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Continuous Processing of Sausage Products.

While the average American or Canadian frankfurter may bear little resemblance to the German smoked sausage from which it is derived, nevertheless its popularity in these two countries is enormous. Americans consume over a billion pounds per year and Canadians, relative to their population, almost as much. It is, therefore, perhaps not surprising that, in recent years especially, extensive mechanization of the manufacturing process has taken place.

Traditionally, frankfurters have been prepared by making a fine "emulsion" of meat, fat, water and spices, with or without an added cereal or protein "binding agent". This emulsion originally was stuffed into casings prepared from animal intestines, but for many years such casings have been almost completely supplanted by artificial ones prepared from regenerated cellulose. In either case, the stuffed casings were linked into sausage lengths by twisting or by tying with string. The linked casings were then hung on sticks which in turn were placed on racks or trucks which could be pushed into chambers for the various smoking, cooking, and chilling steps required. In the case of frankfurters smoked in cellulose casings, the casings were usually removed by hand prior to packaging.

Today, frankfurter emulsion in larger factories may be pre-

pared in 1000 kg or larger batches, using combinations of ingredients selected by a computer to give, at the lowest possible cost, the quality characteristics desired in the finished product. In one system mechanical devices automatically load casings onto a stuffing horn, stuff the casings to predetermined diameter at rates exceeding 60 meters per minute, twist the stuffed casings to form 500 or more individual frankfurters per minute, and finally deposit the linked casings on hooks on a conveyor for transport through smoking, cooking, and chilling zones. Other machines then strip the casings from the frankfurters at high speed, group the skinned franks into consumer-sized lots, and deposit them on the conveyors of vacuum or gas packaging machines. Little or no hand labour is involved in performing this sequence of operations.

The conveyorized smokehouse is an integral part of any continuous frankfurter processing system. This paper will discuss the various types of systems that have been developed in North America over the past ten years.

All of the commercial systems in operation in the United States and Canada today involve stuffing and linking in cellulose casings. There would be obvious advantage in a system that did not require the use of casings, and numerous U.S. and Canadian patents have been issued on methods for producing frankruters without casings. Of these, only two have been carried to commercial development. These are the Swift & Co. system, first introduced in the United States in 1960, but since abandoned, and the Emhart system, introduced in 1963 but now also abandoned.

In the Swift system frankfurter emulsion prepared by conventional means was pumped into banks of Teflon-lined moulds. The ends of the moulds were formed by concave electrodes of stainless steel plated with gold. 10,000 cps current from a motor-generator set at 350 volts was passed between the electrodes, heating the emulsion to aout 55°C in 8 seconds.

The frankfurters thus formed were then ejected onto a belt conveying them through smoking, heating, and chilling zones. During passage through the first two zones the product was heated to an internal temperature of 71°C. This required about 60 minutes. Chiling required 20 minutes, the product being discharged at about 4°C and ready for immediate packaging.

A number of these units, ranging in capacity from 230 kg per hour to 1100 kg per hour, were installed in Swift & Co. factories in the U.S., but it is our understanding that none are in operation at the present time. The chief problem appeared to be in the appearance and texture of the finished product. Thus, the ends were not rounded and the surface was rough.

The Emhart system was similar to the Swift except that 1800 volt current was used for preheating the emulsion in the moulds. This raised the product temperature to 68°C in 0,6 seconds. Because of the higher temperature at the time of ejection only 8 minutes of conventional smoking and heating time was required. Only one commercial installation was made. This was a unit with a capacity of 340 kg per hour. It is no longer in use, presumably because of problems with appearance and texture.

Five systems have been developed for processing frankfurters on a continuous basis in cellulose casings. Three of these are in general operation in the U.S. and Canada today.

The first system was developed by Canada Packers in 1957. Frankfurters stuffed and linked by conventional means were hung in long loops from the hooks of a conveyor describing an S-shaped path through separate smoking, cooking, and chilling zones. The product was heated to an internal temperature of 71°C, and because of the comparatively rapid rate of processing it was necessary to add ascorbic acid to the emulsion to obtain satisfactory internal colour development. A number of these systems have been installed in the U.S. and Canada, ranging in capacity from 680 to

3400 kg per hour. Some current units use liquid rather than conventional smoke. Where this is the case, the uncooked frankfurters first pass under cold water sprays to remove any loose emulsion, then under liquid smoke sprays prior to entering the heating chamber.

A system similar to the Canada Packers one was developed by the Schmidt Provision Co. in 1963. The main differences were in the design of the heating and smoking chambers, the method of loading the conveyor, and in the method of chilling. The Schmidt process also employed a spray treatment of the uncooked frankfurters with an edible acid, in order to facilitate removal of the casings at the completion of processing. A number of installations ranging in capacity from 885 to 2700 kg per hour have been made in the U.S. and Canada.

