Enhancing Dairy Processing Insights through Data Visualization

Hanieh Amani, Surabhi Subhir, John Tobin, Eoin Murphy & Norah O'Shea

Department of Food Chemistry and Technology, Teagasc Food Research Centre, Moorepark, Fermoy, Co. Cork

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.

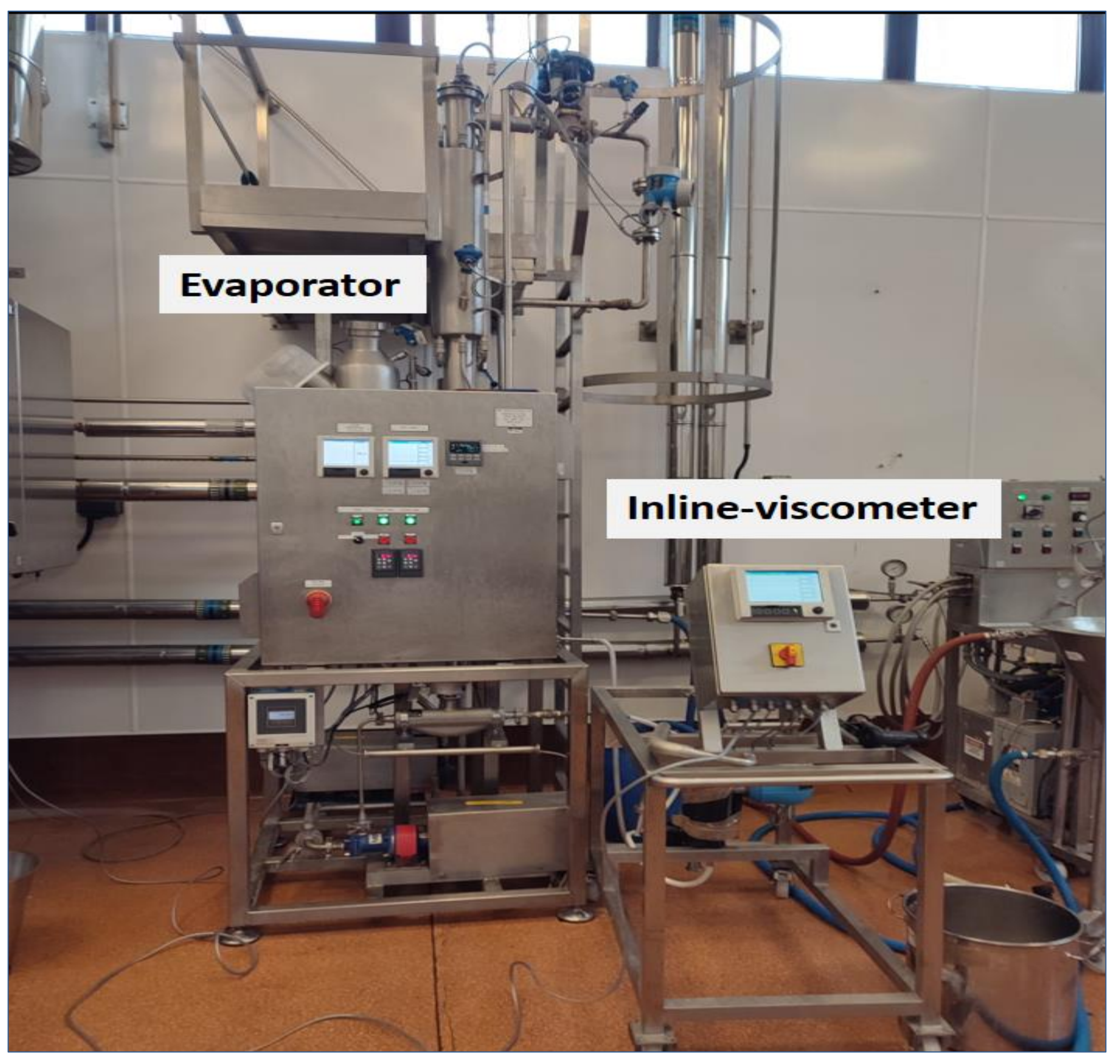

Fig. 1. Promass I 300 viscometer attached to the evaporator for pilot plant trials at Teagasc Moorepark

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 of-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, Carrigtwohill 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/strain 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).

