

FOOD

Optimization of Continuous Processes for the Production of Food Grade Products

Authors: R. Geisler, R. Kunkel

Reactors with indirect contact drying under vacuum conditions are often used for a large variety of different production processes. As a typical example for food processing the production of chocolate- or milk-crumb will be explained and discussed.

Moreover, the potential for process optimization will be shown in this example.

During the production of chocolate-crumb various demands and requisitions should be fulfilled, e.g.:

- Generation of the distinctive flavor, caused by the Maillard-Reaction
- Avoidance of undesired or off-spec side reactions or thermal degradation of the product by limitation of the product temperature
- Long residence time, narrow residence time distribution, combined with a gentle drying step with transition from a pasty phase to a free flowing crumbling product.

Chocolate-crumb is mainly based on a mixture of milk or milk powder, whey, sugar or sweetened condensed milk, cocoa-mass and water. With these ingredients a special base product is manufactured for high value chocolate and chocolate cover for a large variety of sweetness with a distinctive flavor with a long shelf life and special texture.

Process Optimization for the Continuous Processing of Chocolate-Crumb:

Investigations for different arrangements with single- and two-stage configurations were done to determine the optimized arrangement in respect of

- selection and arrangement of the different units

- feed condition and capacity
- heating condition
- operating pressure
- mechanical power input by kneading shafts.

As the result from this first investigation we found out a two-stage configuration as the most appropriate arrangement for this continuous process (see fig. 1)

In the first stage (premix) the ingredients as solid and liquid material are fed into the premixer (e. g. extruder), homogenized, heated up and starting the multi-step Maillard-reaction. The product mixture is conveyed as a homogeneous high viscous and sticky mass directly into a kneading reactor (main stage). This unit is operating under vacuum. The product will again heated up with ongoing Maillard-reaction and evaporation of the water.

Due to the evaporation of water, the product becomes more and more sticky and high viscous and will reach at a certain moisture level a transition from the pasty phase to a free flowing granular phase. During this stage a significant amount of mechanical power will be absorbed into the product as heat and will cause a remarkable increase of the local product temperature.

Experimental tests for the continuous processing of chocolate-crumb were performed to determine the maximum capacity of such arrangements. Excess of local product temperature should be avoided for reason of possible deterioration of the distinctive flavor and texture of the product. Additional calculations, based on mass and energy balance revealed the progress in evaporation with reduction of the product moisture and the local dependency of the product temperature (see fig. 3).



Fig. 1: Optimized configuration with two-stage continuous arrangement

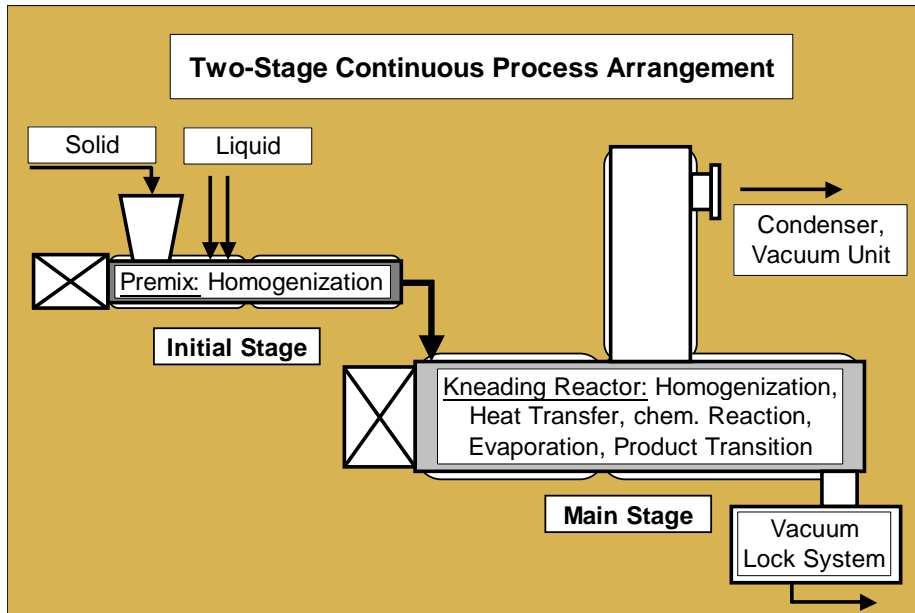


Fig. 2 shows a cross-section of a single-shaft continuous kneader with good self-cleaning property and large specific heat exchange surface.

