A study on the slot coating operating limits of non-Newtonian fluid: focusing on the effect of shear-thinning and yield stress

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Shear-thinning and yield stress are two important rheological properties in industrially using coating liquid, such as slurries. In this study, we use Herschel-Bulkley constitutive equation to describe the flow of coating liquid. We develop the simple model based on the 1-D viscocapillary model. Additionally, the visualization experiment is performed using a custom-made apparatus that mimics all essential industrial-grade slot coater features to detect the location and shape of gas/liquid interfaces and contact lines.

All of the coating windows obtained through experiments and modeling were depicted on the dimensionless space. The effects of variation of dimensionless parameters are evaluated by varying the solution's coating speed and concentration. Like the coating windows of Newtonian fluids, the larger the R_{gt} (gap-to-thickness ratio), the more vacuum pressure required. However, due to the shear-thinning effect, the required vacuum pressure for high R_{gt} is significantly reduced compared to Newtonian fluids. Although the effect of yield stress is more significant in higher R_{gt} conditions, it does not have a dramatic effect under the commonly used conditions.