Numerical Investigation of Churning Losses Caused by the Oil-Piston Interaction within a Calender Roll of a Paper Machine Using a Particle-Based Simulation Method (PARTICLES 2021)

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ABSTRACT

Within the paper production process, certain surface properties of the paper web, e.g. smoothness and gloss, are produced or modified by so-called calenders. This paper machine device consists of several rolls, which apply high pressure and temperature on the paper web. Calenders exhibit large widths up to more than 10 m. Therefore, it is challenging to precisely adjust the required mechanical forces in order to apply a defined line load across the entire width of the paper web. By making use of Voith's Nipco technology, both line load and roll deflection are controlled by multiple pistons which can be individually adjusted. This is achieved by pressure oil injection. The piston works also as a hydrostatic bearing in such a way that a thin lubrication film is formed between the stationary piston head and the rotating roll shell. Additional oil is injected into the roll for cooling purposes.

Within this paper we present an industry-related approach to take advantage of present-day Moving Particle Simulation (MPS) methods. Hereto, we used the commercial software Particleworks® for a numerical investigation of the flow phenomena within a calender roll. The focus of our investigation were the churning losses caused by the interaction between the rotating oil and the mounted piston head. For this purpose, simulations of different oil volumes were performed.

The results show that the piston head has a clear impact on the flow field. Firstly, the oil is reflected in upstream direction, causing disturbances in the subsequent flow. Secondly, the oil which streams around the piston rod leads to the formation of a Kármán vortex street. Thirdly, a reduction of oil volume results in a reduction of the churning loss.

Keywords: paper machine, calender, MPS, Particleworks®, oil, churning loss

REFERENCES

[1] http://www.particleworks.com/home_en.html