Application Note
V-211

Optimizing and forecasting the filling behavior of coatings with the HAAKE CaBER 1

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Keywords:

- Coatings
- Filling Process
- Extensional Viscosity
- Filament Lifetime
- Temperature Dependence
- Stringiness
- HAAKE CaBER 1

Abstract

Two coatings, which showed different stringing behavior when filled into containers during a production process, have been investigated with the HAAKE CaBER 1 extensional rheometer. It was shown that the filament lifetime as measured by the CaBER corresponds directly with the behavior seen in the production process. By changing the processing temperature, the behavior of the problematic sample could be optimized.

Introduction

When filling coatings into containers in industrial processes, the stringiness of the product may cause problems by leaving excess material on the packaging. In the filling process considered here, the process temperature is 60°C. At this temperature product A can be filled into the containers without problems, whereas during the filling of product B the fluid jet will not break-up quickly enough after the filling has stopped. This slow break-up causes strings of coating material spill over the container.

This phenomenon, which is caused by the extensional properties of the samples, can be monitored with the HAAKE CaBER 1 (Capillary Breakup Extensional Rheometer) instrument.

Figure 1 shows the results of two filament break-up experiments. Product A has a filament lifetime of 0.62 s whereas product B needs 0.8 s before breaking up. This time is obviously too long for the process considered here.

Experimental

The principle of the CaBER measurement is simple. A small quantity of sample (less than 0.2 ml) is placed between two parallel plates (diameter 6 mm). The fluid is then exposed to a rapid extensional step strain by moving the upper plate upwards, thereby forming a fluid filament (Figure 2). The filament evolution as a function of time is controlled by the balance of the surface tension and the viscous and elastic forces. The surface tension is trying to „pinch off“ the filament while the extens-ional rheological properties of the fluid are trying to prevent this process. A laser micrometer measures the midpoint diameter of the gradually thinning fluid filament after the upper plate has reached its final position.

From the measured data, which describe the evolution of the filament diameter as a function of time, the filament break-up time, the extensional deformation, the deformation rate and the extensional viscosity can be calculated (2).

The temperature of the samples can be controlled with an accuracy of +/- 0.1 K using a circulator (in this case a HAAKE Phoenix).

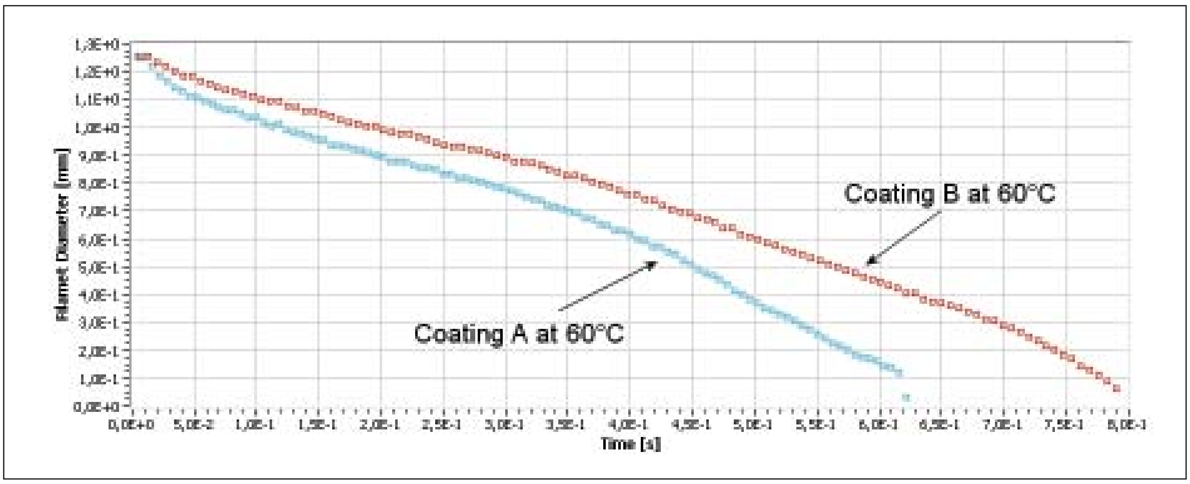

Figure 1: Filament diameter as a function of time for products A and B at a temperature of 60°C.

