

Kraken Automation

Processing (Food Industry)

White Paper

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Processing Systems (Food Industry)

Introduction

Processing systems are as varied as the products being manufactured. Entire processes are comprised of several sub process systems, each with a specific purpose that provides an integral function in the manufacturing of a specific product.

This document will highlight and describe several processes pertaining to two types of food industry sectors, namely cereal, and biscuit manufacturing systems.

A. Cereal Processes

Cereal Cooking Preamble

Manufacturing of breakfast cereals is an art turned into science. One of the first important steps in this process is the cooking of blended cereal grains, minerals and vitamin additives. The cooking process is one that involves three key process variables, which are time, temperature and moisture. From a chemical standpoint, cooking deals with the conversion of indigenous starch granules within the cereal grain into an amorphous, somewhat homogenized form. More specifically, the starch granules are composed of linear glucose polymers (known as amylose) and a branched glucose polymers (known as amylopectin). The composition ratio of these polymers within a given type of starch will depend on the grain used. For wheat, rice or corn type starches, the ratio is approximately 25% amylose, 75% amylopectin.

Cooking, whether it is by continuous cooking or extrusion methods, causes the starch granules to soften and expand with moisture, creating an amorphous mass, a mass that can be processed further to form the desired end product. It is important to note that the three key process variables, time, temperature, and moisture must be properly applied to avoid over-cooking, resulting in a degradation of the starch, and loss of the cooked mass viscosity.

Understanding the behavior of these starch polymers, which are complex in structure, is an important step in determining the proper process operating parameters, either for continuous cooking or extrusion. When exposed to different pressures, temperatures and shear, the complexity of the polymer structure causes the material mass to exhibit properties that have viscous tendencies as well as elastic capabilities. Hence, the cooked material exhibits viscoelastic properties, demonstrating different attributes under different conditions. For example, when left to rest on a flat surface, a cooked dough ball will eventually, over time, spread and flatten, behaving like a viscous liquid. Yet, when pulled, the mass will stretch and eventually break, much like an elastic mass. Determining the

correct cooked consistency requires an understanding of the material being cooked, and the use of specialized instruments to ascertain the process operating requirements and end results. Rheometers are one such instrument food many scientists use in making these determinations. These instruments, which have various designs depending on the material analyzed, will determine such things as the viscoelastic, molecular architecture, melt, fracture and die swell properties, all of which are important in determining reliable cooking or extrusion operation.

Continuous Cereal Cookers

Continuous cereal cooking is one method of cooking cereal grain starches, and is sometimes referred to as low-shear cooking. Typically, this cooking method takes wetted meal (cereal grain, minerals, vitamins), with a moisture content of around 40% - 45%, and heats this mass while undulating in a rotary cut and fold system to around 85°C. The heat introduced into the wet meal mass causes two reactions to occur in the cooking of the starches, which are referred to as gelatinization and pasting. The pasting stage is normally where the mass becomes amorphous and swells due to softening and loss of starch solids.

Continuous cookers physically are comprised of two sections. The main cooker body performs the gelatinizing by taking mixed meal combined with water at one end of the cooking cavity, heats the product by steam jacketing the cavity, cuts and folds the mixed meal as it is cooked using a large ribbon type agitator, and slowly migrates the cooked



mass down the length of the cooking cavity towards the die forming end. By the time the mixed meal mass has reached the die forming end of the cooker, the mass is well cooked and very amorphous, almost the consistency of a pliable dough, but without the stickiness.

Cooked meal is then extruded through a die head which forces the mass through a metal plate or ring that is perforated with a smaller scaled shape of the product to be manufactured. The section of the cooker provides higher shear and pressure, providing the pasting of the dough mass. For example, a ringed cereal product like Cheerios™, would have a die head perforated with small ring shapes, whereas a flake type cereal which is formed from a small pellet, would utilize a die head with small holes. As the cooked meal mass is extruded through the die head, a high speed cutting blade cuts the shaped extruded mass into little dough bits, termed pellets. Again, the die head used determines the shape of the cut pellet.

The addition of mixed meal and water is closely regulated; typically using solid gravimetric feeders (loss-in-weight) for the mixed meal, and coriolis based mass meters for water. The mass ratio is set to provide the cooking moisture content (40% - 45%), taking into account that the dry mixed meal typically contains 20%-27% moisture. Residence time in the cooker cavity is important as longer cooking periods allows for flavor development, which extruded cereal cannot duplicate due to the limited cooking time. In some applications, cookers are placed on weighing systems to maintain a set mass within the cooker during steady state operation, ensuring that the applied temperature and speeds are compensated against resident mass. This ensures a consistent cook regardless of the variances induced during steady state cooking.