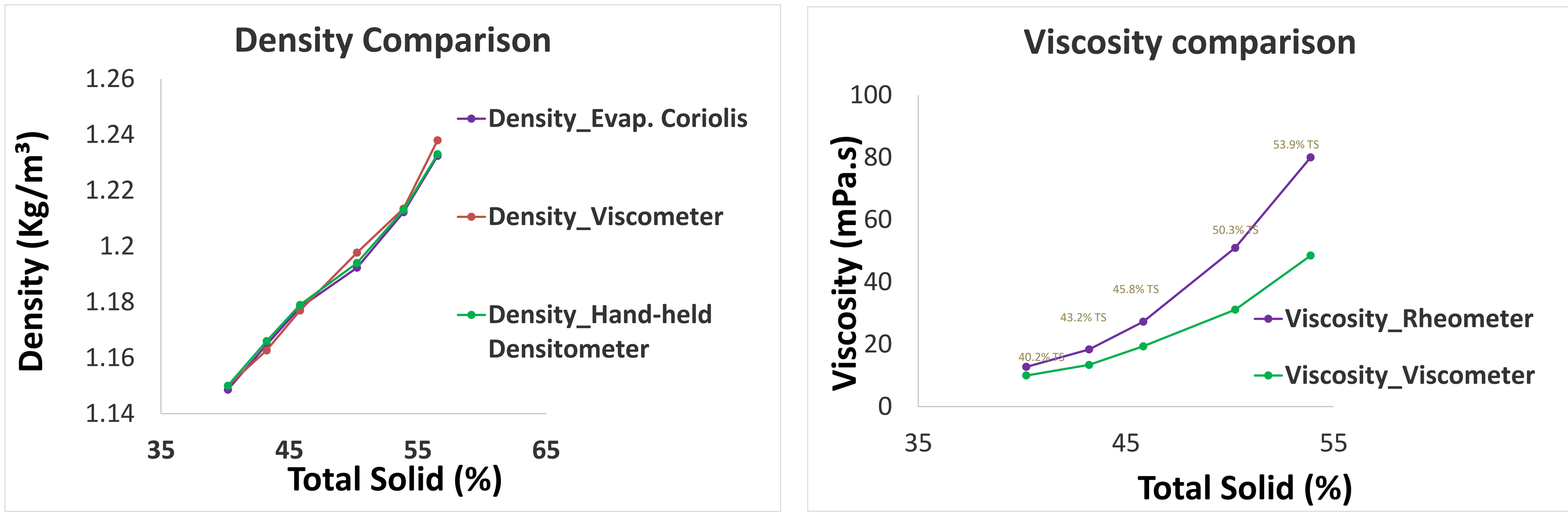

Fig. 2 & 3 (left to right). Comparison of in-line vs off-line measurements

- **Figure 2:** illustrates density measurements of skim milk concentrates as a function of total solids.
- **Figure 3:** offline viscosity measurements were measured as a function of total solids.

