

Application Example

Extruded Dry Pet Food & Treat Processing

Background

Today's manufacturers of high quality dry pet foods and pet treats for dogs and cats rely on manufacturing processes which are cost-efficient, time-saving and sanitary in design. Whether manufacturing in a batch process or in higher volumes via continuous methods, Coperion and Coperion K-Tron feeders and material handling equipment as well as Coperion high efficiency extruders are used throughout the dry pet food and pet treat manufacturing processes. Screw feeders (both volumetric and loss-in-weight), liquid loss-in-weight, and weigh belt feeders are used for metering and highly accurate feeding of ingredients into mixers (batch or continuous) and extruders as well as portioning end products for the packaging line. In addition, Coperion pneumatic conveying systems and components are used for the transfer of dry powder materials, such as grains, premixes, vitamins and even probiotics. Finally, the use of the Coperion ZSK MEGAvolume PLUS twin screw extruder delivers an extremely high product output for optimal efficiency in dry pet food and treat production.

Raw Ingredient Delivery via Pneumatic Conveying

Major ingredients such as grains and flour arrive at the plant in a variety of forms, including railcar, truck and bulk bag systems. These major ingredients are usually stored in specialized silos and then conveyed to the specific weigh batch stations as required for the blend. PLC systems featuring recipe control for multiple ingredients can easily be integrated into this transfer system, in order to allow maximum flexibility for the system.

The arrival and transfer of major ingredients to a pet food plant can include a number of different types of conveying systems. The mode of ingredient transfer is dependent upon a wide variety of process parameters, including material characteristics, distance to be transferred, required rate of transfer, and the type of container in which the ingredient is originally received.

For example, majors such as flour and grains are often received by truck or railcar and then stored in silos prior to usage. Pressure Differential (PD) trucks and railcars use positive

pressure to unload material. Other types of delivery to the batching step of process can involve either positive pressure or negative pressure pneumatic conveying.

(For more information about material transfer and batching methods for macro and micro ingredients see Application Sheets A-800310 and A-800311)

Dilute Phase Transfer: Vacuum or Pressure?

Depending upon the volumes required, other possible sources of ingredient delivery include boxes, sacks, bulk bags or super sacks. Pneumatic conveying systems can be used to transfer these ingredients in all steps of the process, utilizing either positive or negative pressure (vacuum) dilute phase conveying or a combination of vacuum and pressure conveying.

Positive pressure conveying systems are typically used to transport bulk materials over long distances and at high throughputs. Applications which involve pressure conveying often include loading and unloading of large volume vessels such as silos, cyclones, railcars, trucks, and bulk bags.

Conversely, vacuum systems are often used for lower volumes and shorter distances. One of the advantages of vacuum systems is the inward suction created by the vacuum blower and reduction of any outward



leakage of dust. This is one of the reasons why vacuum systems are often used in dust containment applications. Another advantage of vacuum systems is the simple design for multiple pickup points. It should be noted, however, that the distances and throughputs possible with a vacuum system are limited due to the finite level of vacuum that can be generated.

Coperion high efficiency and easy clean rotary airlocks are utilized in both of these types of pet food ingredient conveying applications. These airlocks can be provided for blow through systems or as discharge valves at the bottom of silos or feed bins.

Screening and Sifting Operations

In-line or off-line screeners are often used during the raw ingredient transfer process for



Coperion K-Tron pneumatic conveying system



Coperion ZRD rotary valve with FXS extraction device

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the removal of foreign materials prior to the introduction of the bulk material into the conveying line. Screeners can also be integrated directly into the conveying line for additional conditioning of the ingredient powder. This sifting method is also often used at the end of the process for the proper scaling/sizing of the finished product prior to packaging. Sifters and screeners are an integral part of the overall material handling system for reliable product quality and safety, and are easily integrated into the overall system design by Coperion and Coperion K-Tron system engineers.

Pet Meal Batching and Blending

When creating pet meal blends, two types of operations are used. In a continuous approach, various components including meat and grain meals, vitamins, minerals and other ingredients are fed to a continuous mixer. This approach is often accomplished with weight belt feeders, provided the number of ingredients is limited. In batch applications, a more economical option is to use a Gain-in-weight (GIW) batch system for these same dry ingredients. Here volumetric feeders are used for the ingredient feed and a separate hopper on load cells for the GIW verification.

All ingredients are fed either onto a conveying line as discussed above or introduced directly to the mixer by gravimetric weigh belt feeders or screw feeders depending on the material characteristics and feed rate requirements. Each of the feeders is outfitted with some sort of refill device, e.g. pneumatic conveyors or simple gravity drop bins complete with level indicators.