Cereal Extruders

Continuous cereal extrusion is another method of cooking with an added advantage, namely that the cereal grains can not only be cooked, but puffed to form the end product in one process operation. Extruders can be configured and operated to extrude cooked dough (gelatinized and pasted) in a similar form as continuous cookers, or can extrude cooked, puffed cereal. The configuration defines the extruder zone layouts, extrusion screw flight configuration, screw speeds, zone temperatures, and rates at which water and other brand additives are applied.

Continuous cooking is low shear, extended, long duration process, requiring high moisture content in the cooked material. Moreover, additional process unit systems are required downstream to condition and form the final product. Extruders are a high shear process, providing cooking and forming of the product in one process operation. This is an attractive feature, as the final processing systems are substantially simplified, requiring fewer processing units. Why then would extrusion not be the defacto cereal processing system used? The reason is simply because continuous cooking offers more variability in the areas of cereal taste and texture. Many core cereal brands rely on these attributes, which establishes their user groups. Extruded cereal has established a market, and can be made to closely approximate cereal cooked by traditional means, but it has not achieved certain qualities only found from continuous cooked and formed processes. It does, however, provide for quick changeovers when manufacturing various products, as extruder designs are becoming increasingly modular.

In extrusion systems, a single or two co-rotating screws are contained within a heated chamber, typically demarcated within three zones, namely, the feed zone, the kneading zone and final cooking zone. Material entering the extruder is gradually exposed to higher pressures and temperatures, due to the smaller volumes contained in the extruder screw flights as the material progresses through the extruder body. Around the latter section of the extruder area, the dough mass characteristics change to a shiny, yellow viscoelastic fluid. This fluid has altered physical properties from the dough mass, and can expand and retain gas when it exits the extruder.



Since the fluid at the extruder discharge is at a temperature of 165°C to 180°C, steam can be driven out of the product as it exits the extruder, providing a puffing operation to the product as it cools. Residence time within the extruder is significantly shorter, in the order of seconds vs. minutes in a continuous cooker, since the high stresses and temperatures force the starch to convert more quickly. The caution with using extruders is the sensitive operating range for temperatures and shear stresses, as excessiveness in these areas cause fragmentation of the starch polymers into progressively smaller components, resulting in products exhibiting a distinctive taste, known as “extruded flavor”. Moreover, excessive moisture content is exasperates product quality leaving the extruder. Due to the high temperature/pressure environs of the extruder, this excessive moisture causes the viscoelastic fluid to immediately expand, followed by a sudden collapse, which results in products with high density with undesirable textures.

For specific brand cereals, additional additives are injected into various zones in the extrusion system to add flavor, sweetness and color. The final cooked product exiting the extruder is shaped by the die cap inserted into the extruder end, and by the high-speed cutting blade/wheel at the extruder’s product discharge port. Pelletized products used for flaking or shredding are cut with minimal puff, while puffed products are allowed to expand slightly before cutting.

Pellet Drying

In ready-to-eat cereal manufacturing, formed cooked dough pellets are still high in moisture content and very malleable, making their handling in further processing difficult. Hardening these malleable dough pellets is a step typically taken in a multi-pass, steam heated dryer system.



These process units typically have multiple stacked conveyors, routing product from one end to another, and from top down, contained within a temperature and humidity controlled environment. The process at this point is to drive a specific amount of moisture out of the product, allowing it to contract and harden, while leaving resident moisture content for downstream preheating and puffing process units.

As moisture is driven from the product, humidity levels rise. Control of intake, recirculation and exhaust air must be performed to maintain as low a humidity and possible with constant dryer atmospheric temperature. This ensures a specific amount of moisture is driven from the product, ensuring consistent hardness when exiting the dryer.

