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JANUARY

MICROBIOLOGY

Using novel DNA methods to achieve higher process efficiency and performance

Anu Jaakkola, Mark Nelson, Albert Allen, Markus Korhonen, Marko Kolari, and Jaakko Ekman

Uncontrolled microbiological activity is a challenge for recycled fiber (RCF) mills as it can have negative effects on production and end-product quality. The microbes that exist in these systems have been largely unknown, and the strategies employed to control microbiology have been non-specific. Understanding the specific microbial groups present in RCF mills, their properties, and where they exist, as well as being able to accurately measure the true troublemakers, are key to targeted control of the bad actors.

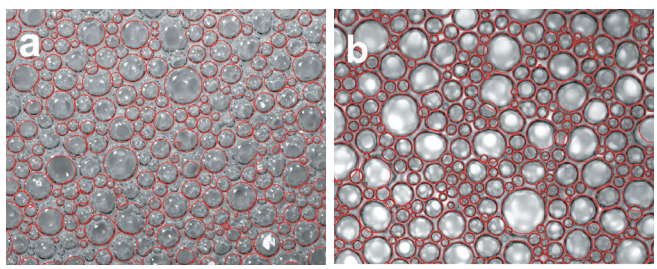
In this study, researchers present the results of a global survey of over 40 RCF paper machines. The same RCF-specific problem-causing bacterial groups were found on different continents, including large densities of newly identified bacteria in paper processes. Those can degrade cellulose and starch, produce acids and odorous substances, and have a big impact on fiber strength and additive consumption. The researchers also demonstrate how modern DNA tools can quantify the impact of biocidal countermeasures against the actual troublemakers, including bacteria found to degrade cellulose during RCF pulp storage. These novel DNA tools can help producers more effectively design and adjust microbiological control to achieve higher process efficiency and performance.

In this study, the researchers identified problem-causing bacteria in RCF processes and showed that they may deteriorate fiber strength properties. Analysis of the bacterial community in the process tells about process health and how much bandwidth there is for improvements.

FOAM FORMING

Advanced real-time digital microscopy of foaming processes

Markus Honkanen and Hannu Eloranta



Closeups of a) front-light illuminated image and b) transilluminated image where the bubble detections are circled.

The properties of aqueous foams play a major role in foam forming and foam coating. Inline real-time foam measurements provide highly desired opportunities for optimization and control of foaming processes.

This research presents inline digital microscopy measurements of aqueous foams in foaming processes. It presents methods for providing detailed information on foam quality parameters, such as foam density and foam homogeneity, in real time from the process.

In addition, this study evaluates the performance of transillumination and front-light illumination in imaging of foams. The tests show very good results for the transillumination approach. Limitations of the image-based optical technique are discussed, and the precision of bubble size distribution measurement is assessed with a certificated reference substance. The measured foam densities are compared against the reference foam densities. In the case of heterogenous foams with a wide bubble size distribution, the bubble size-dependent dimensionless depth of field must be taken into account to obtain accurate estimates of foam density.

This study quantifies the accuracy of digital microscopy in measuring foam bubble size distribution and its standard deviation, and foam density directly from the foam process. It highlights the difference in front light and transillumination approaches and helps the reader in designing the right type of system for the application.

FOAM RHEOLOGY

Flow rheology of light foams generated from aqueous solutions of polyvinyl alcohol

Ari Jäsberg, Janika Viitala, Atsushi Tanaka, Baranivignesh Prakash, and Antti I. Koponen

Recent studies have shown that foam-assisted application of additives into a wet web has advantages over the conventional way of adding chemicals into the pulp suspension before forming, e.g., increased

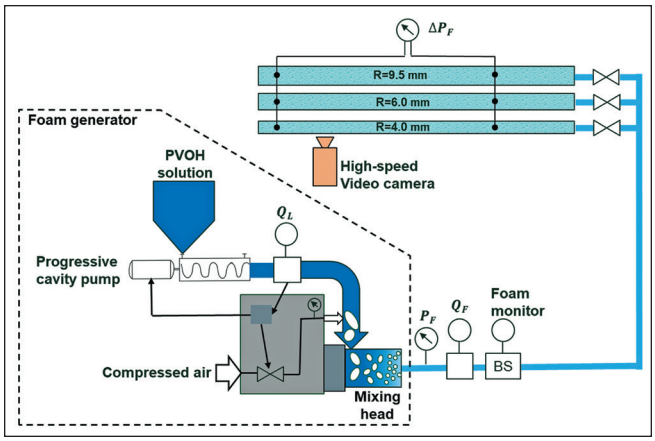


Diagram of the process researchers used.

mechanical retention as well as high dosage, giving increased wet strength without impairing sheet uniformity. To engineer processes using this new technology, we must quantify the complex flow behavior of applied foams. At the minimum, we need to know the foam viscosity and the slip velocity at the solid surfaces to build practical research models.