The mixture leaving the mixer is often referred to as the "mixed meal". It is then loaded into another feeder and fed with

the pigment directly into the extruder.

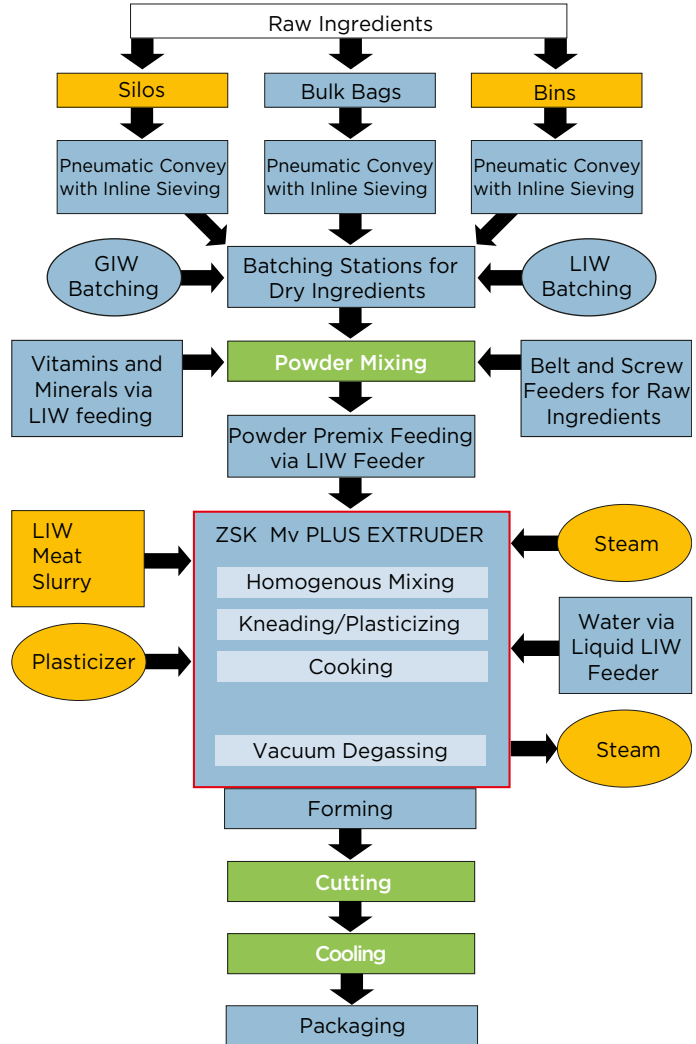
Feeding and Proportioning via Screw Feeders

The mixed meal can be fed to the extruder using either volumetric or gravimetric feeders. Volumetric feeders are typically used only with meal that is "preconditioned", or optimal for screw feeding flow, without a possibility of bridging or buildup. However, the addition of other proportioned ingredients such as water, steam, animal fat, and molasses can change the flow properties of the mix considerably.

**It is important to note that the use of the Coperion ZSK extruder may not require the use of a preconditioner prior to the extrusion step. This is accomplished using direct steam injection which brings the material quickly the correct operating temperature without the need for an additional piece of equipment.*

Managing the delivery of the dry premix to the extruder is most important to tight ingredient and moisture control. If these key process parameters are not controlled, improper extrusion can result, causing manufacturers significant costs in wasted product. In order to achieve an acceptable degree of dry feed accuracy ($\pm 1\%$ of the maximum delivery rate), a high precision gravimetric feeder system is imperative. Volumetric feeding systems for an extruder can often vary as much as $\pm 6\%$ accuracy due to factors such as improper flow of premix to the screws and sensitivity to the hopper level.

Coperion K-Tron's loss-in-weight algorithm and smart refill techniques ensure that a consistently high accuracy of dry ingredient feed can be maintained. Once a predictable dry premix delivery system is set, then the other ingredient



Pet Treat Process Flow: equipment for all process steps in blue are manufactured by Coperion / Coperion K-Tron. Equipment for all process steps green/yellow can be supplied as part of a complete system.

feeds (dry or liquid additives) can be managed by coordinating them to the dry feed system proportionally.

