



Technical Paper

Pumping of special liquids

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Three Phase Pumping of Viscous Fluids - New Ways in Medium Consistency Pumping

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Summary

Medium consistency (MC) pulp is a three phase fluid including dissolved and unresolved air, fibres as solid matter and water as the liquid phase. The medium though relatively high consistency - as compared to normal liquid pumping - can easily provoke blockage effects as the water fibre mixture can be modeled as a Bingham fluid. And the eventually high gas contents require the usage of an additional vacuum pump both for pumping as for system purposes.

The paper describes a new way of efficient and reliable stock pumping without vacuum pumps – and thus claims to change the rules for MC-pumping by setting new standards for efficiency, maintenance and usability for medium-consistency pulp (up to 14 %). Using new solutions to fluidize the pulp the pump also operates without an additional vacuum pump – neither internal nor external – and generates efficiencies which have the potential to become the new benchmark in the MC market. Additionally a very detailed market investigation was performed to cast the demands of MC-pump users “simpler – better – more reliable” into detailed design targets.

Knowing the complex handling and adjusting work required to operate existing MC-pumps and estimating the installation and maintenance costs for the vacuum system, the eliminating of the vacuum pump would generate notable benefits for the customer. Naturally this aim was to be achieved without reducing process stability! One focus was on efficiently separating the air from the pulp and skillfully guiding it out of the pump - avoiding fiber loss.

In this paper the hydraulic development process is described. Based on functional requirements for the new pump system, CFD*-calculations (*Computational Fluid Dynamics*) were carried out to understand the complex flow in the pump system. From existing 3D-models different structured and unstructured grids were generated for the drop leg, the connecting pipe, the fluidizer with liner, the runner including back vanes and the space to the hub shroud, the pressure balancing holes, the volute and the outlet pipe. A RANS-calculation (*Reynolds Averaged Navier Stokes*) gives detailed information on the degassing process, the fluidization of the pulp into the stand pipe and the efficiency improvement potential for the whole pump configuration. A pulp model integrated as beta function in the commercial CFD-code, modified pure substances and Bingham medium were used for the solid-liquid components as fluid models in multiphase calculations with air as a third phase.

At the same time a MC-pump test rig equipped with online air content and other measurement systems was used to carry out a series of more than 1000 (!) test trials for the experimental part of the development process, and thus systematic variations of different elements were verified.

Both approaches resulted in a general understanding of where and how the air is separated from the stock, which is the key of successful stock pumping, and resulted in a unique design for parts to fluidize the pulp, to separate the air from it and to press it out of the flow regime. As MC-pumps are process-critical components, the new system was tested under industrial conditions in a pulp mill to demonstrate its applicability. More than half a year of continuous operation without any operating problems in a very difficult position – in the brown stock area – proved its expected quality.