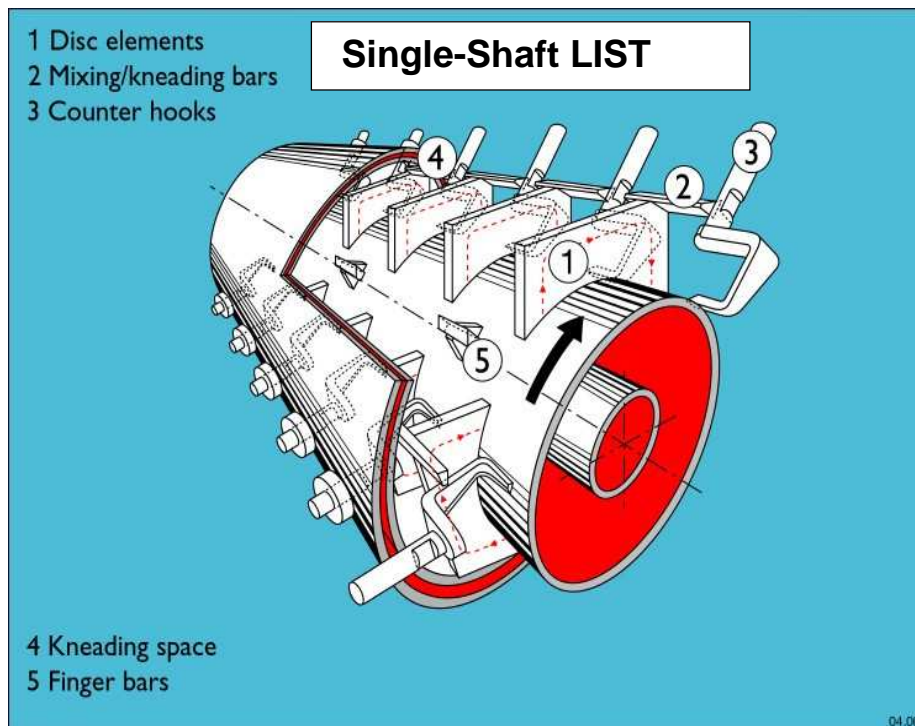


Fig. 2: Cross-section of a single-shaft kneader

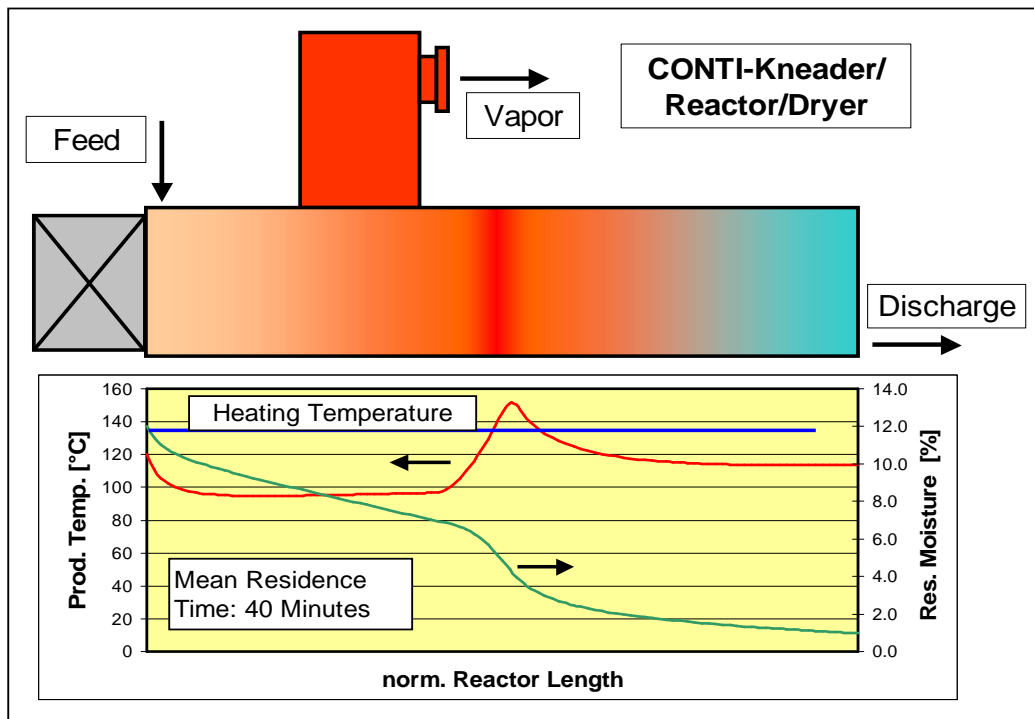


Fig 3: Simulation results of the local product temperature and local moisture content in a continuous reactor

As a conclusion of these calculations the maximum local product temperature is predominantly depending on

- throughput
- heating temperature
- mechanical power input.

The maximum local product temperature is always in the section with the highest local mechanical torque, vice versa the highest local power absorption. Therefore, the determination of the local product temperature along the reactor length scale is vital in order to avoid undesired product changes.

Summary and General Conclusion:

As a combination of experimental trials and simulations, an optimized process arrangement was found in respect of throughput and product quality demand with

- increased capacity
- increased process stability
- enlarged flexibility
- safe scale-up design for large-scale continuous production plants.

Moreover, these results of the process optimization for chocolate-crumbs can also be transferred to many other applications in the range of high-viscosity processing.

For service please contact:

- [Europe and South America](#)
Phone +41 61 815 30 30
- [North America](#)
Phone +1 704 423 54 78
- [Asia](#)
Phone +65 63 38 78 76
- [Rest of World](#)
Phone +41 61 815 30 30

LIST AG
CH-4422 Arisdorf
Switzerland

Phone +41 61 815 30 00
Fax +41 61 815 30 01

www.list.ch
info@list.ch

LIST USA INC.
1629 Cross Beam Drive
Charlotte, NC 28217
USA

Phone +1 704 423 54 78
Fax +1 704 423 02 10

www.list.us
info@list.us

We develop and industrialize advanced and customized solutions for processing of viscous, sticky and crust-forming products for the polymer, chemical, fiber, food and environmental industries.

LIST AG
(SINGAPORE BRANCH)
122 Middle Road
#06-03 Midlink Plaza
SGP-Singapore 188973

Phone +65 63 38 78 76
Fax +65 63 38 37 71

www.list.sg
info@list.sg