Extrusion of Pet Treats

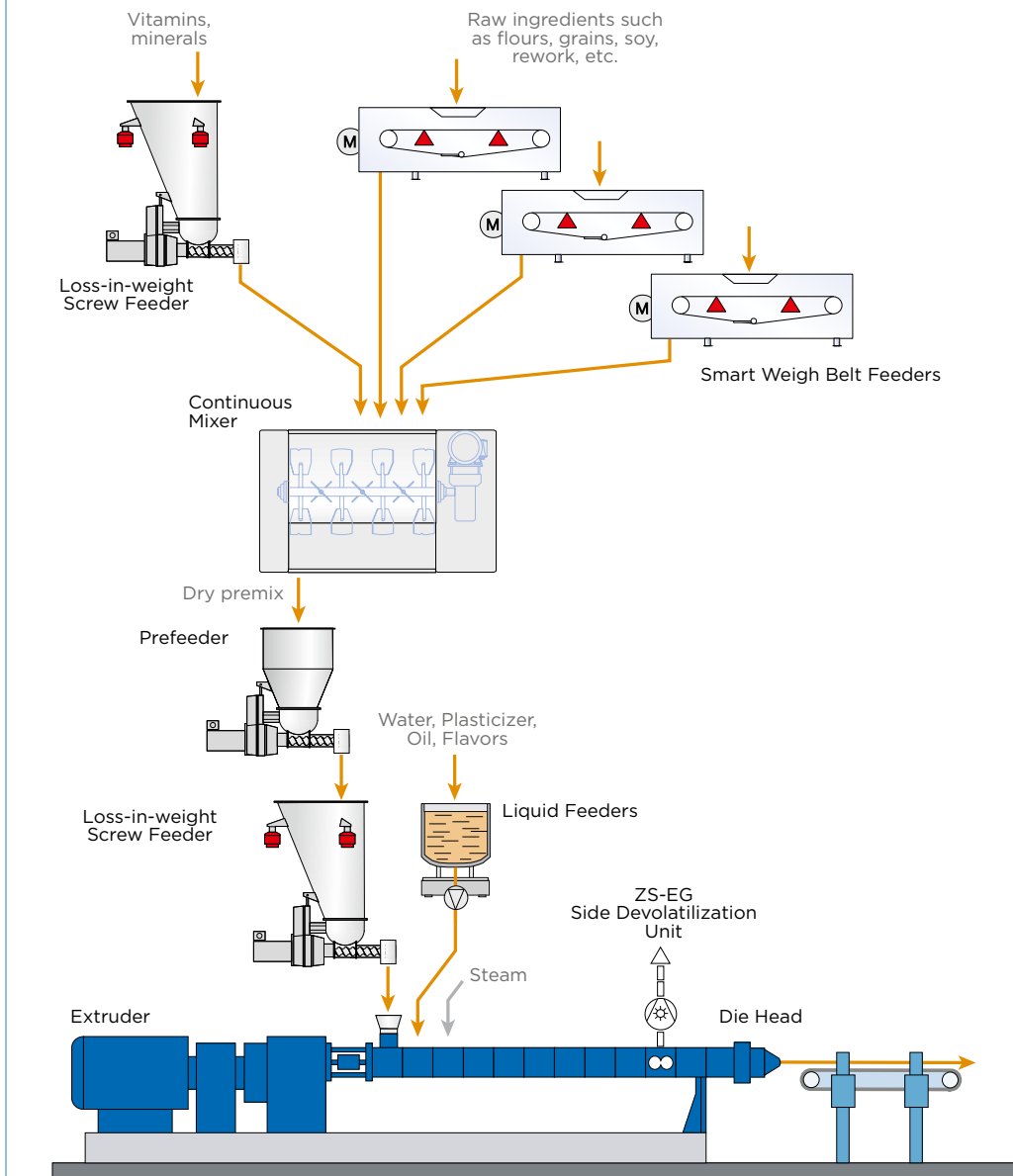
Twin screw extrusion is well known to be a suitable High Temperature Short Time (HTST) process for pet treats. Depending on the process complexity and the amount of feeding inlets required for raw materials the process length can vary between 36 L/D and 48 L/D (L = screw length, D = screw diameter). Each barrel is about

4 L/D which means that 9 to 12 barrels are necessary to design a proper process.

The barrels and screws are designed as a modular system which offers the possibility to set up a custom configuration tailored to the process requirements. All materials of construction which are in direct contact with the product conform to food standards and are resistant to abrasion and corrosion.

Coperion's twin screw extruder series ZSK MEGAvolume PLUS with D_o/D_i (outer to inner diameter) of 1.8 is the twin screw

From Batching/Blending to Extrusion



extruder with the highest free volume on the market. This enables our customers to run higher throughputs than on other machines with similar screw diameters.

For processing pet treats the typical process steps are as follows. First the premix of solid ingredients (mainly based on proteins and carbohydrates) is fed via Coperion K-Tron LIW feeders into a hopper fixed above an open barrel of the ZSK extruder. Usually these raw materials have a bulk density between 0.2 and 0.7 kg/dm³, making them difficult to feed.

The performance of the extruder strongly depends on the feed rate of both the solid and the liquid raw materials. The extruder is generally referred to as the “slave” of its feeders. It depends on consistently reliable feeding equipment to supply a constant flow of material. Gravitric loss-in-weight feeders are state-of-the-art and are in most cases the best choice for a continuous extrusion process.

