INDUSTRIAL PILOT PROJECT

Neutron imaging as a tool for sustainable production of cellulose-based insulation materials for power transmission

THE INDUSTRIAL CHALLENGE

Pressboard, manufactured by Hitachi Energy, is a key component of their high-voltage transformers. More efficient manufacturing processes and improved material performance will thus contribute to the ongoing electrification of our society. Developing viable mathematical models, i.e., simulation tools, of the Pressboard dewatering and drying process can improve process control and efficiency and contribute to enhanced performance.

WHY USE A LARGE-SCALE FACILITY?

To validate these models, it is imperative to gain knowledge of the dynamics and transport of water and steam in the cellulose fibre mats that constitute the Pressboard. Neutron imaging provides a unique methodology that allows direct allows quantification of the water content and the steam generation and transport in the fibre mat (paper sheet) during hot-pressing. Complemented by thermal infrared imaging, this provides a complete insight into the physics of the industrial process.

HOW THE WORK WAS DONE

The experiments were performed at the FISH thermal neutron imaging station at the Hoger Onderwijs Reactor (HOR), at the Delft University of Technology, with Dr J. Plomp and Ing. M. Thijs. Using a setup designed within the project, experiments on paper samples (40×40×4 mm^3) were performed using time-resolved neutron imaging at industrially relevant conditions, i.e. 220 °C, 1 bar and a starting dryness of 20-40%, see Figure 1.

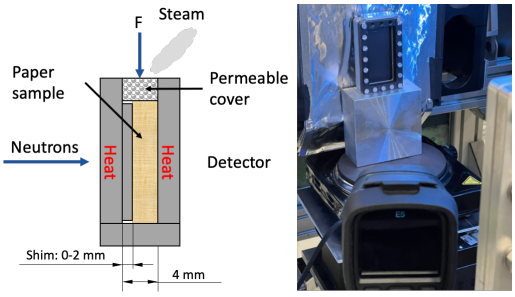

Figure 1. The principle of the experiment (left), which was mounted in the FISH imaging station with a heating plate below and a thermal imaging camera visible in the foreground (right).

THE RESULTS AND EXPECTED IMPACT

The results from the experiments show that it is possible to track the time-dependent drying of the thick fibre mat (the Paperboard) as a function of water content and compression, see Figure 2. The image sequence represents excerpts from the entire sequence of 500 images, where each represents 2 s exposure of the drying process.

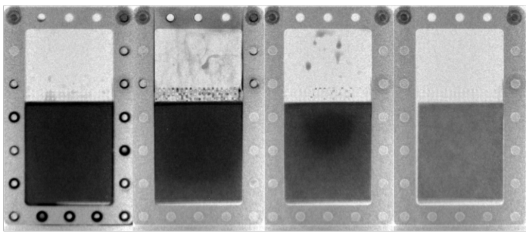

Figure 2. A time series showing how water (darker) boils and leaves the thick fibre mat, seen in the rightmost image.

The captured image sequences can easily be analysed to provide data that shows how the concentration of water changes at different positions, which can be used to validate and tune mathematical models that can be used to predict and control industrial process operations and the structural properties of the final pressboard. The successful setup and results will be the starting point for a project to develop a complete methodology for optimising and controlling the hot-press process.

"The experiments validated our simulation methodology for predicting water and vapour transport during drying. The results will be valuable to improve productivity, improve the basic understanding of the drying process and help to reduce the environmental footprint of production" /Lars Erik Schmidt, Hitachi Energy

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