by an experienced operator from the feel of the cracklings.

The cooked material is dropped into a percolator to separate free-run tallow from the crackling. The greasy cracklings are either pressed or centrifuged to express more tallow.

Advantages, Disadvantages of Batch Dry Cooking

Batch dry cooking is the most widely used type of rendering in Australia. This is, probably because relatively low capital cost is required, particularly for small-scale systems. Batch cooking systems are well suited to small-scale operations since a single cooker can handle 10 tonnes - 15 tonnes of raw material per day.

Multiple cookers are needed for larger operations offering the possibility of streaming different taw material through different cookers to produce a range of products. Batch cooking processes are flexible and can be adjusted easily to cope with different types of raw material or particle size.

Yields from batch cooking should be high because there should be no product loss. However, there may be some meal loss depending on the method of tallow refining and the amount of fines generated through small raw material particle size, over-cooking or over-agitation.

Batch cookers can be pressurised. Although pressure cooking has disadvantages, it is useful for treating raw material with high wool content and may be required to comply with importing country requirements.

Batch systems make environmental control more challenging. After all the cooker must be open during loading and discharge, and odours may be difficult to contain at these times.

Product quality can be another challenge. Because tallow is in contact with fines and other solids at high temperature during batch dry cooking, the tallow from batch dry rendering is likely to have a darker colour than tallow from the same material produced by wet rendering.

Additionally batch cooking systems tend to be more labour intensive than continuous systems. For this reason, semi-automate batch systems may be the solution for some rendering plants.

Continuous Dry Rendering

Two types of continuous dry rendering systems are used in Australia. The most common type, used by about 40% of Australian renderers, is a steam-jacketed vessel with steam-heated central shaft. The heat transfer surface area is increased by steam-heated satellite tubes clustered around the central shaft. The other type of continuous cooker has a series of steam heated discs on a central shaft.

Raw material is continuously fed into one end of the cooker with tallow and dried solids discharged from the other end. Hydrostatic displacement moves the material through the cooker.

In the tube cluster type of cooker are two disc baffles of almost the same diameter as the cooking vessel that are fixed to the central shaft to control the flow of material through the cooker. In the disc cooker, the discs provide some control over the rate of flow through the cooker.

As with batch cooking, raw material is size-reduced before being fed to the cooker. The typical particle size is about 30 mm.

The temperature profile in the cooker is probably similar to that in a batch cooker. The raw material boils at 100°C in the first part of the cooker and, at some point along the length of the cooker, the temperature increases as tallow becomes the major part of the fluid. The end-point temperature is 110°C-145°C, depending on the type of material. Transit times through the cookers range from 35-90 minutes.

Material discharged from the cooker usually passes over a screen to separate free-run tallow from the coarse solids. The solids are pressed to further separate tallow from solids.

Continuous rendering systems are associated with other continuous operations such as draining of cracklings, feed to presses and tallow refining. This increases the capacity of continuous rendering compared with batch systems and reduces labour.

The capacity of continuous systems range from 3 tonnes to 12 tonnes raw material per hour, depending on the size of the heat transfer area of the cooker and the water content of the raw material.

Advantages, Disadvantages of Continuous Rendering

Although more Australian renderers use batch dry rendering rather than continuous rendering, more product is processed through continuous systems because the efficiencies are more pronounced with higher throughputs.

Continuous rendering is more or less an automatic process and can be operated with less labour than a batch system. A 10-tonne-per-hour continuous system, for example, can be run by one person. An equivalent batch system would require about eight batch cookers and four operators unless the system is highly automated.

Environmental control is more efficient with continuous systems. The rendering odours are better contained in the cooking vessel and can be collected and treated. Little odour escapes during loading and unloading, as occurs with batch rendering. Similarly, continuous rendering is more energy-efficient because the loss of heat that occurs during loading and unloading batch cookers is avoided.

A current disadvantage of continuous dry rendering is that material cannot be pressure-treated in the rendering vessel. Raw materials with a high wool content cannot be satisfactorily treated in a continuous cooker because the wool fibres are not broken down when cooked at atmospheric pressure. Additionally, without a pressure treatment, products cannot receive the heat treatments required by some countries.