The third system in commercial use is that developed by Oscar Mayer in Madison, Wisconsin. Special equipment is used to stuff 10 cellulose casings simultaneously. The casings, as they are filled, move onto parallel conveyors each equipped with mechanical crimping means at frankfurter-length intervals. The stuffed casings are formed into frankfurters when the crimping means close at the start of the process. The strands remain crimped in this manner throughout the entire processing cycle. The general U.S. Patent describing the Oscar Mayer process indicates that the total processing time is 38 minutes, in 9 processing stages. In the first stage the product is smoked for 7 minutes at 40°C. It then moves through zones of increasing temperature until a "house" temperature of 104°C is reached. When discharged from this zone the product has an internal temperature of 77°C. The frankfurters are then conveyed under cold water sprays for 2 minutes, and finally under brine sprays at -9°C for 7 minutes.

At the completion of chilling the crimping means open and special machines remove the casings from the product. The

skinless frankfurters then move to the packaging machine where they are vacuum-packaged in Saran film extruded from resin directly onto the packaging line. This system is undoubtedly the most sophisticated in operation in North America today. The capacity of the unit at the Madison factory is reported to be 1600 kg per hour. Similar systems are installed at all five Oscar Mayer factories.

A fourth system, which has apparently not yet passed the protype stage, is that developed by the Visking Division of Union Carbide, a large supplier of cellulose casings. As in the Canada Packers and Schmidt processes, conventional stuffing-linking equipment is employed. However, the linked frankfurter strands, instead of being hung on hooks, are laid in stainless steel baskets for transport through smoking, cooking, and initial chilling zones. The frankfurters are discharged from the baskets for final chilling under brine sprays at -4°C, and are conveyed to conventional stripping machines for removal of the casings.

The total processing time is reported to be about 35 minutes, with 8 minutes in smoke, 16 minutes in cook, and 11 minutes in chill. The capacity of the one protype unit in operation at the present time is 800 kg per hour.

One final system remains to be described. This system involves a rather daring departure from conventional processes, but unfortunately it has not been successful. Several commercial units were brought into operation but we believe all have now been abandoned.

Basically, the system substitutes a solution of dextrose and salt for the heated air used in conventional frankfurter processing. This provides much more rapid heat transfer, but presents problems of metal corrosion and solution contamination.

The Frank-O-Matic process (as the system is called) employs conventional means for filling the casings with emulsion, but the stuffed strands are formed into frankfurters and

conveyed through the process in a similar manner to that in the Oscar Mayer process.

The strands, linked by crimping means, are first conveyed for 7 1/2 minutes through a smoke chamber at 99°C. They then pass up and down through a tank containing about 7500 liters of a solution containing 40 % dextrose and 10 % salt, at a pH of 4,5. The temperature of this tank is about 74°C. Dwell time is 14 minutes, the product reaching an internal temperature of 68°C. The frankfurters are then conveyed through a solution of similar composition held at -4°C. Dwell time in this tank is 7 minutes, the frankfurters emerging at a temperature of about 7°C. The crimping means are then released and the individual frankfurters squeezed out of the casing by a special device on each strand. After removal of the frankfurter, the empty section of casing is cut off to facilitate release of the next frankfurter.

After removal of the casings, the frankfurters drop on a shaker-conveyor equipped with a moving absorbent paper belt. This belt dries the product and conveys it to the vacuum packaging machine.

The solutions for cooking and chilling are filtered continuously through beds of sand and activated charcoal.

The production capacity of each unit built to date has been 440 kg per hour. Severe problems with corrosion of the conveyor chains and linking means have, however, been encountered, and none of the units are in operation at the present time.

While it is clear that many millions of dollars have been lost in the development and construction of unsuccessful continuous frankfurter processing systems, it is also clear that the future trend will be more and more to continuous processing. Already there are at least 16 continuous units in daily operation in the U.S. and Canada. These units range in capacity from 450 to 3500 kg per hour.

The advantages of continuous processing are substantial.

Product uniformity is greatly improved, shrinkage is more accurately controlled, and labour is practically eliminated. In the more automated systems operators are present only to inspect for detective product and to monitor equipment operation.

Where does the industry go from here? It would appear that nearly all of the labour that can be saved has been saved. There is, however, one very substantial saving still to be made. In the U.S. alone over $ 20 million is spent annually for cellulose casings for frankfurter production. These casings serve only to shape and contain the product during smoking, heating, and chilling. At the completion of these operations they represent only a removal and waste-disposal problem.

Some day, perhaps in the not too distant future, a method will be found for manufacturing frankfurters of acceptable appearance and quality without the use of casings. This will be good news for the meat processor, if not for the casing manufacturer.