

TJ Summaries

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KRAFT PULPING

Modeling of the solubility of different inorganic sodium salts in black liquor under varying conditions
By Rickard Wadsborn and Rune Rådeström

Burkeite, a sodium salt ($\text{Na}_2\text{CO}_3 \cdot 2\text{Na}_2\text{SO}_4$), is a mineral that precipitates during black liquor evaporation at a dry solid content of ~50% or more. It forms scaling on the heat transfer surfaces in black liquor evaporation units. This scale has to be removed by washing or by boiling it out with black liquor, which decreases the efficiency of the process equipment.

In this research, the authors created a model for predicting the solubility of burkeite and related sodium salts in the evaporation train of a kraft pulp mill by conducting experiments covering the precipitation of burkeite and dicarbonate ($2\text{Na}_2\text{CO}_3 \cdot \text{Na}_2\text{SO}_4$). They then implemented the results from the experiments in a chemical model that used the Pitzer ion-interaction theory to describe the activity factors of the constituting ions in solution at high ionic strength.

Application: The predictive model can be useful in avoiding problems related to the scaling of burkeite and dicarbonate in evaporation trains of kraft pulp mills.

KRAFT PULP UNIFORMITY

The nature of single fiber kappa distributions

By Richard Gustafson, Guarav Rayal, Ming Qiao and Jingliang Mao

Pulp uniformity has always been of major interest to researchers, but in the past it has been challenging to measure. Recent development of a single fiber kappa analyzer (FKA) has allowed for rapid measurement of pulp kappa uniformity. The development of the single fiber kappa analyzer permits a more direct and quantitative measure of pulp uniformity.

The authors examined the uniformity of a variety of kraft pulps with the University of Washington's single fiber kappa analyzer, and found some consistent patterns and trends with regard to pulp uniformity. This paper provides a synthesis of the significant observations made in examining the kappa uniformity of kraft pulps.

Hardwood pulps are generally more uniform than pulps from softwoods, but all the single fiber kappa distributions are broad. Virtually all softwood pulps have high kappa tails, whereas hardwood pulps have a high kappa tail only if the pulping is extremely non-uniform. Hardwood pulp kappa distributions appear to be Gaussian. Softwood pulps from commercial digesters



FEATURED PAPER:

PULP YIELD

Seasonal Variations in Wood: Perceived and Real Impacts on Pulp Yield
By Peter W. Hart

Wood is one of the significant input cost factors of a pulp mill. Over the course of a year, many mills experience substantial variations in reported pulp yields per green ton of wood. In early spring, more wood must be consumed to produce the same amount of good quality pulp. These seasonal effects can mask the

and the seasonal reproducibility of wood moisture in chips. Seasonal changes in the amounts of bark, pin chips and fines in the chips going to the digester are also examined. Other potential seasonal accounting impacts on reported pulp yield and costs are also considered.

"I have worked in several mills," writes author Peter Hart regarding this research. "In many of these mills, accounting would determine that the digester yield had dropped during the spring months and operations personnel would spend days proving to management that they were running their process correctly

"The fact that accounting data could suggest a potential US\$200,000 swing month-to-month due to seasonal variation in a 1,000-tpd mill was enlightening."

effects of other process changes being investigated in mill trials. They also make it difficult to calculate reliable per-ton cost figures.

This paper examines the extent of seasonal changes

and had not changed anything to create a yield drop. The one thing that was always overlooked during these 'discussions' was the seasonal impact of the wood."

are generally much less uniform than those made in the laboratory. The differences in uniformity in hardwood pulps from laboratory and commercial digesters are less dramatic than for softwood pulps. The hardwoods examined for this work appear to be much easier to pulp with uniformity than softwoods.

Application: The results of this study provide a summary of what is currently understood about kappa uniformity in kraft pulps. This information can give operators a framework for assessing pulp uniformity in their own mills.

PULPING

Evaluation of various mechanical pulping processes for mature and juvenile loblolly pine in lightweight coated paper

By Zhirun Yuan, Cyril Heitner, Keith Miles, Ingunn Omholt, Peter McGarry and Tom Browne

Although loblolly pine (*Pinus taeda*) is less costly than northern softwoods, loblolly pine mechanical pulps tend to be of poor quality and are mainly used in low-value grades such as newsprint. This paper reports work that evaluates various mechanical pulping processes for mature and juvenile loblolly pine and their potential for use in value-added grades, especially in lightweight coated (LWC) paper. For comparison purposes, the authors also included results for black spruce.