Preheating and Puffing

Pellets prepared from a cereal cooking/drying process are formed into their final shape using a puffing system. This process can be a batch process, where a charge of pellets are loaded and puffed, or continuously, where pellets are metered through a device known as a 'puffing gun'. The principle of puffing is based on altering the atmospheric pressure and temperature through which the pellets pass, heating the pellet to a high temperature, but not allowing the water moisture to escape due to a high atmospheric pressure (vapour pressure of water is changed to a higher boiling point). When pellets are sufficiently heated in this high atmospheric pressure, they are immediately released to a normal pressure environment. Any moisture retained in the pellet is superheated, and immediately flashes steam, resulting in the product being puffed. This process holds for corn or oat based cereal pellets. Puffed rice is formed by passing rice pellets through a hot air dryer, causing the moisture within to eventually heat and escape as steam, puffing the product. This process is similar to puffing corn kernels in making popcorn.



In continuous puffing processes, the pellets are initially conditioned with a coating. This coating enhances the forming of the final product, enhances flavour and reduces static charge generation. Static charges are typically generated as the pellets chaff against each other as they are buffered in a live storage system (counter-rotating screw conveyors). When a substantial live buffer is contained, the pellets are first introduced into a device known as a preheater. The preheater performs two functions. The first function is further reducing moisture content within the pellets prior to puffing, and the second is raising the pellet temperature to reduce added energy required to further raise the pellet temperature in the puffing process. This device is a large rotating steel barrel, equipped with a large metal coil surrounding the barrel. The metal coil is energized with a medium voltage at medium current, controlled by a high power SCR drive. The coil acts as a transformer, inducing eddy currents within the barrel skin, and the resistance in the skin generates heat from the induced eddy currents. Barrel temperatures are measured using water-cooled, non-contact infrared thermometers, and these temperature signals are used to regulate the SCR drive to maintain a set preheat operating temperature. Pellets enter the top end of the barrel, slanted at 30° to 35° angle, exit from the bottom end, tumbling internally as the barrel is rotated.

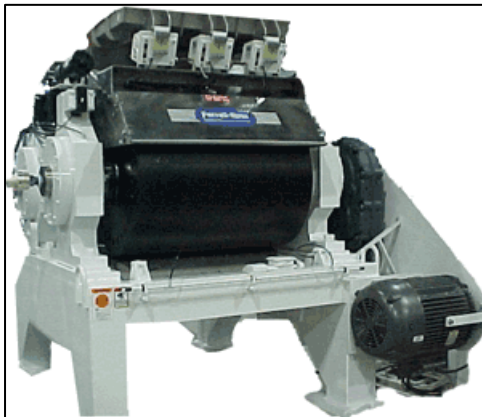
Heated pellets are now presented to the puffing gun for forming of the end product. The puffing gun is constructed similar to the preheater, namely a rotating barrel enclosed within a metal coil, or in some instances, a gas fired refractory. As with the preheater, electrically heated puffing barrels (or E-Guns) have the barrel temperature controlled with a SCR drive, and monitored using water-cooled non-contact infrared thermometers. Refractory heated puffing barrels are heated using an array of gas burners encased within a refractory that completely surrounds the barrel. The main difference between the preheater and the puffing gun is the method by which the pellets are introduced into the puffing barrel. Heating the pellets to higher temperatures without 'flashing' the moisture from the product requires the pellets to be contained within a high-pressure, super heated atmosphere. This is accomplished by metering pellet charges into a superheated steam stream (pressures of 100 psi, temperatures of 650°F to 700°F). Metering is performed using a device known as a sweep valve, where preheated pellets are introduced at the top of the valve, and swept internally to the bottom of the valve, where they are introduced and transported in the superheated steam stream.

This valve provides a means of introducing pellets from a normal to high-pressure environment, while maintaining continuous product flow. Once contained within the barrel, the pellets are further heated and 'roasted' until exiting the barrel out of a gun shaped tube at high velocity. As the pellets are at a higher temperature than when they entered the barrel, and resident moisture in the product is still contained due to the high barrel pressure, the instantaneous change from high temperature/high pressure to high temperature/low pressure causes the superheated moisture in the product to flash steam, thereby puffing the product. The degree of 'puff' is dependent on the amount of moisture resident in the product entering the puffing barrel and the temperature of the superheated steam. The amount of roast is dependent of the barrel temperature, and the speed of barrel rotation.

Quality of cereal exiting the puffing barrel is based on two factors, puffing density and color. Puffing density is determined by taking discrete samples of product exiting the puffing barrel to a known weight, and measuring the volume. Using the same sample, the puffed product is placed in a colorimeter to ascertain proper color attributes. Of late, intelligent vision technology has been incorporated to measure product density, shape and color on line, and in some cases, used as a means of process control feedback to the puffing gun system.

