



TJ SUMMARIES

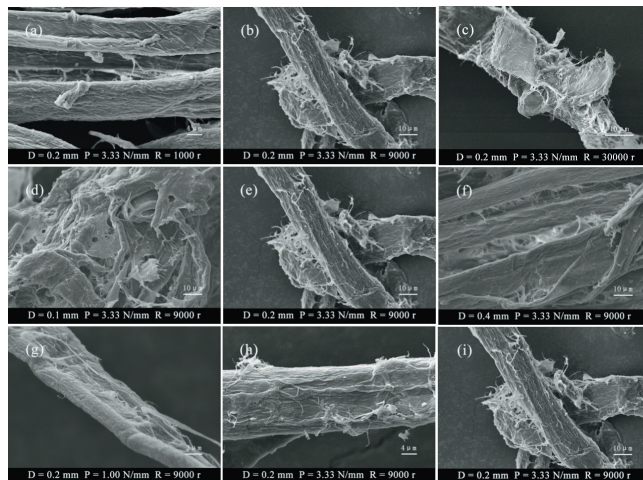
The papers summarized here are from the May and June 2020 issues of *TAPPI Journal*. *TAPPI Journal* is an online publication of relevant and timely peer-reviewed research delivered via email and free to all TAPPI members. To receive *TAPPI Journal*, join TAPPI at www.tappi.org.

MAY

RECYCLING

Effects of a PFI refiner's operational parameters on the swellability of recycled fiber

Xiaoning Shen, Bo Li, Wenxuan Mo, and Xin-Sheng Chai



Scanning electron microscope images of recycled fibers refined at different linear pressures and gaps.

This study presents data on the effects of operational parameters (number of revolutions, linear pressure, and gap) of the PFI refiner on the swellability of recycled fiber, which was characterized by water retention value (WRV). The results showed that the increase of recycled fiber's WRV was proportional to the number of revolutions and the linear pressure, but inversely proportional to the gap. The mathematical relation between these parameters and the fiber WRV could be described by an empirical model for gaps greater than 0.1 mm.

Scanning electron microscopic images of fiber morphology showed that the basic framework of fibers could be maintained with the gap greater than 0.1 mm, but was destroyed with smaller gaps. This model provides a technical reference for quantitative control of refining treatment and an effective method for improving recycled fiber quality. It offers a mathematical equation to calculate the WRV of recycled fiber using the operational parameters of the PFI mill.

RECOVERY CYCLE

Alternative "green" lime kiln fuels:

Part I—Pulping/recovery byproducts

Peter W. Hart

This study is the first of a two-part series on "green" lime kiln fuels. The first part of this work reviews the use of pulp mill and recovery byproducts as either full or partial replacement of oil or natural gas in the kiln. The second part reviews the use of various forms of woody biomass, bio-oils, gasification, and hydrogen as potential carbon neutral or carbon-free lime kiln fuels.

Several mill-produced byproducts are identified for potential use as a "green" kiln fuel to reduce a mill's carbon footprint. The pros and cons of each fuel and potential fossil fuel replacement levels are identified.

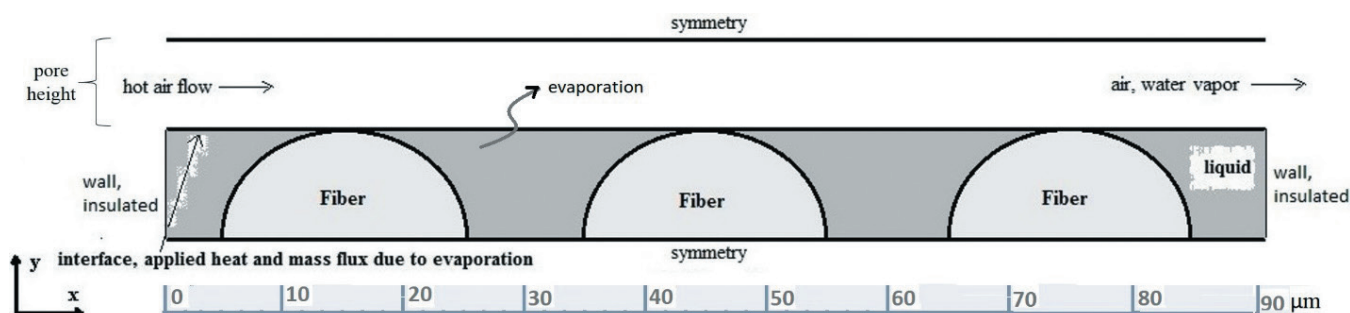
PAPERMAKING

Fundamental understanding of removal of liquid thin film trapped between fibers in the paper drying process: A microscopic approach