Results

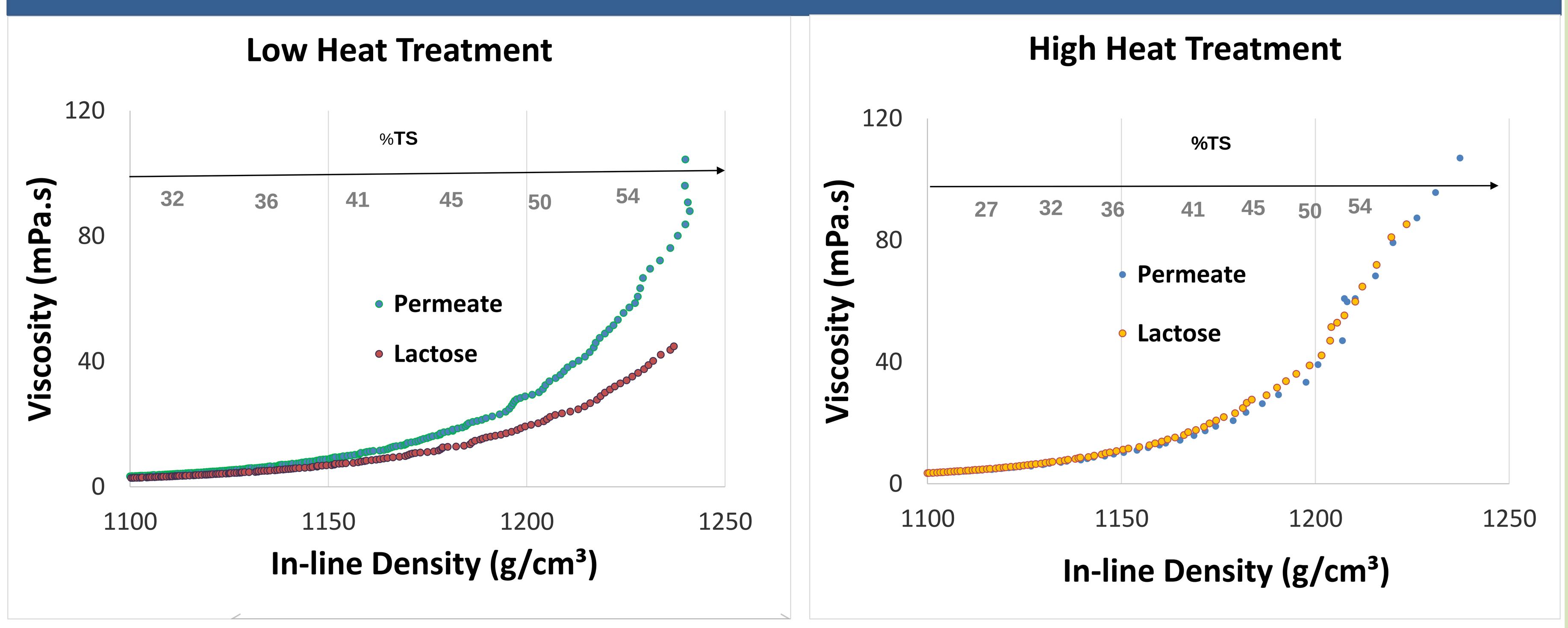

Fig. 4. Dynamic viscosity vs density during evaporation of liquid skim milk: comparing Lactose and Permeate as standardising media, utilising low heat treatment (left) & high heat treatment (right)

- 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.

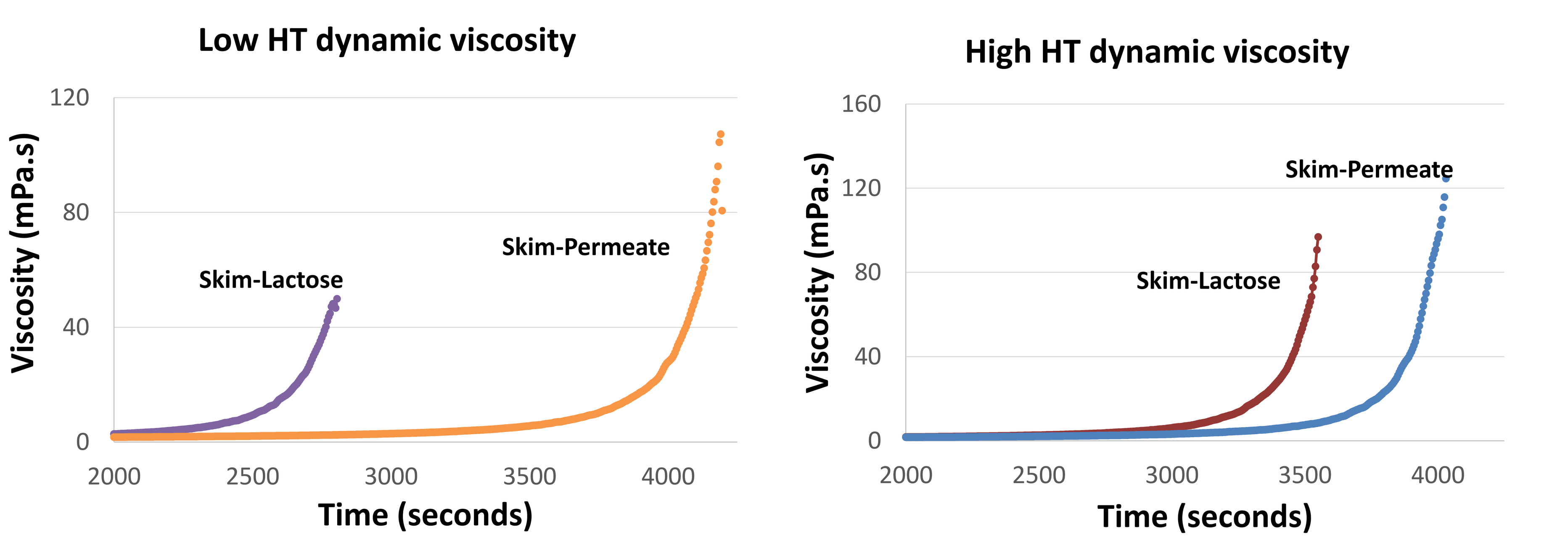

Fig. 5. Dynamic viscosity during evaporation process of liquid skim milk: comparing Lactose and Permeate as standardising media, utilising low heat treatment (HT) (left) & high heat treatment (right)

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.

The information on this poster is CONFIDENTIAL This work has been supported by Enterprise Ireland. Grant Agreement Number : TC 2020 0028.

Agriculture and Food Development Authority