Flaking

Flaking is an alternative process to puffing, where pellets are flattened using a flaking mill. Pellets entering the flaking mills are typically at moisture contents of 10% to 17%, depending on the ingredients used. As an added measure, homogeneity in the moisture distribution, the pellets are held in storage bins for a preset time period, allowing the moisture to settle and evenly permeate within the pellet. In some facilities, this preparation procedure is known as tempering. Once tempered, the pelletized product is conveyed and distributed to flaking mills.



This mill is typically a machine with two large drums, each with a highly polished, smooth surface, rotating such that pellets are directed in between the rotating drums, and subsequently flattened into a flake. Care is taken to ensure that the flakes are of the correct thickness (too thin causes breakage downstream). As high compression of the pellets into flakes generates a substantial amount of heat, the material being flaked will have a tendency to cook, and possibly stick to the drum surface. To prevent this, the flaking mills drums are typically hollow, and cooled from the inside to minimize and/or eliminate sticking.

A final step in flaking is toasting, which also provides an added amount of drying. Toasting is accomplished by passing the newly formed flakes through a hot air stream either in rotating drums or perforated vibrating trays. At the end of this process, flakes will have moisture contents of 1% to 3%.

Product Classification

Puffed product prior to final processing is classified and subsequently stored. Classification is performed on three product attributes, namely shape, density and color. Maladjusted parameters in the puffing process can result in product being too small, too large, charred or fragmented.

Shape classification is performed by vibratory scalping systems, filtering small or fragmented pieces, and forwarding this out of spec product to a side process known as refeed (see below).

Color classification is typically performed on-line using a vision system coupled with a blow-down reject, and offline using colorimeters. For online systems, product is analyzed and subsequently launched across a gap. Areas deemed suspect (due to significant color deviation) is blown down out of the launched product stream. The reject blow down device is a linear array of air jets, programmed to activate from the vision system. Offline analysis is performed when puffed product is sampled for density measurement. Colorimeters are used for this test, where the sample is inspected under different color sources (red, blue, green), and spectrally analyzed to determine color quality.



Discrete sampling of puffed cereal and subsequent measurement of weight and volume provides density classification. In these situations, product is rejected to refeed until it is deemed as within density specifications. Sampling is usually taken after shape and color classification is performed.

Slurry Preparation

Slurry preparation is another side process used in preparing sugar-based coatings for some branded breakfast cereals. This liquid preparation process is typically a batch operation, blending powdered sugar, hot water and specific additives from drum or tank (vessel) contained products (e.g. liquid honey, etc.). All ingredients are batched into a stainless steel kettle, steam heated (jacket), and blended as the ingredients are added. Once batching is complete, the mixture, known as slurry, is further mixed and heated until the sugars thicken.



Kettles used in the preparation of slurries are mounted on strain gauge load cells to provide for automatic weighing and addition of slurry ingredients. All material intake and discharge connections are made flexible to allow for weight measurement. As batches are prepared, they are transferred to a process buffer tank which, like to batch kettles, are steam heated (jacketed) and agitated to keep the slurry fluid for use in the cereal enrobing system (see below).

Cereal Enrobing and Final Processing

Enrobing is another sub-process step that coats puffed cereal with liquid slurries prepared in the slurry preparation process (see above). Upstream of this area, puffed cereal is classified, and good product is retained within a series of large surge bins. Each of these bins is mounted on a strain gauge weighing system to track available inventory of 'base' product for final processing. Similarly, liquid slurries are retained within holding tanks, also mounted on strain gauge weighing systems.



The enrobing process is a continuous operation, whereby base cereal is dispensed by gravimetric belt feeding equipment into one end of a large rotating stainless steel cylinder, called the enrobing drum. Slurries are applied to the base cereal as it tumbles within the cylinder, either through spray nozzles or 'piccolo' tubes. Liquid slurries, as with the base products, are also applied as by mass, as a ratio to the base product mass flow rate into the enrobing drum. For liquids, coriolis type mass flowmeters are used in these processes. Since slurries are predominantly sugar based, the piping and liquid supply equipment (e.g. positive displacement pumps, valves, etc.) is heated to maintain fluidity, and avoid crystallization. Furthermore, these liquid delivery systems are equipped with valving and connections to hot water flushing and/or CIP (Clean In Place) systems to purge slurry from the lines when the liquid delivery system is idle.

