Concentration of Dairy Permeate for Lactose Crystallization

Category: Rotary Evaporator
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Lactose (milk sugar) is used in many different ways: as a filler or fat binder in the food industry, as a filler, binder and adsorbent in the pharmaceutical industry, and as a starting material for the synthesis of lactic acid in the chemical industry. In the extraction process of lactose, the whey is first clarified from the cheese dairy and the cream is separated. Fat and proteins are removed from the whey and the dairy permeate thus obtained is then concentrated with a large-scale rotary evaporator. The lactose is then crystallized from this concentrate.

Challenge of the conventional method

Lactose can be considered one of the most important by-products obtained from cow's milk. The concentration of lactose in cow's milk is about 5%. Since lactose is a solid compound, it can be crystallized to win the pure form, which then is used either directly or further processed. First, the milk proteins and fats are removed from the cow's milk via ultrafiltration. The residual milk permeate, mostly consistent of water, lactose and salts, is then concentrated before the lactose can be crystallized from that concentrate.

Concentration by evaporation is a commonly used technique to reduce the water content of milk permeate for lactose crystallization. Conventional evaporators have the disadvantage that the milk permeate has to be handled manually and that undesired pre-crystallization often occurs during the evaporation process. The reason are the big amounts that are introduced to the process at once and the unsteady conditions during the evaporation. It is hard to control and stop the process at the exact time to still achieve the desired concentration, yet to avoid undesired precipitation.

Automation of the evaporation process by using an automatic module in combination with the large-scale evaporator offers the ability to introduce very small amounts at a time. This can help to avoid crystallization during the evaporation process.

Objective: Concentration of dairy permeate to a homogeneous dry mass of 60 – 70 % without undesired pre-crystallization

Using a Hei-VAP Industrial large-scale evaporator with the automatic module Hei-VOLUME Distimatic from Heidolph can remove the limitations of conventional rotary evaporators.

The TIME mode of the automatic module allows to repeatedly introduce only small amounts of media at regular intervals into the rotation flask. This is often of benefit for concentration processes. The material can be kept from drying out. In addition, the consistent system parameters in the automated process do not only increase the efficiency, but also provide much more control of the process compared to a manual setup. Indeed the automated system detects when the storage tank is empty and the process is stopped. The system including the periphery is switched off automatically. For this reason, the system can run over night and the weekend without the need of supervision. Our customer from a Bavarian dairy farm company wanted to evaluate the possibility to use a Hei-VAP Industrial with the Hei-VOLUME Distimatic Module for the concentration of milk permeate without undesired pre-crystallization in order to obtain lactose.

Method: Successful concentration of dairy permeate from 22 % dry mass to 67 %

The goal was to concentrate milk permeate from a dry mass of 22 % to a dry mass between 60 – 70 % without undesired pre-crystallization inside of the rotating flask.

The experiments were run with the customer at the Heidolph application laboratory in Schwabach, Germany. The setup included a Distimatic Industrial Platinum 8 package combined with a Rotavac 20 vacuum pump and a Hei-CHILL 5000 recirculating chiller. The heating bath media was water. Table 1 sums up the parameters for the two experiments that have been carried out to find the optimal parameters.

For the first trial, the heating bath temperature was set to 50 °C, the rotation speed to 60 rpm, the temperature of the recirculating chiller to 5 °C and the vacuum value to 30 mbar. Using the TIME mode of the Hei-VOLUME Distimatic module, the parameters were set to an automatic FILL time of 3 seconds and an EVAP time of 2 minutes 55 seconds. Evaluation of the results showed that a thick layer of pre-crystallized lactose formed around the rotation flask. The result was found not suitable for further processing by the customer, so another test run was carried out.

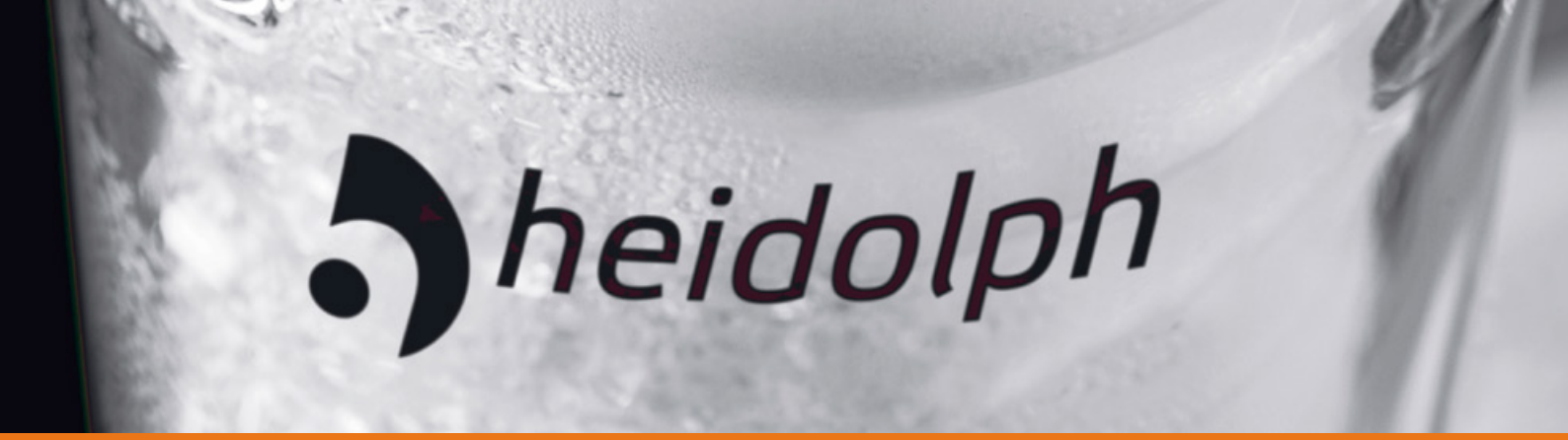
Tab. 1: Parameters of the two attempts to fulfill the customers' requirements

	Trial 1	Trial 2
Heating bath temperature	**50 °C**	**80 °C**
Rotation speed	**60 rpm**	**60 rpm**
Vacuum value	**30 mbar**	**80 mbar**
Chiller temperature	**5 °C**	**5 °C**
FILL time	**3 sec**	**13 sec**
EVAP time	**2:55 min**	**3 min**

In the second attempt, the heating bath temperature was increased to 80 °C and the vacuum value set to 80 mbar. The rotational speed and chiller temperatures were maintained. The FILL time was set to 13 seconds, the EVAP time to 3 minutes. With those parameters, the concentration could be carried out successfully without unwanted pre-crystallization. The process was run twice with these parameters, resulting in a dry mass of 71 % and 67 %, both meeting the requirements of the customer.

Conclusion: Heidolph's Distimatic Industrial Platinum 8 Package meets the challenge

The example shows that Heidolph products enable the automation of milk permeate concentration. The undesired pre-crystallization of lactose during the evaporation process was successfully prevented by using the TIME mode of the Hei-VOLUME Distimatic module.



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