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BLENTECH ROTAMASSAGER

Patent Applied For

RotaMassager Development

This development relates to a meat marinating machine and specifically to a machine for massaging a liquid into the structure of the meat by massaging the meat under a vacuum and simultaneously chilling it to a temperature very close to its freezing point. The system has substantial advantages when used on meat products such as poultry, ham, beef, and turkey.

Background of the Development

For many years various equipment has been used to work a marinating liquid into meat products. Originally, the method used was to inject the liquid into the meat by means of a series of hollow needles which penetrated into the muscle structure of the meat. The liquid was injected through these hollow needles. More recently it was found that by massaging the meat under a vacuum in the presence of the liquid, the air in the meat could be extracted and the liquid would replace the air. For some large pieces of meat a combination of liquid injection and vacuum massaging was used to more evenly distribute the liquid throughout the meat structure.

Typically, the liquids which are massaged into the meat are water-based liquids which contain different additives to produce different results. These additives may include phosphates, salt, flavorings, proteins, binders, tenderizers and other meat additives.

The challenge has always been the best method to get the liquid additives into the meat, distribute it evenly throughout the meat structure, and avoid having the liquid purge out of the meat later during processing the meat or after packaging. This purging process occurs regardless of whether the meat is packaged raw or cooked. As much as 50 percent of the liquid will ooze back out of the meat during further processing or after packaging resulting in reduced flavor, lower yields and an unattractive appearance inside the package. This purging problem is especially significant when the product is cooked. It is inevitable that a certain amount of liquid will come out of meat products when they are cooked, however, vacuum massaged products sometimes lose most of the liquid which was massaged into the meat during processing.

The type of equipment used for vacuum massaging varies. In the ham industry, the most common type of machine used for vacuum massaging is a drum vacuum tumbler with internal vanes which rotate around a horizontal axis. The product tumbles over the vanes under vacuum causing the liquid to be massaged into the meat. Most of the poultry industry also uses a tumbler for marinating, however, a single agitator or twin agitator vacuum mixer is sometimes used. This is a horizontal tub with paddles fixed to horizontal shafts which rotate through the product. The action of the paddles against the product creates the massaging energy which works the air out of the product. Under a vacuum this action massages the liquid into the meat.

During the massaging process the mechanical action of either of these systems adds energy to the product causing it to warm up. During a typical massaging cycle for ham of 3 – 4 hours, a 12° - 15°F temperature increase is not uncommon unless the tumbler is operating in a refrigerated room. In a 30-minute cycle of massaging poultry products, a 2° - 3°F increase in the product temperature is common.

Several years ago it was found that if ham products are vacuum massaged at a temperature very close to the freezing point of the marinade, the liquid is stabilized in the meat matrix and a much smaller percentage of it purges out of the meat after processing. This process of chilling the product as it is being vacuum massaged is commonly used in the ham industry where the product is vacuum massaged for several hours.

By jacketing the tumbler drum and circulating a refrigerant through the drum jacket, the ham products could be gradually chilled offsetting the increase in temperature due to the mechanical agitation and taking additional heat energy out of the product causing the temperature to drop down close to the freezing point. The continued vacuum massaging of the product as a temperature close to the freezing point stabilizes the liquid into the meat structure reducing the problem of liquid purging out of the product.

This process is practical in the case of ham products because of the length of time (4 – 5 hours) that the ham is mechanically vacuum massaged. The process is not practical with poultry products since the massaging process lasts only 20 – 25 minutes. There is not enough time in the ham type drum tumbling equipment for sufficient heat transfer to occur to reduce the temperature of the poultry product fast enough.

Process Improvements of the RotaMassager

This development (PATENT applied for) is an improved vacuum marinating machine for products that have a short vacuum massaging cycle. This new machine provides advantages in the amount of heat exchange area that is exposed to the product and at the same time provides a mechanical agitation action which improves the mechanical massaging process to increase the rate in which the product is chilled and the rate in which the liquid is absorbed into the meat products. The result is an undamaged product with a maximum of liquid marinade absorbed and

with the marinade and product reduced to a temperature close to freezing to improve the stabilization of the liquid in the meat matrix.

The machine is comprised of a substantially horizontal cylindrical body with the top open to form a loading opening the full length of the body forming a keyhole cross-sectional shape (see Drawing SKB-070197). A paddle agitator rotates around a horizontal axis inside of this vessel. Triangular shaped paddles are attached to the agitator shaft at an angle to result in the product being pushed toward one end of the horizontal vessel when the agitators are rotated in one direction and then in the opposite direction when the agitators are reversed. The movement of the agitator paddles through the product causes the massaging action to work air out of the product.

