On numerical Simulations of Polymer Extrusion Instabilities

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Abstract:
The objective of this study is mainly to review recent work concerning the numerical modeling of the stick-slip and gross melt fracture polymer extrusion instabilities. Three different mechanisms of instability are discussed: (a) combination of nonlinear slip with compressibility; (b) combination of nonlinear slip with elasticity; and (c) constitutive instabilities. Furthermore, preliminary numerical simulations of the time-dependent, compressible extrudate-swell flow of a Carreau fluid with slip at the wall, using a realistic macroscopic slip equation that is based on experimental data for a high-density polyethylene, are presented.

Zusammenfassung:
Das Ziel dieses Übersichtsartikels ist es die neueste Arbeiten der numerischen Modellierung des "stick-slip" und der Extrusionsinstabilitäten bei Polymeren, die durch Schmelzebruch verursacht werden, vorzustellen. Es werden drei verschiedene Instabilitätsmechanismen besprochen: (a) die Kombination von nichtlinearem Gleiten mit Kompressibilität; (b) die Kombination von nichtlinearem Gleiten mit Elastizität; und (c) konstitutive Instabilitäten. Im weiteren werden vorläufige numerische Simulationen von zeitabhängiger, kompressibler Stranggaufweitung einer Carreau-Flüssigkeit mit Wandgleiten vorgestellt, wobei für HDPE eine auf experimentellen Daten beruhende makroskopische Gleit-Gleichung verwendet wird.

Résumé:
L'objectif de cette étude est principalement de passer en revue les travaux récents qui visent à modéliser numériquement les instabilités rencontrées lors de l'extrusion de fondus de polymères telles que le glissement-accrochage et le phénomène de fracture. Trois mécanismes différents d'instabilités sont discutés: (a) la combinaison d'un glissement non linéaire avec la compressibilité; (b) la combinaison d'un glissement non linéaire avec l'élasticité; et (c) les instabilités constitutives. De plus, des simulations numériques préliminaires sont présentées. Elles simulent l'écoulement d'extrusion compressible avec gonflement d'un fluide de type Carreau avec glissement aux parois. Ce dernier est modélisé à l'aide d'une équation macroscopique réaliste, basée sur des données expérimentales obtenues avec un polyéthylène haute densité.

Key Words: Extrusion instabilities, Melt fracture, Slip, Carreau model, Oldroyd-B model, Compressible flow, Constitutive instability, Viscoelastic flow

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