These disadvantages can be overcome by chemically hydrolysing woolly material before rendering and by pre-pressure treating or post-pressure treating raw material or finished meal.

Compared to batch rendering, continuous rendering is not flexible. Continuous systems are designed for a specific throughput and can be difficult to operate on lower throughputs. Also, it can be difficult to quickly adjust rendering conditions to suit different types of raw material, particularly material containing high water and low fat content.

Wet Rendering

About 10% of Australian renderers use some form of wet rendering. Wet rendering systems are all continuous processes and can be considered in three stages.

In the first stage, materials are heated to coagulate protein and release water and tallow from the material. In the second stage, free water and tallow are separated from the solid material, and, in the third stage, the solids are dried.

Raw material is broken into a small particle size in preparation for wet rendering, particularly in those systems which use a short heating time. Typical raw material size is 12 mm.

Wet rendering's initial heating stage has three approaches. Systems such as MIRINZ low temperature rendering (MLTR), Pfaudler and Alfa Laval centriflow use a short heating time of 5-20 minutes at about 95°C. These systems depend on a small particle size of raw material, and materials are highly fluidised in the rendering vessel to achieve rapid heat transfer into the particles.

Material is heated either by direct injection or by steam coils. Tallow or water may be re-circulated to the rendering vessel to achieve the high degree of fluidisation needed to quickly heat materials.

Stord Bartz and Atlas systems require longer heating times and use indirect steam heating through the rendering vessel shell and discs on a central shaft. These heating vessels are similar to small-scale, continuous dry rendering systems.

After the pre-heating phase, tallow and free water are separated from the solid particles with decanter centrifuges in the MLTR, Pfaudler and Alfa Laval systems and by pressing in Stord Bartz, Atlas and Rendertech systems. In all cases, the liquid phase is a mixture of tallow and stickwater by centrifugation. The solids still contain about 50% water after liquid phase separation.

The various systems for drying the wet solids are interchangeable with the various pre-heating and liquid phase separation systems. Batch dry cookers, direct-fired cascading rotary dryers (Flo dry and Duske) and indirect steam-heated contact dryers such as the Stord Bartz disc dryer are all in use with wet rendered product.

Advantages, Disadvantages of Wet Rendering

The main advantage of wet rendering is that much of the water in raw materials is removed by physical means (centrifugation) rather than by evaporation. Consequently, wet rendering systems use less heat energy than dry rendering systems. The difference in energy uses between wet rendering and dry rendering increases with water content in the raw material.

If the heat used to evaporate water in dry rendering can be recovered and used, the energy advantage of wet rendering is small.

The quality of products from wet rendering is claimed to be better than that from dry rendering. Since the tallow temperature does not exceed 100°C in wet rendering, the tallow usually has a low bleached colour even though the raw material may be dirty.

Wet rendering systems are well suited to processing relatively dirty raw material with low fat content. Since it is less important to wash gut material processed through wet rendering, tallow yields may be improved because losses during washing are avoided. Also, the residual fat content in wet rendered meals is low, thus maximising tallow yield. Plus, wet rendering systems generally produce low odour compared to dry rendering.

A large volume of stickwater is produced by wet rendering – about 40% of the raw material. Additionally, this stickwater contains nutrients and fat – about 150,000 mg COD/L. As a result of volume and content, treatment and disposal of the stickwater can be difficult.

Loss of product yield can be another problem. Because stickwater contains about 4% protein and 2% fat, product yield is reduced. Renderers, however, can combat this problem, since the stickwater can be concentrated by evaporation and recovered as product.

Wool and hair in raw materials can be another challenge in wet rendering systems. These materials are not broken down in the rendering process and may appear in the meat meal or be caught on screens. In direct-fired dryers, wool may be scorched and subsequently broken in the hammer mill. Woolly materials should be chemically hydrolysed or kept out of raw material processed by wet rendering.

Doubts exist about the ability of low temperature rendering systems to sterilise meal. While wet rendering systems usually do not apply pressure treatments, no evidence exists to suggest that the degree of sterilisation of meals from wet rendering systems is any less than from continuous dry systems. Pressure treatments of raw material or finished meal can be added to wet rendering systems.