The outer wall of the vessel is jacketed with a hollow jacket over the entire area contacted by the product. This jacket has a baffling system which controls the flow of refrigerated liquid through the jacket in a serpentine flow. To provide additional heat exchange area, the agitator shaft and paddle surfaces are also hollow allowing a refrigerated liquid to be pumped through to chill all agitator surfaces (see Drawing SKA-070297). (PATENT applied for.) This machine is designed with a long body with a relatively small diameter. This shape is to maximize the jacket and agitator heat exchange area for any capacity vessel.

The combination of the vessel jacket, the hollow agitator system and the long body shape provide an extremely large surface area for heat transfer for rapid chilling of the product during the short massaging cycle. If a refrigerated liquid such as glycol which has a temperature of 10° - 12°F below the freezing point of the marinade is circulated through the vessel jacket and agitator system, the heat energy put into the product due to mechanical agitation can be offset. In addition the temperature of the product can be reduced by up to 10°F below the temperature of the original product at the time the product was put in the machine. This temperature drop can be obtained in a 20 – 25 minute massaging cycle.

The action of the rotation of the agitator contributes to chilling the product even faster. The drive of the agitator system is designed to automatically reverse directions of rotation every few seconds. The time between reversing of the agitators is variable and programmable. During the rotation of the agitator in one direction, the flow of product over the surface of the paddles on the leading surface of the agitator paddles is more efficient in heat transfer than the surface of the paddles on the following surface of the paddle. When the agitator changes direction there is improved heat transfer on a surface that is colder and, therefore, the product which is flowing over the colder surface will be chilled more rapidly.

The changing of the direction of rotation of the agitator results in chilling the product faster than the product will be chilled if the agitators are rotated only in one direction regardless of the temperature of the refrigerated liquid which is being pumped through the hollow agitator

paddles. It has been found through testing that the more frequently the agitators are reversed, the more effective the cooling (PATENT applied for).

The combination of all of these design elements results in a machine which is substantially more efficient in massaging and chilling than any other machine on the market. Chilling the product more quickly and simultaneously vacuum massaging the product and marinade at very close to

the freezing point results in a product which absorbs more liquid in a shorter period of time, and more importantly, will lock that liquid into the structure of the meat even during cooking to give better yields and a juicier, more flavorful product.

The following is a comparison of the Blentech RotaMassager against conventional drum style tumblers:

- a) Floor space is utilized best with the RotaMassager. The drum style tumbler uses only the lower one-half of the drum requiring a much larger diameter vessel to do the job.
- b) Some brands of tumblers can be dangerous. Sanitation of some brands of tumblers is more difficult and often requires a person to crawl into the unit for proper cleaning.
- c) Vacuum loading of a RotaMassager can be accomplished with a permanent vacuum line. Vacuum loading of most tumblers requires a line to be sealed then disconnected for each batch. The procedure wastes valuable production time – up to 5 minutes per batch.
- d) Yields can be increased through better protein extraction. The AUTO/REVERSE function of the RotaMassager can be set to maximize the mechanical extraction. The AUTO/REVERSE function also increases the contact of the product to the chilled surface of the RotaMassager. Colder extraction temperatures mean higher yields. Our in-plant trials suggest that 2 percent increases are possible.
- e) Product testing has shown that the RotaMassager does not cause any increase in degradation. Poultry products tested were breast fillets, skin on breast, tenders and wings. High agitator speeds did not tear apart any product but did increase protein extraction.
- f) The glycol chilling unit was able to take products from 42°F (5.6°C) to 32°F (0°C) in 25 minutes. This depends on the incoming temperature of the marinade. We do suggest that the marinade be chilled below 36°F (3°C).
- g) The type of phosphate used is critical to produce improved yields. The phosphate must not come out of solution at low temperatures. Only a few phosphates will stay in solutions at temperatures close to freezing. If the phosphate comes out of solution, the product will not benefit from the phosphate addition and lower yields will result. Blentech can recommend a low temperature phosphate.

Operating Cost Comparisons

RotaMassager

The energy cost for running a 12 ton glycol chilling unit including a 60 minutes per hour compressor run time and a .05 kwh rate: for running a 15 HP compressor, 1 HP fan and 1 HP recirculatory pump, the yearly cost should not exceed **\$2,550**, based on a 16-hour day, 5-day week and 50-week year. The initial cost of the chilling unit (12 tons) is \$35,000. The yearly maintenance cost should be low with a complete replacement of the glycol costing \$300.

Drum Style Tumbler Chilled with CO₂

The BTU requirement for chilling 4,000 lbs of poultry products is 44,800 BTU. Using a BTU potential of 84 BTUs per pound of liquid CO₂ and a cost of \$0.04 per pound; the cost per batch is **\$21.33**.

The yearly cost for 1 batch per hour is \$85,328.

The yearly cost for 1.5 batches per hour is \$127,980.

The yearly cost for 2 batches per hour is \$170,640.