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CRYOTROL

Cryogen Control System for Chilling and Forming

General Description

Cryotrol is a control system that can determine the exact amount of liquid nitrogen or carbon dioxide required to be mixed into meat products to sufficiently freeze the meat until it is stiff enough to form effectively. The computerized control system indirectly measures the viscosity of the product and turns off the flow of cryogen when the proper forming viscosity or stiffness is reached.

Background

There is a large market for meat patties and other shapes composed of whole muscle pieces formed together. During the removal of meat from the bones of beef or chicken many small pieces of flesh are generated which have much less value than the large fillet pieces. When these small pieces are formed together into larger shapes, the value per pound of meat increases dramatically. In order to form them together and remain intact until they are cooked, it is necessary to partially freeze the meat to help solubilize the myosin protein and make the product stiff enough for forming.

In the industrial processing plants, the freezing of the whole muscle meat pieces is typically accomplished with carbon dioxide or liquid nitrogen spray inside of a twin agitator meat blender or vacuum tumbler.

Liquid CO_2 and liquid nitrogen are expensive per pound. It normally takes more than one half pound of cryogen to chill one pound of meat stiff enough to form it, therefore, the cost of cryogen is a very significant part of the overall cost of producing a formed product. It is not uncommon for a processor to spend three or four hundred thousand dollars per year to operate a chilling vacuum tumbler or twin agitated blender.

Processor often waste up to 20% of the cryogen because they have no accurate way to control the amount used to chill the product for forming. The three control methods most commonly used are, the sound of the product tumbling inside the drum, the total accumulated tumble time, or the temperature of the product at the end of the preset cycle. None of these methods are consistently accurate.

The temperature method is not accurate because it is only necessary to freeze 30 to 40 % of meat cells to get the product stiff enough to form. Since the temperature of matrix remains constant throughout freezing, it is impossible to know the percentage of cells frozen by simply measuring the product temperature.

The chill time method lacks accuracy because there is a potential for variable cryogen flow rate. Factors such as cryogen delivery system design, storage tank configuration, tank level and demand from other machines can result in fluctuating pressures and flow rates.

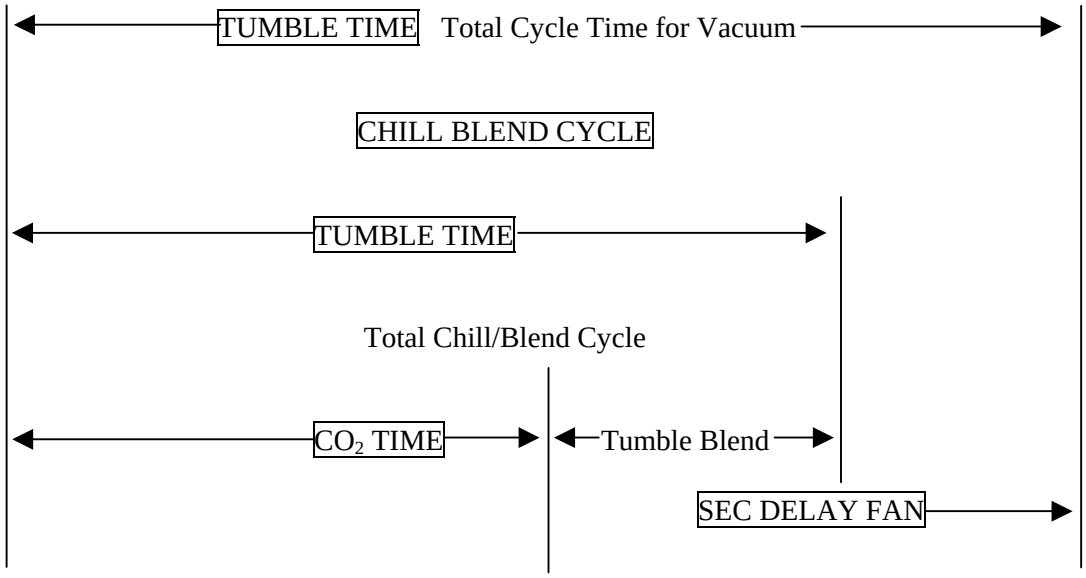
The most widely used control method in the industry today is to train the operator to recognize the sound generated by the product at the proper forming point. As the product starts to freeze is begins to sound like gravel rolling around inside the drum. One of the fundamental problems with this method is that it is left to the judgment of the operator and potentially varies from batch to batch. The tendency is to chill a little more than necessary to be certain. High levels of factory noise can also play a large roll in operator variability. These factors result is wasting the expensive cryogen.

Description:

As cryogen is sprayed over the product for chilling the load on the variable frequency drive increases. This value continues to increase until the product begins to freeze. Once the product begins to freeze the load, or energy, required to turn the motor starts to lessen. There is a fixed relationship between the length of time it takes to reach the maximum energy level and the length of time it takes to become adequately chilled for forming. Cryotrol continually measures this load or torque required by the motor and compensates for variable flow rates of cryogen, initial product temperatures and variances in product batch capacity.

Basically, Cryotrol measures the torque required to turn the motor and until the product begins to freeze and the torque curve peaks. After a peak has been reached, Cryotrol determines the amount of time remaining required to chill for forming. The control system can react to automatically stop the flow of cryogenic within seconds of reaching the point where the product is stiff enough to form. The proper stiffness for forming is established manually by trial and error methods, and then locked into the PLC control.

VACUUM TUMBLE BLEND CYCLE



Calculating your estimated savings:

Facts for Chicken Products

Specific Heat	.79-.83
Latent Heat	90-100 BTU/Lb
CO_2 Pressure at tumbler	300 psi
Freezing Point	27.0 °F
BTU potential per lb of CO_2	84 BTU/Lb

Assume we want to chill 2,500 lbs for forming:

Chill from 40°F to freezing:

Product weight (M) x specific heat (SH) x Temperature change
(2500 lb) (.80) (40 °F-27°F) = 26,000 BTU

Freeze all product cells:

Product weight x Latent Heat
(2,500 lb) (95) = 237,500 BTU

Freeze only 35% of cells:

Product weight x Latent Heat x (% freeze)
(237,500 BTU) (35%) = 83, 125 BTU

Total BTUs if product is chilled down to 26 °F:

26,000 BTU + 237,500 BTU = 263,500 BTU

Total BTUs if product is just chilled to the point it can be formed:

26,000 BTU + 83,125 BTU = 109,125 BTU

Assume a conservative average of 10% overshoot per batch:
Savings per batch:

(109,125 BTU x (110%) – 109,125 BTU) x 1/(84 BTUs per lb CO_2) = 130 lbs CO_2

Savings per year:

130 lbs CO_2 per batch x 1 batch per hour x 16 hours per day x 5 days per week
x 50 weeks per year = 520,000 lbs per year

Summary

Historically, no accurate method has been available to control the amount of liquid CO_2 or liquid nitrogen used to chill products in tumblers. Controlling by elapsed time, temperature or having the operator control it by listening to the sound inside the drum is unreliable. With the rising cost of cryogen it is very easy to waste $10,000 to $20,000 per year, per tumbler due to inadequacy of control.

The PATENTED new Blentech Cryotrol System measures the force required to turn the tumbler drum. As the product stiffens during chilling, the drive force increases to the point that the product starts to roll into balls. The Cryotrol controller processes this data to determine the exact moment when the product will be stiff enough to form properly. At this point, the controller automatically turns off the flow of cryogenic. The system can produce optimally chilled product that is uniform from batch to batch, thus eliminating over chilling. This translates into cost savings for you.