The degree of enrobing is determined by the retention time within the enrobing drum, along with the rate of rotation. Retention time is a function of the angle of the enrobing drum from the point where base product enters to the discharge section of the drum, causing gradual or quick migration of product through the drum. Moreover, products with more deliberate coats of slurry would require that the drum slant be more acute to ensure flow out of the enrobing drum.

Once enrobed, the product is dried through another, multi-pass, steam heated dryer system. Similar to the pellet dryer, the final processing dryer ensures the internal dryer atmosphere is maintained to specific temperature and humidity setpoints, ensuring a properly dried finished product. Finished drying also ensures that the finished product exhibits the required palatable textures associated with the branded cereal.

Some cereals are composites of enrobed product and post final drying additives. These additives can comprise of marshmallow pieces (sometimes referred to as 'marbits'), dried fruits, nuts, or combinations thereof. To provide the proper blend and distribution of these additives, finished product is typically retained in final surge bins, and mass blended (using gravimetric belt feeders) with the additive in a continuous mixing process which not only ensures good final product to additive distribution for packaging, but provides for required dust collection and allergen cleaning capabilities (where nuts are used).

Cereal Final Product Distribution

The last sub-process is the distribution of final product to one, or a number of, packaging lines. The method by which final product is distributed may vary from plant to plant, as well as from product to product. Finished ready-to-eat breakfast cereal requires transport systems that are gentle on the product, minimizing dust generation, and maintaining product integrity.



Two methods are typically used in these areas, namely x-axis vibratory conveying, or low pressure dense phase conveying (refer to the Kraken Automation Inc. Materials Handling White Paper). The arrangement of conveyors must allow for buffering and refeed, in the event that the downstream packaging systems are full, as well as the ability to provide flexible distribution to all packaging line storage bins.

Most product distribution systems utilize a packaging line rating with storage bin level based prioritization algorithm to effectively meter product to all enabled packaging lines from a single source of finished product. In this system, an operator will establish which packaging lines are enabled, and the priority of the enabled lines. Using level probes (typically low, middle and high level) in the packaging line storage bin, the control algorithm will attempt to satisfy all low levels within all enabled packaging line bins, starting with the highest priority line down to the lowest priority. When all low levels are

satisfied, product is distributed until all mid levels are satisfied, again starting at the highest priority line down to the lowest priority. This is repeated for all high levels when the mid levels are satisfied. If, during this filling procedure, any bin level receded below the low levels, those bins would be

B. Biscuit Manufacturing

Biscuit Manufacturing Preamble

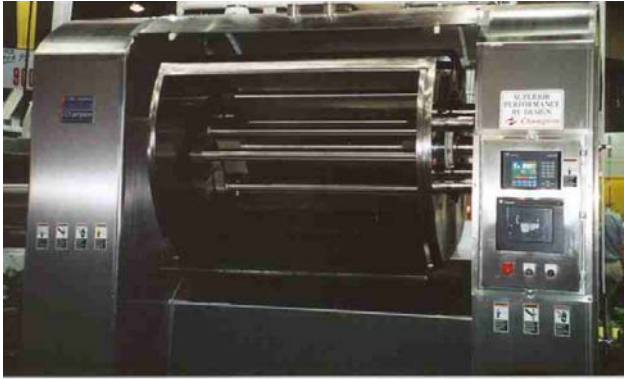
Biscuit manufacturing pertains to the preparation of, and processing of prepared dough. Unlike cereal manufacturing, which requires a form of shearing and heat to gelatinize and cook cereal grain, dough is prepared in a batch process, combining solid and liquid components (flours, sugars, molasses, liquid yeasts, etc.), kneaded in a large mixing machines, and allowed to rise in a process known as proofing.

This process of dough preparation is also used in bread manufacturing, but utilizes different machines to handle the dough and bake bread type products. This review of biscuit manufacturing will discuss specifics in the processes involved pertaining to wafer or cracker type products.

In the biscuit and bakery business, the prepared dough is sometimes referred to either as “soft” or “hard” dough. Hard dough is typically used for traditional crackers type products; whereas soft dough is used more for soft biscuits, snack products and cookies.

Mixing and Proofing

The preparation of biscuit dough begins by mass batching liquid and solid ingredients into a large dough-mixing machine. Raw ingredients will typically include oat flours of various types (white, stone ground, etc.), sugar, baking sodas, liquid lards, cream yeasts, baking sodas and water. For specialty products, other ingredients are added to provide color or flavor (i.e. cheese powders, molasses, etc.). Hard dough products tend to use more chemical leavening (i.e. baking sodas), versus soft dough, which uses more yeast as the active leavening ingredients.