In this study, researchers quantified rheological behavior of foams having polyvinyl alcohol (PVOH), a widely used strength additive chemical, as the surfactant. The foam density was varied between 100 g/L and 300 g/L, and the concentration of the PVOH solution was varied between 0.5 - 6.0 percent (w/w). Researchers measured the rheological properties of the foams by using a horizontal pipe bank. The viscosity and the dynamic surface tension of the PVOH solutions were quantified with commercial laboratory devices.

The results indicated that PVOH foams can be described with high accuracy as shear-thinning power-law fluids where the detailed behavior depends on the foam density and the PVOH concentration. Slip flow, as usual, increased with increasing wall shear stress, but it was also dependent on the PVOH concentration, the air content, and the bubble size. For both the foam viscosity and the slip flow, a correlation was found that described the quantitative behavior of all the studied foams with good accuracy.

This study helps engineers to develop foam coating devices and processes by providing rheological correlations for foam viscosity and slip flow.

FOAM FORMING

New opportunities in the paper and nonwovens industries with foam-assisted web forming and chemical application

Antti Oksanen, Tuomo Hjelt, Jani Lehmonen, Timo Rantanen, Jaakko Asikainen, and Kristian Salminen

Foam-assisted web forming and chemical application technologies have great potential to improve manufacturing efficiency and product quality in the paper and nonwovens industries. This study demonstrates the benefits of foam forming and foam-assisted application of chemicals in a pilot machine trial.

Uniform high-bulk webs of unrefined bleached softwood kraft pulp (BSKP) and viscose fibers were manufactured by foam forming. It was shown that foam formed low-grammage and high-bulk viscose fiber webs can be strengthened by foam-assisted application of latex onto the wet web. Correspondingly, foam-assisted application of carboxymethyl cellulose (CMC) and anionic polyacrylamide (A-PAM) improved the strength of the foam formed low-grammage and high-bulk BSKP web.

Overall, the pilot machine results indicated that material cost savings could be achieved and a high-performance product could be manufactured with foam-based technologies. These technologies may enable manufacture of new products with older paper machines or enhance the production efficiency of the current product.

Other Research Appearing in *TAPPI Journal*'s January 2023 Issue:

TECHNICAL BRIEF: FOAM ADDITIVES

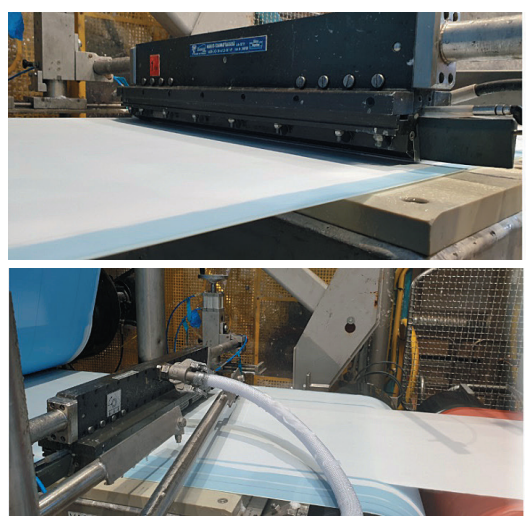
Chemical addition to wet webs using foam application

Tuomo Hjelt, Emmi Henriksson, Aayush Kumar Jaiswal, and Antti Oksanen

FOAM ADDITIVES

Z-direction chemical analysis for new application methods

Matthew Nicholas, Terry Bliss, and Tiffany Bohnsack


Foam applicator above the vacuum unit in the forming section of the pilot machine. A 100 percent viscose fiber base was used, and latex was applied by foam on top of the wet web.