Results and Discussion

In order to optimize the filling process of product B, it was measured in the HAAKE CaBER 1 at different temperatures. Figure 3 shows that the filament lifetime decreases with increasing temperature.

At a temperature of 80°C, the filament lifetime is reduced to 25% of the original value. The filament lifetime of sample B at a temperature of 65°C is 0.66 s. For sample B, a temperature increase to 65°C would be sufficient to make it perform like sample A at 60°C, thereby solving the filling problems.

Conclusion

With the CaBER experiment the properties of coatings that are important during the filling of the coating in containers can be analyzed quantitatively. The filament life time is a direct measure of the stringiness of the product, as observed in the filling process. By changing the processing temperature the behavior of the problematic sample could be optimized. The capillary break-up experiment is a valuable tool for forecasting the behavior of the investigated coatings in the filling procedure.

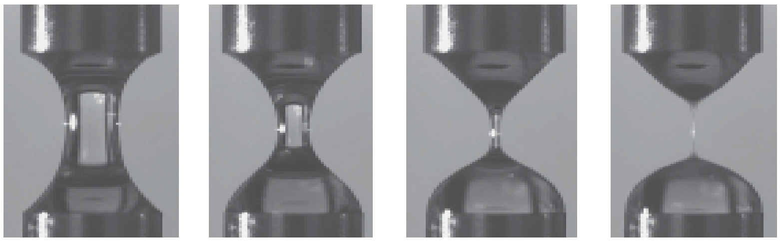

Figure 2: Sequence of a CaBER measurement [1].

References

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[2]*Tripathi A., Spiegelberg S., McKinley G. H.: Studying the extensional flow and breakup of complex fluids using filament rheometers, Proceedings of the XIIIth International Congress on Rheology, Cambridge, UK (2000), 3-55 - 3-57*

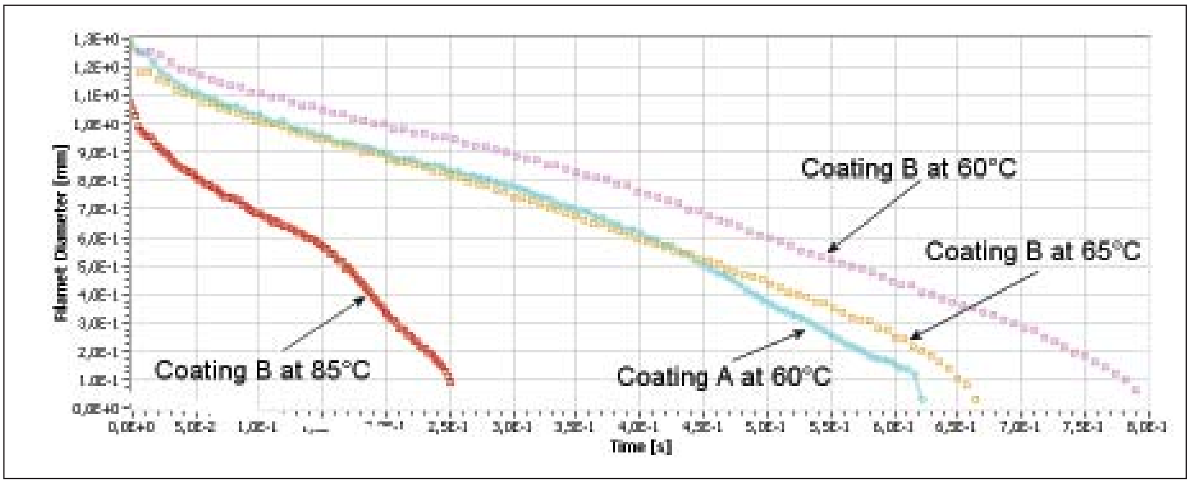

Figure 3: Filament diameter as a function of time at different temperatures for product B at T = 60°C, 65°C and 80°C and product A at T = 60°C.

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