Zahra Noori, Jamal S. Yagoobi, and Burt S. Tilley

In papermaking, drying requires considerable energy consumption. In the structure of wet paper, there are two different types of water: free water and bound water. Free water can be removed most effectively; removing bound water consumes a large portion of the energy used.

The focus of this study is on the intermediate stage of the drying process, from free water toward bound water, where the remaining free water is present on the surfaces of the fibers in the form of a liquid film. For simplicity, the drying process considered in this study corresponds to pure convective drying through the paper sheet. This research explores the physics of removing a thin liquid film trapped between fibers in the paper drying process. The film is assumed to be incompressible, viscous, and subject to evaporation, thermocapillarity, and surface tension. By using a volume of fluid (VOF) model, the effect of the previously mentioned parameters on drying behavior of the thin film is investigated.



Schematic of the model for an evaporating liquid film between three fibers bounded by a flowing gas layer.

Given the importance of water removal in the final stages of drying and its impact on energy efficiency, the results of this research help pulp and paper makers understand the effect of different parameters on removal of water trapped between the fibers.

JUNE

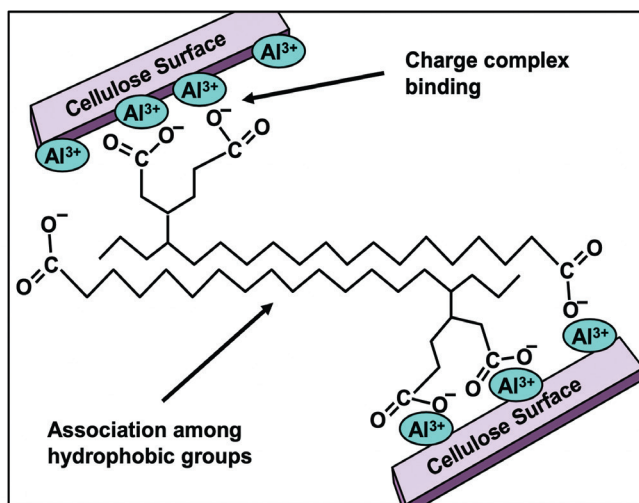
PAPERMAKING

Cationic emulsions of maleic anhydride derivatives of oleic acid and abietic acid for hydrophobic sizing of paper

Ahsen Ezel Bildik Dal, Martin A. Hubbe, and Lokendra Pal

Ordinary rosin sizing agents are mixtures of resin acids that include abietic acid and related compounds obtained from softwoods such as pine. Fatty acids, which are another byproduct of the kraft pulping of softwood species, also may have hydrophobic effects, but their use as sizing agents has seldom been considered.

In this study, abietic acid and oleic acid, in the absence of other components, were first modified by reaction with maleic acid anhydride. Then, the maleated derivatives (maleated oleic acid [MOA] and maleated abietic acid [MAA]), which were emulsified with cationic starch at the 1:1 and 3:2 ratio, respectively, were added to fiber furnish containing aluminum sulfate (papermaker's alum). Researchers dried the prepared sheets and measured the chemical, optical strength, and absorption properties. The presence of the sizing material was confirmed using time of flight secondary ion mass spectrometry (ToF-SIMS), and the retention of the sizing agent on fibers was supported by evidence of hydrocarbons on the paper surface.



Suggested mechanism whereby ionic complex formation and association among oleophilic groups may contribute to inter-fiber bonding.

