

Rimming flow of a weakly elastic fluid

Fomin S., Shankar R., Danes N., Yasuda A., Chugunov V.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

© 2014, Springer-Verlag Berlin Heidelberg. We present a theoretical description of the flow of a thin polymeric film on the inner wall of a rotating horizontal cylinder. We account for polymer elasticity with the quasi-linear Oldroyd-B constitutive relation. We apply several simplifications to derive analytical solutions to this otherwise analytically intractable problem. Because the film is thin and the Reynolds number is small, we can implement a lubrication approximation. Furthermore, if we consider weakly elastic polymers, we can expand perturbation series in the limit of a small Deborah number. The analytical approximation for the steady-state free surface shows qualitative agreement with previous numerical simulation. Numerical solutions of the approximate evolution equation demonstrate the destabilizing effect of elasticity on the film's perturbed steady-state profile.

<http://dx.doi.org/10.1007/s00162-014-0327-4>

Keywords

Approximate model, Rimming flow, Visco-elastic fluid