After all desired ingredients are batched, the components are thoroughly blended and kneaded in a large dough mixer for a preset time period. This ensures full incorporation of all liquids within the solids, and complete dispersion of the active ingredient, yeast, within the dough prior to proofing. The mixers are designed to dispense the mixed dough batch by reclining the mixer body, dropping the charge of mixed dough into a reject chute,

or receiving tub. Good dough batches are subsequently moved into a proofing room. In certain applications, mixers are equipped with variable speed mixing to provide the staged mixing, beginning with incorporation of products to high speed mixing/kneading.

Proofing is a process step to allow the active ingredient in the dough, which is either yeast or baking sodas, to ferment, allowing the dough to rise. Good batches of dough, contained in large stainless steel tubs, are arranged within an enclosed room that has a warm, humid atmosphere. Temperatures within the proofing room are stabilized around 26° C to 30° C with 95% to 100% humidity levels, allowing the dough to properly activate and ferment. Proofer room air temperatures are maintained using a return air handling system, using steam heating to raise the room temperature, or mixing outside air as required to lower room temperature. Humidity levels are managed through the use of relative humidity sensors positioned opposite to steam misters, which inject humidity into the proofer room atmosphere. Tubs are retained within the proofing room for one to two hours, depending on the product manufactured.

Lamination

Lamination is the initial step in the manufacture of sheeted biscuits (such as saltine type crackers), as opposed to formed biscuits, which are processed using a dough-forming machine (see below).

Proofed, hard dough is extracted from the proofing room, within a portable tub, and dispensed initially into a roll former. This device is a large hopper, with stainless steel rolls located at the bottom, to draw the dough out in a thick sheet. The separation between the discharge rolls is adjustable to achieve a desired dough slab thickness, which is subsequently conveyed to the infeed section of the laminator.

The dough slab entering the laminator is again compressed to a thinner slab using another set of infeed rollers. After exiting the rollers, the thinned slab is dusted with flour to prevent further sticking within the laminator process. Passing the dusted slab through a vertical oscillating conveyor performs the lamination process by zigzagging the slab onto a horizontal belt conveyor. Lamination is the process, which provides the tiered, wafer like texture of the cracker/biscuit after final forming and baking. The laminated dough sheet is sized to the correct width for the downstream sheeting processes, and to the correct thickness for the first gauge rolling system.



The laminator discharge conveyor is also typically equipped with a metal detector to sense metal contamination after initial rolling and lamination. A variety of techniques are used to handle suspect dough sections, from stamping the section for removal, stopping the laminated sheet conveyor, to a having the end of the laminated sheet conveyor equipped with a cutting knife and nosing section to reject the suspect area.

Gauge Rolling



Gauge rolling is the second step in the manufacture of sheeted biscuits. This section typically consists of three pairs of gauge rollers with apron type belt conveyors, each equipped with a 'skinner' blower.

The gauge rollers comprise of an upper and lower stainless steel roller drum set to a preset separation. In a typical, three gauge roller system, each roll pair separation is gradually reduced from the upstream to downstream roller pairs, as are the roll speeds. Gauge roll speeds are set to specific ratios depending on the biscuit manufactured.

After each gauge roll, the flattened dough sheet is laid onto a discharge belt conveyor, and exposed to an air stream using a blower in a process known as 'skinning'. By exposing the dough sheet to this air stream, a thin, slightly hardened skin is formed onto the sheet to aid its handling into the downstream gauge roller (preventing sticking).

After the final gauge roll and apron discharge conveyor, the sheet is conveyed on a horizontal belt conveyor, and allowed to 'relax'. Relaxation is an interim step prior to cutting, which allows the dough sheet to set and stabilize. During gauge rolling, the dough sheet dimensions will be in flux during forming and thickness sizing. Thus, this conveyor is referred to as the relaxation conveyor.

Cutting, Trimming and Salting

Cutting, trimming and salting are subsequent steps in the manufacture of sheet biscuits to cut the dough sheet to the desired shape, trim the excess from the sides, and salt the cut sheet prior to baking.

