Viscoplastic sculpting in stable triple layer heavy oil transport flow

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Ohio University, IAN A. FRIGAARD, University of British Columbia — In [1] we 
introduced a novel methodology for efficient transport of heavy oil via a triple layer 
core-annular flow. Pumping pressures are significantly reduced by concentrating 
high shear rates to a lubricating layer, while ideas from Visco-Plastic Lubrication 
[2] are used to eliminate interfacial instabilities. We purposefully position a shaped 
unyielded skin of a viscoplastic fluid between the transported oil and the lubricating 
fluid layer to balance the density difference between the fluids. Here we address 
the sculpting of the shaped skin within a concentric inflow manifold. We use the 
quasi-steady model to provide inputs to an axisymmetric triple layer computation, 
showing the development of the streamwise skin profile and establishment of the 
flow. For this, we use a finite element discretization with the augmented-Lagrangian 
method to represent the yield surface behaviour accurately and a PLIC method to 
track the interface motion. [1] P. Sarmadi, S. Hormozi and I.A. Frigaard,” Triple-
layer configuration for stable high-speed lubricated pipeline transport”, Phys. Rev. 