Investigation of draw resonance instabilities in the continuous glass fiber drawing process

Company: 3B-the fibreglass company
ULg Laboratory: Multiphysic and Turbulent Flow Computation
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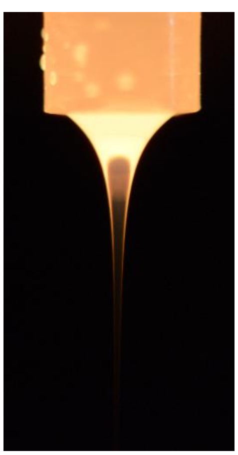
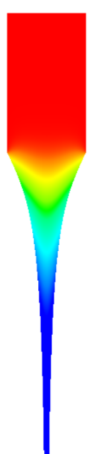
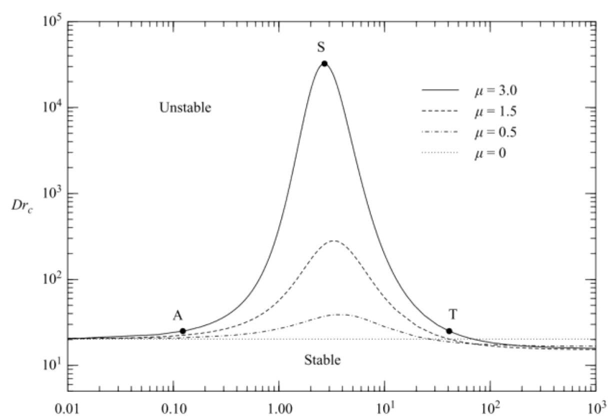
Context

An industrial project on the manufacturing process of continuous glass fibers is currently underway in the *MTFC Research Group* in collaboration with the company *3B-Fibreglass*[1]. Its goal is to optimize the process by reducing the number of fibers that break during forming.

The fiber drawing process consists in continuously drawing and cooling a high viscous glass melt into very thin fibers. The melt, which is delivered by an upstream furnace, flows through small orifices. The liquid glass then becomes a free jet that is quickly cooled to reach the glass transition and then wound at high velocity. During this cooling process, the glass viscosity increases dramatically until transition, where the melt becomes solid.







(Scheid,B. *et al*, 2009)

[1] http://www.3b-fibreglass.com/

Description and objectives

For optimal operation the glass free jet should remain as stable as possible. However, it sometimes exhibits instabilities characterized by oscillations of the free surface of the fiber. Since the glass is cooled and drawn, the system has the particularity of “freezing” and convecting the instability. This leads to undesirable variations in the final fiber diameter and potentially to the breaking of the forming fiber. It is thus important to understand the physical mechanisms governing the emergence of this instability.

The goal of the proposed project is to investigate the instability from a theoretical and numerical point of view. More specifically, a stability analysis must be performed on a simpler quasi-one-dimensional problem, in which different levels of simplification are considered. This analysis should lead to the identification of the key physical parameters and their critical value. In a second step, unsteady simulations of a forming fibers will be performed using an existing model. The objective is to reproduce the instability, and thus to test the findings of the first phase. The final goal of this project is to provide a critical threshold for the relevant parameters to ensure a stable flow.

In particular, the student is asked to:

- review the scientific literature,
- characterize the relevant physics,
- perform a theoretical stability analysis to identify the unstable modes and their corresponding parameters,
- run unsteady simulations to reproduce these unstable modes,
- identify and quantify the key parameters governing the instability,
- derive a diagram of the critical thresholds.

Profile

The student must have some familiarity with fluid dynamics and heat transfers.