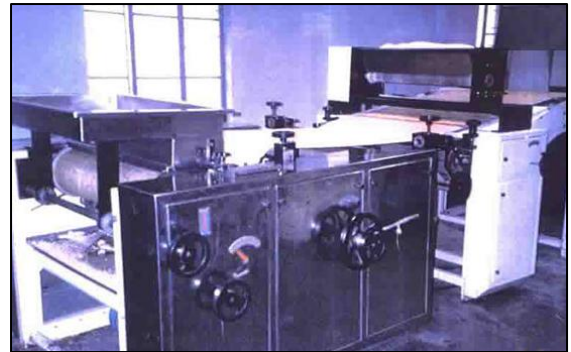
The cutting section comprises of one, or two, rollers with preformed shapes within the roll faces that are positioned at a preset distance above the belt conveyor moving the relaxed dough sheet. Furthermore, the cutting roller rotations are paced to the belt conveyor speed to cut the dough sheet cleanly as it passes through the cutting rolls.

Excess dough at the edges, or scrap around the cut dough is removed in-line, onto conveyors, which are closely paced to the main belt conveyor speed. All scrap dough is typically re-routed back to the front end of the process via a series of small scrap belt conveyors, usually into the infeed of the dough laminator.

Cut and cleaned dough is finally salted prior to entering the baking oven. This machine is a grooved roll which slowly sprinkles salt from a storage hopper (above the roll) evenly onto the prepared dough sheet. As the salter conveyor is the last conveying system before the baking oven, the end of this conveyor is typically designed with a nosing attachment to allow retraction of the conveyor when the dough sheet is out of specification and needs to be scrapped.

Dough Forming

Dough forming is an alternate preparation procedure to the lamination/rolling/cutting method. This method is typically used when a formed biscuit with a very unique shape needs to be manufactured, and cannot be properly cut using the lamination/rolling/cutting method. Typically, this method of dough preparation is used on soft dough type products.



Proofed dough dispensed from the dough tub is initially de-lumped, or kibbled, into smaller pieces, and dispersed evenly across the infeed of the forming machine rolls.



The dough forming machine comprises of two rolls, comprising of a die roll, and the other, the forming roll. These rolls are situated adjacent to each other, counter-rotating to direct the kibbled dough into the center, between the rolls. The die roll is a roll with preformed shapes cut into the roll surface. As dough is compressed between the die and forming rolls, the die roll compresses the dough into the shape of the die, and presses the cut dough onto the forming roll. The forming roll removes the adhered, shaped dough out of the die cavity, and transfers the cut pieces onto a smooth belt conveyor, called a transfer conveyor.

This method of dough handling not only requires the correct ratio of speeds between the die roll, forming roll and transfer conveyor, but also the consistency of the dough. Dough that is too 'wet' will always stick to the die and/or forming rolls and not migrate to the transfer conveyor. Conversely, dough that is too 'dry' will crumble or break apart during the die forming or transfer process.

Oven Baking

Dough that is conditioned and prepared for baking using the lamination/gauging or dough molding methods is presented to a multi-zone convection oven for baking.



These ovens comprise of multiple heating/baking zones that provide bakery operations with the ability to preheat, and bake biscuits with the proper rise, hardness and color.

In this part of the baking process, several control and operational factors is key in achieving the desired biscuit baking characteristics. Some of these are:

- (a) Proper control of gas fired burners to provide required flame width and size in delivering the proper heat profile to the biscuit mass moving through the zone. This is a combination of manual burner width adjustment and automatic gas pressure/temperature control;
- (b) Automatic adjustment of zone burner control based on biscuit mass situated on the oven conveyor. This involves tracking of product gaps and automatic adjustment of the zone burner controls to prevent over heating and stressing of the oven conveyor belt, which can result in biscuit charring;
- (c) Proper circulation of heated air within the oven zones to provide even turbulence and circulation above and below the biscuit surface. This is typically accomplished using multiple zone air return and recirculation systems, in combination with internal, air flow directional ducts. This aspect of oven zone control reduces 'edge burn' of the biscuit mass;
- (d) Application of newer oven conveyor belting materials to reduce and/or eliminate rusting due to high humidity environments or "bright spots" due to belt chaffing against seized components. These defects create uneven heat distribution on the baking surface, resulting in poorly baked or reject biscuit masses. Newer materials, such as graphite skidding, replaces traditional carbon steel belting.

Other methods of heat energy are employed in baking applications. These include radiant microwave heating. Microwave heating systems have been used as an assisted baking technique to standard, conventional convection baking ovens, allowing comparable baking results using shorter oven lengths where space is a concern.