Pilot plant results have shown that loblolly pine is inferior to spruce in terms of sheet density, brightness ceiling, and long fiber coarseness. To some extent, the quality disadvantages of pine pulps could be off-

This paper shows how, assuming a 1,000-tpd mill with a nominal wood cost of US\$45/green ton, these seasonal changes can account for a variance of almost US\$600,000/month between the best and the worst operating month. In the worst month, an additional 0.5 green tons of wood per ton of pulp must be processed. These figures call into question the common mill practice of using straight-line forecasts over the year to predict wood consumption and costs.

"In doing this work, the potential magnitude of financial impact surprised me," comments Hart. "The fact that accounting data could suggest a potential US\$200,000 swing month-to-month due to seasonal variation in a 1,000-tpd mill was enlightening."

Application: A better understanding of seasonal wood variations should lead to a more realistic assessment of changes in wood costs and yield throughout the year.

set by proper chemical pre-treatment, high specific-energy application, or both, in the pulping process. With proper chemical pretreatment or refining, all the loblolly pine mechanical pulps should have adequate strength and light-scattering ability for LWC and supercalendered grades, compared with the general requirements reported in the literature. However, paper containing pine mechanical pulp is rougher on the surface, less dense, and has higher air permeability than the paper with spruce mechanical pulp. Therefore, proper papermaking strategies are essential to reduce sheet surface roughness and pore size before coating.

Application: With proper strategies in chip pretreatment, refining and the papermaking process, papermakers can use mechanical pulps from mature and juvenile loblolly pine in value-added grades such as LWC.

CHEMICAL RECOVERY

Effects of chloride, potassium and sulfate on the causticizing reaction in the kraft recovery process

By Sona Saeidi, Honghi Tran, and Vladimiro G. Papangelakis

This paper examines the effects of chloride (Cl), potassium (K) and sulfate (SO₄) on the equilibrium of the causticizing reaction over a wide range of causticizing conditions, using OLI, an advanced thermodynamic program for equilibrium calculations in aqueous solutions of ionic salts. Cl, K and SO₄ were shown to have little or no effect on the causticizing equilibrium. Under a given causticizing condition, coastal mills, due to their much higher NaCl concentration, are predicted to have a causticizing efficiency 1%-2% lower than that of in-land mills.

The authors write, "Although there has been much speculation about the effects of chloride, potassium, sulfate and other non-process elements on causticizing equilibrium, the effects have not been systematically examined. Our work complements our research on chemical recovery, particularly our understanding of the effects of chloride, potassium and sulfate in the causticizing plant."

Application: Mills do not have to worry about the effect of chlorine, potassium and sulfate on their causticizing plant performance.

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CORRUGATING

Application of a pilot-scale pulsed electrocoagulation system to OCC-based paper mill effluent

By Yuan-Shing Perng, Eugene I-Chen Wang, Shih-Tsung Yu and An-Yi Chang

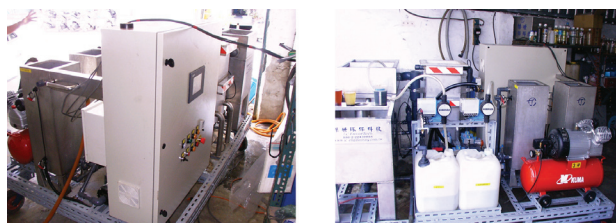
To reduce water pollution in the environment and receiving waters, effluent discharge regulations for paper mills have become increasingly stringent. Together with a higher proportion of water reuse, traditional wastewater treatment units often cannot remove the accumulated electrical conductivity (ionic species), dissolved solids, colloidal substances, and color in process water, thus leading to disturbances in the mill's wet-end systems. Treatment units installed in typical paper mills are mostly sedimentation or dissolved air flotation processes for primary treatment, and activated sludge processes for secondary treatment.

Researchers conducted a pilot-scale study using pulsed electrocoagulation technology to treat the effluent of an old corrugated containerboard (OCC)-based paper mill in order to evaluate its treatment performance (see photo). The operating variables were a current density of 0–240 A/m², a hydraulic retention time (HRT) of 8–16 minutes, and a coagulant (anionic polyacrylamide)

dosage of 0–22 mg/L. Water quality indicators investigated were electrical conductivity, suspended solids (SS), chemical oxygen demand (COD) and true color.

