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Extruders

Confectionery process design with co-rotating twin screw extrusion

Author

Gabriela Saavedra
Thermo Fisher Scientific, Karlsruhe
Germany

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Process 16 Twin-Screw Extruder

Introduction

The development and production of confectionaries are based on a chain of changes to protein, sugars, starches, and fats on a molecular level. The ingredients are usually mixed, heated, sheared, and shaped. In doing so, Maillard reactions take place. Proteins and starches are broken down and gel, and sugars and fats crystallize. The control of all these transformations requires precise heating and shearing, as well as long cooking times. Therefore, optimization and new developments involve many unit operations, long manufacturing times, and a large amount of floor space usage. Twin-screw extrusion offers a modular and flexible method to test and produce new confections.

The use of a co-rotating twin-screw extruder for confectionery applications is relatively novel. Twin-screw extruders allow for the reduction of floor space usage and manufacturing time, and most importantly, the shift from a batch to a continuous process. Other advantages include higher hygienic standards, lower energy consumption, and more control over the transformation of raw materials to obtain the desired material properties.

In this application note we aim to showcase the extrusion of confectionery laces using a Thermo Scientific™ Process™ 16 Twin-Screw Extruder including some tips for process development to obtain a desired confection.

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Feeding of sugary slurries

The first step for every extrusion process, regardless of the application, is to get the feeding right. Feeding sugar slurries into the extruder presents one of the main challenges in confectionery extrusion. The slurries contain from 70 to 85 % dry matter and are highly viscous materials. Feeding these materials with a conventional twin-screw gravimetric feeder or with a peristaltic pump is not an option.

The best way to overcome this challenge is by using a progressing cavity pump. Additionally, the temperature of the slurry plays an important role when dosing. An increase in temperature decreases the viscosity of the material, which in turn facilitates dosing and pumping of the sugary slurry. The best way to characterize the flow behavior of any melt is using rheometry. The viscosity curves give an insight into the temperature dependency of the material flow properties and can help to choose the right pump, hose diameter, and temperature settings. Figure 1 shows viscocity's dependency on the melt temperature. The curves were measured using a HAAKE™ MARS™ 60 Rotational Rheometer and a Couette Measuring geometry.

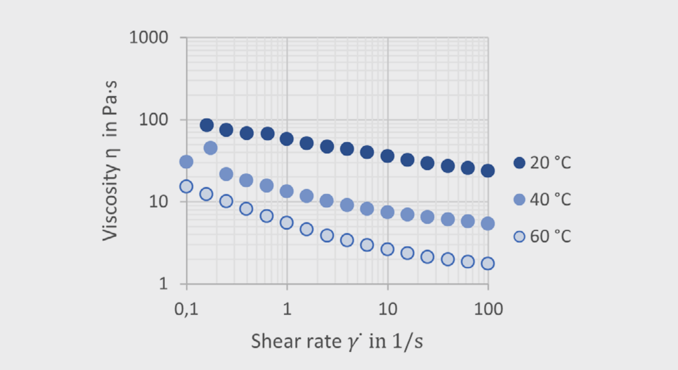

Figure 1: Viscosity curves measured at different melt temperatures.

However, the temperature must be kept under 80 °C to avoid caramelization and subsequent hardening of the material.

Extrusion process

The extrusion process of confectionery laces combines multiple unit operations in one single piece of equipment:

- Feeding of sugar slurry
- Mixing of the slurry
- Cooking of starches, melting of fats, caramelizing of sugars
- Reducing the water content with a degassing port or a vacuum pump to reduce air bubbles
- Cooling down the slurry to solidify the melt
- Addition of aroma (volatile compounds)
- Shaping the product through the die

Figure 2 shows a typical extruder setup for confectionery laces.

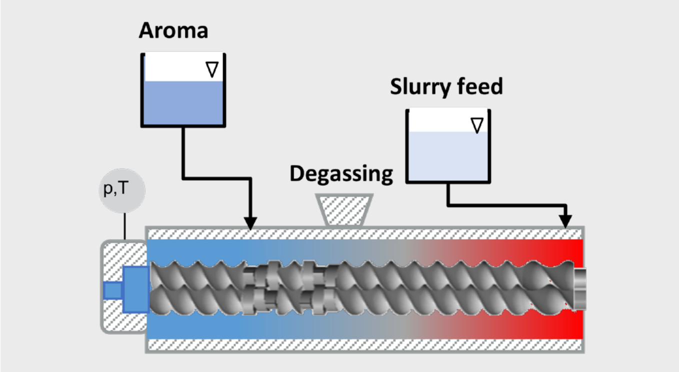

Figure 2: Schematic extruder setup.

Another important point to consider is the screw configuration. This must mix and plasticize the starch and retain the melt in the barrel long enough to cool it down to 50–60 °C (residence time is key).

Typical extrusion speed range from 200 to 600 rpm and temperatures are $T_{barrel2}$= 135 °C, $T_{barrel3}$= 135 °C, $T_{barrel4}$= 135 °C, $T_{barrel5}$= 115 °C, $T_{barrel6}$= 80 °C, $T_{barrel7\text{-}8\text{-}}$= 60 °C, $T_{die\_adapter\text{-}}$= 60 °C.

Downstream processing

After extrusion cooking, confectionery laces are usually cut to the desired length and coated with a food-grade wax. This prevents the laces from sticking to each other and gives them a glossy shine. Typical methods to wax confectionery laces are spraying them directly after production or using a water bath.

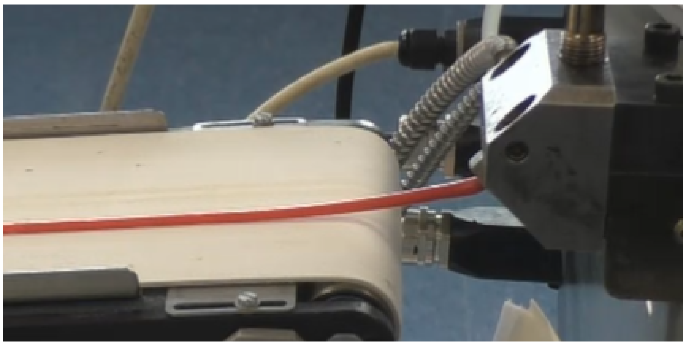

Figure 3: Taking off the confectionery lace with a conveyor belt.

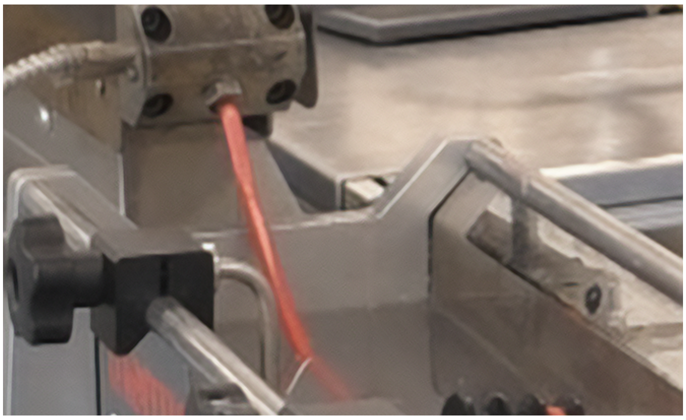

Figure 4: Coating confectionery laces with food-grade wax using a water bath.

Conclusions

This application note addressed the process design for confectionery extrusion using a co-rotating twin-screw extruder.

Reference

1. The Technology of Extrusion Cooking, Chp. 6 Confectionery extrusion – E.T. Best, 1994

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