Two Step Study of Flow in an Industrial Pulp Screen, Solved with COMSOL Multiphysics® Mixer Module

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Abstract

The modern pulp and paper industry involves several high technological processes, for example washing, screening, mixing and bleaching. In this study the pulp screening process is investigated. Pulp from cooking always contains unwanted solids such as sand, metals or poorly separated fibers. One method of separating the solids from the pulp is to pump the dilute pulp (2-4%) through a screen barrier. In order to avoid the fiber network to plug, it is necessary to 1) fluidize the shear thinning pulp 2) expose the barrier with pressure pulses which causes plug to release. In this 2-step study we will see this phenomena in both macro and micro scales.

The screening is here studied in two steps. First we investigate the macro flow in the full size screen, figure 1. This is done in the COMSOL Multiphysics® Mixer Module where the inner rotor body is modeled as a rotating domain using the Rotating Machinery, Fluid Flow physics interface with k-ω turbulent flow. The screen barrier is not resolved but the pressure drop over the barrier is controlled using momentum volume forces. The high rotation (15 rev/s) together with a tangential periodicity enables the use of a steady state frozen rotor study. The full setup includes 433096 elements and it is solved in a few hours on a 16Gb, 64 bits, Intel i7 3.90 Ghz machine.

The second step focus on the pulsating flow in the vicinity of the screen barrier - here in the form of long and thin vertical rods with narrow slots. The flow in a single slot with neighboring rods is studied under the presence of the transient pressure pulse from the first study. This setup involves a 34734 elements 2D representation of the geometry and a transient k-ω turbulent flow solver.

The full screen frozen rotor simulation gives the pressure pattern over the screen barrier where suction pulses are in the magnitude of 1 bar, figure 2. Even though the main pulp flow is directed out through the barrier the passing pulses are strong enough to cause local backflow through the slots in order to tear a plug. The micro study gives a good understanding of the flow on the feed side of the barrier. A small vortex cause the fibers to bend and redirect into the slot when stiff or heavy impurities remain on the feed side and be transported to the reject zone, figure 3.

It is obvious from the results that the design of the pressure pulse rotor elements is crucial for the flow pulses through the screen barrier. CFD can be used to tailor exactly the kind of pulse needed for different types of fiber network and impurities. Also the barrier rods can be

optimized regarding to slot with and angles of surfaces. It is clear that COMSOL Multiphysics® software could work as a well suited tool for understanding complicated flow in the demanding pulp and paper industry.

Figures used in the abstract

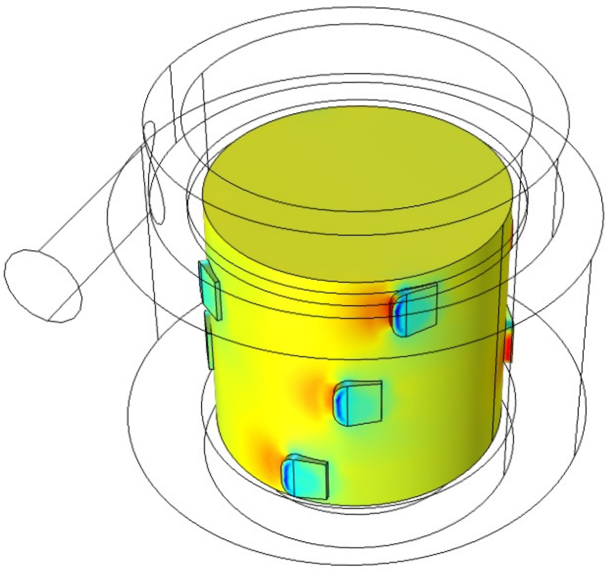

Figure 1: The pulp screen

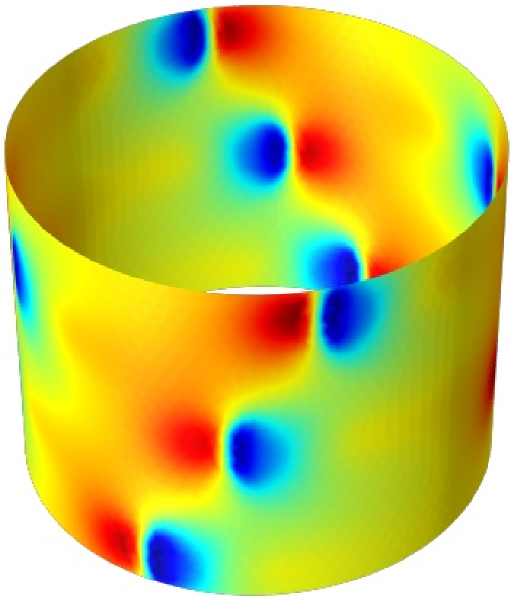

Figure 2: Pressure pulses on the screen barrier

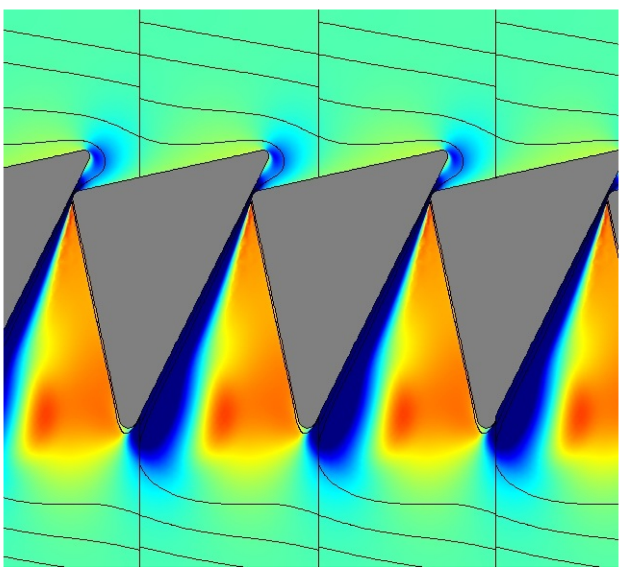

Figure 3: Pulsating flow around the screen barrier