Scission of flexible polymers through contractions: predicting the effects of multiple passages

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When injected through a contraction, high molecular weight polymer solutions exhibit a sharp increase of apparent viscosity due to chain stretching; this stretching can induce polymer scission, which then decreases the extensional viscosity.These phenomena are often observed in situation where flow instabilities appear. In order to disentangle the two effects we have measured the pressure-flux relation for high molar mass polymer solutions passing through a hyperbolic contraction. The ratio of the pressure drop to that of the (Newtonian) solvent has a maximum due to the competition between polymer extension and degradation (scission). From the dependence of the pressure maximum on flow rate and equivalent molecular weights we can quantify the decrease in equivalent molecular weight due scission in the contraction. We find a geometry-dependent relation between the flow rates at which the maximum occurs for successive passage in a given contraction, which appears to be independent of molecular weight, concentration, solvent quality and viscosity, and can be used to predict the degradation under successive passes.