The results were encouraging. According to the authors, the water qualities attained in this study should be adequate to allow reuse of a substantial portion of the treated effluent as process water makeup in papermaking.

Application: The addition of a pulsed electrocoagulation unit can remove more pollutants and ultimately resolve the problem of off-spec effluent and help to stabilize the wastewater treatment process. **360**



Researchers used a pulsed electrochemical reactor (Model JC-10) developed by Jye-shi Environmental Technologies and Engineering (Chungho, Taiwan). The reactor, shown here, can treat 0.1–0.5 m³/h of wastewater with an HRT of 0.13–0.65 h.

COMING IN APRIL'S TAPPI JOURNAL

PULPING

Industrial Lo-Solids pulp digester simulation by the Purdue model

By Francisco J. Araneda, Diógenes L. Melo and Edgardo R. Canales

Researchers adapted the Purdue model to simulate an industrial Lo-Solids pulp digester using ad-hoc reaction kinetics for *Pinus radiata* cultivated in Chile. The mathematical model was then applied to simulate an increase in filtrate flow to the modified continuous cooking zone to save white liquor consumption.

Application: Pulp mills can use the mathematical model to simulate different conditions of operation in order to improve pulp digester performance.

PULP BLEACHING

Comparison of various hardwood kraft pulp pre-bleaching techniques

By Kelley Spence, Jarrod Tucker and Peter W. Hart

The authors examined five pre-bleaching methods with the same starting hardwood kraft brownstock pulp to determine their effects on reducing bleaching costs. For each method, they calculated the amount of ClO₂ required to obtain D1 stage 79.1% ISO brightness and

determined the net cost savings for each sequence. They also determined net cost savings resulting from pretreatment of the fully bleached pulps.

Application: Pulp mills can use the information to better assess the relative impacts on cost structure of various pre-bleaching methods.

FILLERS

Modified Egyptian talc as internal and surface treatments for papermaking

By Maha M. Ibrahim, Fardous Mobarak, Ehab I. Salahel-Din, Abd El-Hay E. Ebaid and Mohamed A. Youssef

In many paper grades, fillers such as clay, calcium carbonate and titanium dioxide are added to enhance its properties. This study produced paper with improved mechanical properties using modified Egyptian talc as internal and surface treatment.

Application: Papers made with modified talc as additives show an improvement in mechanical properties and thus fiber-filler-fiber bond.

CORROSION

Corrosion of carbon steel tubes in the mid-furnace of kraft recovery boilers—environment characterization

By Preet M. Singh, Vikas R. Behrani and Jamshad Mahmood

Accelerated corrosion of carbon steel waterwall tubes

has occurred in the mid-furnace of kraft recovery boilers in recent years. For this work, researchers installed gas sampling ports in the mid-furnace areas with high and low corrosion rates of carbon steel waterwall tubes. During boiler operation, gases were sampled and analyzed using a specially designed gas chromatograph. Results from this study indicate that the accelerated mid-furnace corrosion phenomenon in recent years might result from changes in boiler operation.

Application: These results will help boiler owners, manufacturers, and operators to better understand and mitigate corrosion problems in this area of recovery boilers.

PULPING

Effects of specific gravity and wood chemical content on the pulp yield of loblolly pine

By David E. White, Charles Courchene, Thomas McDonough, Laurie Schimleck, David Jones, Gary Peter, Robert Purnell and Gopal Goyal

In this paper, the authors quantified the effects of wood density and wood chemical composition (cellulose, hemicellulose, and lignin) on the kraft pulp yield of 13-year-old loblolly pine trees (*Pinus taeda*) grown as part of a genetic selection study. Both bleachable (kappa No. 30) and linerboard grade (kappa No. 100) pulps were made from 18 trees selected for combinations of wood specific gravity and cellulose:hemicellulose:lignin ratios. Researchers collected near infrared (NIR) spectra from wood samples and correlated them with the total kraft pulp yields. The analyses for both pulps provided strong calibration statistics.

Application: Output from the database can be used to establish forest biology economics directed at tree improvement programs that will have a direct effect on mill operating costs. **560**

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