Simulation of an Oxygen Delignification Reactor in the Kraft Pulp Production Process

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Abstract

Oxygen delignification is a technology established worldwide and a common operation in pulp mills that use Kraft cooking. The reasons for using this technology are the reduction of organochlorine compounds in the effluents, and economy of chemicals in the bleaching stage. The objective of this work is to analyze alternatives for process optimization, through multiphysics simulation, in the aspects of operating conditions and fluid dynamics of the reactor.

The delignification reactor consists of an upflow pressurized vessel with a pulp distributor at the bottom and a pulp discharger at the top. The simulation was performed in 2D axissimetric and 3D geometry. The mesh created for the simulation of the geometries was the free triangular, being refined sequentially until obtaining different degrees of refinement. The modules used were the transport of diluted species to simulate the fiber suspension inside the reactor, and the turbulent flow module was used to simulate the fluid dynamics and the heat transfer module in fluids for the temperature distribution inside the reactor.

In the 2D simulation, there were three main zones inside the reactor, which showed a larger recirculation at the bottom near the distributor, while in the reactor length there is a rising current without significant mixing, and recirculation zones in the top of the reactor. In the 3D simulation it is possible to analyze an improvement in the recirculation along the reactor, this is due to the holes that were added to the bottom of the reactor for distributing the pulp, also there was improvement in the viscosity coefficient, not being observed a preferential channel near the reactor wall as in the 2D simulation. The values found in the simulation are within the expected range, as the delignification should be approximately 50% of the input value and this is observed since the output delignification value had a difference of 9.54 in comparison to the 18 value in the input.