Ancillary Equipment

Contained within the biscuit preparation process, either before or after baking, are ancillary equipment systems that provide additional enhancements to the biscuit texture and/or taste. These include:

(a) Salting machines, which dispense a fine dusting of salt on top of the sheeted, cut dough before entering the oven for final baking. These units consist of a main belt conveyor, possibly a nosing conveyor for biscuit reject at the discharge, and the salt dispensing system, which comprises of a salt retention hopper mounted above a dispensing drum, which evenly meters the salt with vibratory and rotational motion. These systems are contained within a portable structure to allow removal from the main conveying system for cleaning.

(b) Sugar coating machines, which spray prepared sugar slurry on the biscuit prior to entering the oven. These units consist of a meshed belt conveyor, over which the dough is tracked through a series of nozzles/rotating discs, evenly dispensing the sugar slurry. The unused slurry is contained within a waste retainer and pumped away from the unit. In some situations, the slurry is prepared within an off-line batch preparation and containment process, and transported/pumped to the spray system using heated lines and tanks. When in an idle mode, sugar supply and return lines are typically flushed with hot water to prevent plugging of cooled sugar slurry;

(c) Oil spray machines, which spray vegetable based oils on the biscuit after exiting the oven. These units are similar to the sugar coating machines, consisting of a meshed belt conveyor, over which the dough is tracked through a series of nozzles/rotating discs, evenly dispensing the oil from both the top and bottom. The unused oil is contained within a waste retainer and pumped away from the unit. In some situations, the oil is prepared within an off-line preparation and containment process, and transported/pumped to the spray system using heated lines and tanks. When not in a production mode, these units are equipped with a clean in place (CIP) control system to de-oil and sanitize the oil spray nozzles, spreader discs, conveyor and receiving hoppers;

Kraken Automation Offering for Processing Systems

Having reviewed a synopsis of information pertaining to other processing systems, it is obvious that the implementation of these systems may appear to be daunting at first, but in reality, can be accomplished fairly systematically if a proper approach is taken.

Kraken Automation Inc. has over 18 years of automation experience in a variety batch and/or continuous processing systems. Our team of engineers and design technicians has been in industries that have utilized a wide spectrum of processing techniques, and have a sound knowledgebase on equipment and automation specification, design and implementation. Some of these include breakfast cereal, biscuit (cracker and snack food), bread, pet food and confectionary (hard/soft candy manufacturing) industries. Furthermore, Kraken can integrate these processes with batching to prepare configured product recipes and material handling systems to transport and acquire raw materials from bulk storage, or forward formulated products to downstream processes (i.e. mixing, cooking, extrusion, etc.). All concepts developed at Kraken are designed with industry standards and regulations in mind.

More specifically, Kraken has the capabilities to provide the following offerings:

Processing System Evaluation:

Review and evaluation of new or existing process system architectures to define client needs, and propose alternate technologies to optimize system performance while conforming to budget and schedule requirements.

Processing System Design:

Conceptualization, design, assembly and commissioning of any type of processing system architecture, including procurement of hardware and software to client standards, configuration of various control and HMI packages, and final commissioning.

Processing System PLC Programming Services:

Program development, documentation, testing and commissioning for a variety of PLC families such as Allen Bradley, Modicon, GE Fanuc, Mitsubishi, Siemens and others, with code compartmentalized into phase/function logic groups.

Processing System Operator Interface (OI) Configuration:

Configuration, testing and commissioning of local operator interface systems for a variety of brands such as Nematron, EXOR Uniop, Allen Bradley Panelview and Panelview Plus, Eaton/DT Panelmates, and others.

Processing System SCADA Design and Configuration:

Conceptualization, design, assembly and commissioning of processing SCADA systems, including procurement of hardware and software to client standards, configuration of various industry packages (WW Intouch, GE iFIX, Rockwell RSVIEW32), and final commissioning.

Processing Business System Integration:

Conceptualization, design, configuration and commissioning of process business system integration schemas, including procurement of hardware and software to client standards, configuration of industrial data historians (WW InSQL, GE iHistorian, Rockwell RSSQL), interface configuration to production scheduling and material tracking systems, and final commissioning.

Process System Support:

Comprehensive post-commissioning site or web-enabled support in process and software troubleshooting, including affordable service support plans, or on an “as required” basis, available 24 hours, to address any customer’s batch control system needs.

Other Related Expertise and Services:

Electrical, Control and Instrumentation, Batching Systems and Materials Handling.