Abstract

Data visualization plays a pivotal role in the dairy industry by transforming complex data into clear, actionable insights. In dairy processing plants, data visualization can be tailored for the end-user i.e. plant manager versus a process manager. For example, dashboards designed for plant managers provide a concise overview of production line efficiency, inventory tracking, and product quality assurance. It can also calculate and visualize individual unit operation energy and water usage. Important process parameters can also be monitored for each operational unit, offering insights into the effect of different process conditions i.e. evaporation conditions, on process efficiencies in real time.

Objective

Investigating the application of an in-line viscometer for monitoring skim milk concentration prior to spray drying.

Experimental Design

- A two-day experimental investigation was conducted to examine the impact of heat treatment on evaporation efficiencies and concentrate behaviour i.e. viscosity.
- This examination was conducted utilizing a single effect falling film evaporator, operated at batch mode, with a specific emphasis on the evaporation of skim milk (SM).
- Comparison of in-line vs off-line measurements of density and viscosity was done using rehydrated SM subjected to low heat treatment and actual trials conducted on liquid SM.
- To evaluate the robustness of the viscosity measurements, various factors were introduced to increase the complexity of the trials, such as different standardizing media and heat treatments.
- Process viscosity was monitored using an in-line viscometer (Promass I 300, Endress+Hauser, Fota Business Park, Unit 4A No. 11, Carrigwoolli Co. Cork, Ireland).
- Process density was obtained from a Coriolis meter (Promass F, Endress+Hauser).
- Apparent viscosity was measured offline, using a cup & bob attachment on a controlled stress/stain rheometer as a reference method (Anton Paar, street 20, 8054 Graz, Austria). Density was also measured offline using a handheld density meter (Anton Paar, Austria).
- Figure 1, illustrates the process viscometer inline with the evaporator at Teagasc Moorepark pilot plant.
- The comparison of viscosity & density measurements reading was initially carried out using different methods of off-line & in-line.
- Process parameters of concentrate density (kg/m³), concentrate temperature (°C), and feed flow (kg/h) were monitored using the dashboard (Work Area Performance System (WAPS), Smart Factory, Nexus Centre, Tierney Building, University of Limerick, Limerick, V94 NYD3).

Results

- After comparing the off-line and in-line measurements, data was captured using the inline viscometer.
- In-line density measurements played a crucial role in identifying the real-time solid content of the concentrate during the evaporation process.
- The in-line measurement of viscosity indicated that upon reaching a specific solids content, the material’s properties in the pipe became independent of the standardizing medium but remained dependent on thermal load (Figure 4).
- As displayed in Figure 5, in-line viscometer facilitated the real-time visualization of viscosity data, highlighting the point at which the concentrate rapidly increased, particularly evident in the final 10 minutes of the process.

Conclusions

- The utilization of an in-line viscometer facilitated the systematic acquisition and representation of crucial data points, ensured a deeper understanding of the relationships among the production variables.
- This integrated approach will not only benefit economic viability but also contribute significantly to reducing the environmental impact of dairy processing.
- Having the exact data from critical measuring points empowers process managers to make informed decisions regarding process changes.