Effect of viscosity on liquid curtain stability

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Presented at the 18th International Coating Science and Technology Symposium
September 18-21, 2016
Pittsburgh, PA, USA

The effect of viscosity on liquid curtain stability was studied by high-speed visualization. Glycerol/DI water solutions with viscosities varying from 19.1 to 210 mPa.s were used as coating liquids. The experimental set-up included a slide die delivery and straight stainless steel tube edge guides. Velocity measurements within the curtain at different distances from the edge guides revealed that away from the edge guides, the velocity is predicted by the free fall effect, but close to the edge guides the liquid moves slower due to the presence of a viscous boundary layer.

The critical condition was determined by examining the flow rate below which the curtain broke. Curtain breakup was initiated by the expansion of a hole within the curtain, close to the edge guides. Visualization results indicated that the hole forms in a circular shape and then becomes elliptical by faster expansion in vertical direction compared to the horizontal direction. Measurements of the hole rim velocity show that the liquid viscosity slows down the growth rate of a hole in the curtain. The minimum flow rate for destabilization of the curtain rises as the liquid viscosity increases, indicating the connection between the interaction with the edge guides and curtain stability. The liquid viscosity affects liquid curtain stability in two ways: It slows down the retraction speed of the rim of a hole in the curtain, stabilizing it; but also slows down the curtain speed inside the viscous boundary layer that is formed near the edge guides of the curtain, promoting

curtain breakup. With an improved edge guide, the viscosity has a stabilizing effect in both ways.

Acknowledgements

We would like to acknowledge the financial support from the Dow Chemical Company.