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EXPLANATION OF THE EFFECT OF DIE SURFACE ON EXTRUSION INSTABILITIES IN POLYMER PROCESSING

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Extrusion is one of the main processes in the thermoplastic industry. In this process, the polymer melt is pushed through a die to obtain profiles with specific dimensions (plaques, films, tubes…). At high extrusion rates, volume irregularities or surface defects appear on the polymer extrudate (sharkskin, stick-slip…). These instabilities are one of the main concerns in the polymer processing industry, limiting the maximum production rates on commercial applications. This work is focused on the instability observed for linear polyethylenes at high shear rates, i.e. stick-slip. This defect is characterized by a pressure oscillation in the reservoir, which also results in a periodic flow at die exit. To model this phenomenon we have considered the slip of the polymer melt at the die wall [1]. Using the Brochard-de Gennes model, we have determined the critical strain and stress from the rheological properties and molecular weight distribution. In the expression of the critical shear stress [1], the Cad parameter takes into account the contacts between the adsorbed molecules and the die surface. In recent developments, we express this coefficient as a function of the wettability of the polumer on the die surface or more precisely function of the apparent contact angle polymer/die surface. This enables us to confirm the results of Anastasiadis and Hatzikiriakos [2] and Larrazabal et al.[3]. Now, the expression of the critical shear stress takes into account the molecular structure of the polymer, the molecular weight distribution, the polymer/wall interactions and the effect of die wall roughness.

[1] A. Allal and B. Vergnes, JNNFM, 2009; [2] H.Anastasiadis and S.G. Hatzikiriakos, J. Rheol, 42(4), 1998; [3] H.J. Larrazabal, A.N. Hrymak, J. Vlachopoulos, Rheol Acta (2006) 45: 705-715