OTHER RESEARCH IN TAPPI JOURNAL'S MAY 2020 ISSUE:

RECOVERY CYCLE

Alternative "green" lime kiln fuels: Part II—Woody biomass, bio-oils, gasification, and hydrogen

Peter W. Hart

OTHER RESEARCH IN TAPPI JOURNAL'S JUNE 2020 ISSUE:

PULPING

Development of a fast brightness testing method for mechanical pulp based on microwave oven drying

Xiaohan Wang, Yanqun Su, Jingang Liu, Zhibin He, and Yonghao Ni

In addition to achieving sufficient water resistance features with MAA, a lesser hydrophobic character was obtained when using MOA. Compared to commercial applications, relatively large amounts of sizing agent were used to obtain a sufficient sizing degree. The sizing treatments also resulted in substantial increases in tensile index value. Since cationic starch was used in the formulation of the sizing agents, the increase in tensile index may have been due to the influence of cationic starch. Contributions to paper strength from a combination of ionic complexation and mutual association of hydrophobic groups is also proposed.

In this work, the researchers show a new chemical approach to preparing sizing agents from components of wood resin. Progress has been achieved in development of hydrophobic treatments for paper.

RECOVERY CYCLE

Integrated study of flue gas flow and superheating process in a recovery boiler using computational fluid dynamics and 1D-process modeling

Kunal Kumar, Viljami Maakala, and Ville Vuorinen

Superheaters are the last heat exchangers on the steam side in recovery boilers. They are typically made of expensive materials due to the high steam temperature and risks associated with ash-induced

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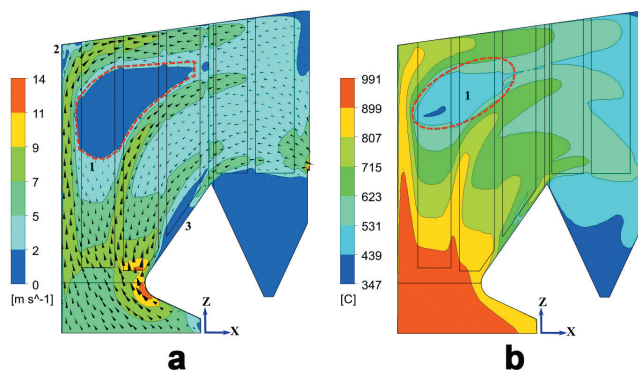
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The solved velocity field for flue gas (a) and the solved flue gas temperature field (b) in the middle of the superheater region.

corrosion. Detailed knowledge about the steam properties and material temperature distribution is essential for improving the energy efficiency, cost efficiency, and safety of recovery boilers. In this study, for the first time, a comprehensive one-dimensional (1D) process model (1D-PM) for a superheated steam cycle is developed and linked with a full-scale three-dimensional (3D) computational fluid dynamics (CFD) model of the superheater region flue gas flow.

The results indicate that: (1) the geometries of headers and superheater platens affect platen-wise steam mass flow rate distribution (3-7 percent); and (2) the CFD solution of the 3D flue gas flow field and platen heat flux distribution, coupled with the 1D-PM, affect the platen-wise steam superheating temperature (45-122 percent) and material temperature distribution (1-6 percent). Moreover, researchers found that the commonly-used uniform heat flux distribution approach for the superheating process is not accurate, as it does not consider the effect of flue gas flow field in the superheater region.

These new observations clearly demonstrate the value of the present integrated CFD/1D-PM modeling approach; this present approach is advantageous for troubleshooting, optimizing the performance of superheaters, and selecting their design margins for the future. It could also be relevant for other large-scale energy production units, such as biomass-fired boilers.

TECHNICAL BRIEF: POWER & ENERGY

Case study: Paper mill power plant optimization—balancing steam venting with mill demand

Ricardo B. Santos and Peter W. Hart

Most power departments are tasked with generating steam to support millwide operations, generate electricity, and reduce operating costs. To do this, power boilers generate high pressure steam that is reduced to intermediate and low pressures for process utilization in the mill by means of steam turbine generator extraction or pressure reducing valves.

The most economical method to reduce steam pressure is the use of steam turbine generators, as electricity is generated from the steam when it is reduced in pressure. Electricity produced by these generators provides a substantial financial benefit and helps offset overall operational costs. To achieve tangible financial gains, the mill must evaluate the overall cost of steam production and the price of electricity.

The current work provides a case study of power plant optimization that evaluated electricity production and steam production costs balanced with mill steam demand. Process and cost optimization led to a significant reduction in low pressure steam venting, resulting in reduced fuel consumption and reduced operating cost. **360**