STABILITY ANALYSIS OF THE FILM BLOWING PROCESS INCLUDING THE AIR EFFECT

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The stability of the well–known film blowing process, used to produce biaxially stretched polymeric films, including the aerodynamic effect of the air jet is studied for first time in the literature. The non-linear coupling between the air and the polymer is examined by assuming axisymmetric and isothermal flow for both phases. The viscoelastic properties of the film are taken into account by employing the Upper Convected Maxwell model, the Phan-Thien and Tanner model and the Giesekus model. The governing equations for the polymer are simplified by following the thin-film approximation and the corresponding ones for the air are derived by applying a boundary-layer type analysis. The final set of differential equations for the film is first solved numerically using finite differences in order to predict the steady state solution for the bubble shape, film thickness, and polymer extra-stress profiles. Subsequently, a linear stability analysis under small axisymmetric perturbations of the base state is performed. The steady state results show that the force caused by the airflow has a significant effect on the film shape and the characteristics of the final product. Furthermore, the stability analysis reveals that the aerodynamic force increases the stability operation window of the process, in agreement with the experimental and industrial experience.