After the premix is fed into the process section of the ZSK extruder one or more liquids are injected. Typically water, a plasticizer and a slurry are added to achieve proper moisture for processing and a suitable texture and taste of the final product.

After all ingredients have been fed into the extruder, they must be mixed homogeneously. Usually this can be done by one or more mixing zones, which consist of combinations of different



The Coperion ZSK MEGA volume PLUS is especially suitable for the economical processing of dry and semi-dry dog and cat food and treats.



Coperion K-Tron Smart Weigh Belt (SWB) feeders are available in closed frame (shown) or open frame models.

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types of kneading blocks. Depending on the raw materials, special mixing elements might also contribute to a satisfactory result. During mixing the product is also sheared, which adds mechanical energy. Steam injection helps to increase the temperature and to accelerate the cooking process.

Next the mixture is plasticized within a shear-intensive cooking zone. Combinations of elements are used which cause high mechanical energy input. Due to the increase of pressure, shear and temperature the protein denatures and the starch gelatinizes. The hot plastified mass is then degassed via a ZS-EG side devolatilization unit which leads to a reduction of moisture and temperature.

After a total residence time of a few seconds up to some minutes (depending on the length of process section, screw speed, screw configuration and throughput) the material is pushed through the orifices of the die without significant expansion. As a last step the product strands are conveyed to a strand cutting system where they are cut into bars/sticks.

Flavor Enhancing/ Particle Blending during Coating

The cooked and "baked" pet food product by itself is rather unpalatable. Typically various animal fats and flavors are gravimetrically added to the product after drying and before packaging. Due to the higher cost of these ingredients, and a definite need for overall quality control, the use of weigh belts, loss-in-weight feeders and Coperion K-Tron PID pump control sys-

tems are of utmost importance. Coperion K-Tron's unsurpassed repeatability and stability in feed accuracy through the use of the patented SFT load cell design are critical for control of cost and quality.

After the dried product is weigh-metered, it is often sprayed with liquids prior to going to the packaging line. The addition of these liquids can be accomplished in one of two ways. For a more economical approach, a Coperion K-Tron control system can be integrated with a liquid flow meter. The liquid pump delivery is controlled by a PID function to provide liquid addition in gravimetric proportion.

As an alternative, and in cases where even tighter control of liquid addition is necessary, a liquid loss-in-weight feeder combined with a positive displacement pump is used to meter the liquids sprayed onto the product.

Packaging

After coating and drying the finished product, it is often conveyed to the packaging line via dense phase positive pressure conveying. Dense phase conveying allows for much gentler transfer of the finished product and minimizes damage or attrition which may occur with other methods of automated transfer such as dilute phase pneumatic transfer or mechanical transfer via screw conveyors.

In the case of a varied product mix, e.g. multiple colors and/or shapes, each line of dried and sprayed product is sent to its own individual weigh belt feeder, where it is metered and sent to a horizontal conveying line, and then on to the packag-

ing machine. The proportion of each individual component is managed by the recipe controls.

Coperion Advantage

- Complete systems design integration of the pet food manufacturing process for one source supply.
- Global systems engineering group with extensive application experience for the entire pet food processing line ensures optimal design with an emphasis on product safety, quick product changeover, and increased efficiency.
- Engineered solutions from both Coperion and Coperion K-Tron reflect extensive experience in hygienic and sanitary design standards, including CIP/COP, EHEDG, FSMA, GFSI, USDA, and 3A where applicable.
- The Coperion K-Tron line of feeders provides for the highest degree of accuracy in ingredient and product delivery in order to optimize ingredient cost savings.
- Integrated control systems featuring Coperion K-Tron SmartConnex and customized PLC control allow for a variety of programming options including ingredient control and recipe management.
- Innovative, custom engineered Coperion rotary and diverter valves ensure reliable, long-term and safe operation.
- Highly accurate extruders, feeders and pneumatic conveying components designed to meet highest hygienic requirements.



Coperion K-Tron screw feeders in a vacuum coating process

- Use of the Coperion line of high efficiency ZSK MEGA volume PLUS extruders ensures maximum material loading combined with modular design for increased versatility.
- The efficiency of the ZSK extruder may eliminate the need for a preconditioner, therefore minimizing downtime due to cleaning and optimizing overall space requirements while lowering capital costs.
- Coperion and Coperion K-Tron engineers possess extensive material handling knowledge for a wide variety of ingredients, ensuring that designs include the most efficient means of product transfer.
- Superior global service network to ensure 24-7 support and coverage of your complete pet food processing line.

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