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KNUCKLE FORMATION FROM MELT ELASTICITY IN PLASTIC PIPE EXTRUSION

C. Saengow[1,3,4], A.J. Giacomin[1,2,*] and C. Kolitawong[3]

[1]Polymers Research Group,
Chemical Engineering Department
[2]Mechanical and Materials Engineering Department
Queen's University, Kingston,
Ontario, CANADA K7L 3N6

[3]Polymer Research Center
Mechanical and Aerospace Engineering Department
King Mongkut's University of Technology North Bangkok
Bangkok, THAILAND 10800

[4]College of Integrated Science and Technology
Rajamangala University of Technology Lanna
Doisaket, Chiangmai, THAILAND 50220

ABSTRACT

When plastic pipe is solidified, it proceeds through a long cooling chamber. Inside the chamber, inside the extrudate, the plastic is molten, and this inner surface solidifies last. Sag then happens inside this cooling chamber, and sometimes, thickened regions (called *knuckles*) arise in the lower quadrants of the pipe, and specifically in large diameter thick-walled pipes. To compensate for sag, we normally shift the die centerpiece downward. Here, we investigate this die eccentricity, and its remarkable interaction with fluid elasticity in knuckle formation in annular flow of polymeric liquids.

We develop a map to help plastics engineers predict the extrudate shape, including extrudate knuckles, and then from the mass balance over the postdie region, to predict the extrudate shape entering the cooling chamber. We find that Newtonian extrudates, or extrudates for small pipe, never knuckle. Both of these findings agree with industrial experience. We also include a worked example to help plastics engineers suppress extrudate knuckling.

*Corresponding author: giacomin@queensu.ca