ABSTRACT

Déchelette, Alexis. MSME, Purdue University, May, 2007. Shear-thinning drops impacting flat surfaces. Major Professors: Dr. Paul E Sojka and Dr. Carl R Wassgren, School of Mechanical Engineering.

The major objective of this study is to develop an accurate computational model for the dynamic behavior of a non-Newtonian, power-law, film formed after a drop impinges on a flat surface (i.e., a pharmaceutical tablet).

Non-Newtonian drop spreading is described by a model based on the one of Roisman *et al*. (2002a, 2002b) developed for Newtonian spreading. The model consists of a balance between the viscous, the inertial, the surface tension and the wetting forces. The drop deposition process is divided in four phases, a deformation phase, an advancing phase with a negligible acceleration, a contact angle hysteresis phase with a zero velocity and a receding phase. The effects of variations in non-Newtonian liquid rheological parameters *m* (the consistency index) and *n* (the fluid behavior index) are studied in detail, as well as the effect of surface tension through the Weber number (We).

Results show that a reduction in the viscous forces, through reduction in the effective viscosity, result in enhanced spreading of the film followed by more rapid recession. Changes leading to an increase in the surface tension result in reduced spreading of the film, followed by a more rapid recession. With regards to the maximum extent and diameter predictions, an increase in the consistency index, *m*, can be balanced by a decrease in the flow behavior index, *n*.

Experimental validation is performed for Xanthan Gum-water solutions that exhibit shear-thinning behavior. Drops are generated using a capillary tube and syringe pump with drop diameters obtained using a high-speed video camera. The drop-surface interaction processes, in terms of the diameter, are compared to theoretical predictions.

The model over predicts the experimental results but the discrepancy does not exceed 20% in any case. The over prediction may be caused by the velocity in the lamella and its height that are derived for inviscid fluids. The results are in good agreement for Re>>1 and Oh<<1.