

2018 January JAPAN TAPPI JOURNAL

Vol.72, No.1 Abstracts

**Distribution analysis of Paper Chemicals retained inside of Paper Structure  
- Mechanistic aspect of paper chemicals and their application for a new development -**

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We have been providing many kinds of paper chemicals for the necessity of responding customer requests. In recent, more sophisticated development on paper chemicals have been required and, it must be achieved in paper chemical industries. In the development process of paper chemicals, it is very important to know their action mechanism in inducing corresponding effects. Since 2000, we have been studying the adsorption and distribution of paper chemicals to pulp fibers mainly from the view point of microscopic observation technology.

In this report, visualization method of (1)sizing agent distribution on paper sheet, and (2)paper strengthen agent polymer flocculation form and its adsorption to cellulosic fiber in pulp surry, have been discussed. In addition, we will also describe about an example of utilization in these technique for products development.

**Main steam pressure stabilization and fuel reduction by boiler combustion control optimization system "ULTY-V"**

Yuji Okamura

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If the inputs to the boiler change (e.g. coal with a different moisture content is fed to the boiler), a change is required from the control system to compensate for the variance. However, it is difficult for an existing control system to change gain automatically and continuously depending on combustion condition because the ability to measure all the external factors and to reflect these parameters is too hard to carry out, especially in an older traditional control system.

ULTY has been developed to resolve this problem in thermal power plants, by

calculating the most appropriate gain and altering the control systems output correction factor produced by existing systems for plant controls. ULTY can then improve the stabilization of the combustion state and achieve the best controlled performance.

As well as improving the stability of the combustion state, ULTY will also contribute to fuel-saving, preventing heat-exhaustion and improve boiler pressure stability.

### **Resin Roll for Calender - ZE-K series -**

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We are making researches on resin rolls for super calender.

The resin roll has run on soft nip calender and super calender for high-gloss paper.

The resin roll has been studied on several commercial super calender, but there are still some unsolved problems.

- (1) Rotary heat
- (2) Hardness reduction in temperature
- (3) High pressure resistance
- (4) Run-in
- (5) Paper edge dent
- (6) Improvement of crack resistance
- (7) Gloss reduction of high-gloss paper

We have developed a resin roll, called “ZE-K series”, that might be a solution to these problems.

### **Cellulose Nanofiber Prepared by Phosphorylation and its Application**

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Cellulose nanofiber (CNF) is nano-sized cellulose fiber with high aspect ratio, which is produced by fibrillation of pulp. While CNF has a lot of excellent properties as high Young's modulus, low thermal expansion and so on, it needs high energy consumption to fibrillate completely only mechanical treatment. Then, we established phosphorylation

pretreatment method. Wood pulp was modified by impregnating an aqueous solution of urea and ammonium dihydrogen phosphate, followed by drying and curing in hot air for a few minutes. Then phosphate groups were introduced on the surface of cellulose. We could obtain phosphorylated CNF dispersion by mechanical treatment of phosphorylated pulp. This dispersion showed high transmittance. Transmission electron microscopy (TEM) indicated the presence of 3–4-nm-wide nanofibers. Viscosity of phosphorylated CNF dispersion was high compared to conventional thickeners. The phosphorylated CNFs are expected to various applications, for example, highly viscose thickener, and transparent and flexible sheet. The CNF sheet had high transparency and mechanical properties. The sheet was tolerant to chemicals and highly flexible, therefore, can be expected to apply to a wide range of fields by taking advantage of these properties.

### **Efforts for the practical use of cellulose nanofibers**

Masayuki Kawasaki

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As a comprehensive biomass industry, Nippon Paper Industries Co., Ltd. tries to develop various new business areas making the most of woody biomass. As one of the new use of cellulose, we focus on production and development of various applications of cellulose nanofibers (CNF). We examine the use of CNF not only for functioned nanocomposite (with resin or rubber etc.) utilizing its high fiber strength and low thermal expansion, also for an optical film utilizing its high transparency and for a catalyst carrier or the absorbent utilizing its high surface area. Among those uses, because the use of CNF as functional additives such as thickener or dispersant is a similar use as existing carboxymethyl cellulose (CMC), early commercialization is expected. In this report, as the example of the effort for commercialization we present the development of CNF as functional additives. And the production method of CNF, the solidification technology for practical use and CNF's various characteristics as additives are reported.

### **Commercialization and application development examples of nanoforest**

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Cellulose is one of the most popular recyclable biomass resource on the earth and

is generated as a main component of plant fiber cell.

Recently cellulose nanofiber(CNF) and cellulose nano crystal, produced by cellulose fiber defibrillation into nano size, are extensively studied in the world.

CNF is well known as of its excellent physical properties such as strength, elastic modules, and thermal expansion.

Therefore, a lot of attention has been paid for CNF application development and a lot of studies about CNF have been extensively developed in the world.

In Japan, CNF development was positioned as “Japan Revitalization Strategy” and “Nano Cellulose Forum” was established.

Following these trends, several Japanese paper company had made decision to build CNF production plant and some of it had already started operation.

Chuetsu Pulp & Paper Co., Ltd had started R & D of CNF since 2010 and had started operation of CNF commercial production plant at Sendai mill, Kagoshima on June 2017.

This report will introduce our CNF technical development and application development.

## **Preparation of high performance air filter media from cellulose nanofiber**

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Air filter media containing cellulose nanofibrils (CNFs) were prepared by freeze-drying of CNF dispersions. The CNF content in the filters was controlled by adjusting the CNF dispersion impregnated to the base glass filter. The CNF-containing filter media showed superior filtration properties. When the CNF content was 0.08% in the base glass filter, the filter quality factor showed the highest value. This is because nanoscale and spider-web-like networks of the CNFs with large specific surface areas were formed within the base filter. At the CNF content higher than 0.08%, densely packed CNF networks rather formed and prevented the efficient capture of oil-aerosols used as model particles. After exposing the CNF-containing filter media to high humidity conditions, the pressure drop decreased, and the particle penetration ratio increased. However, the original porous networks mostly remained, and the high quality factors were maintained even after exposing the filter media under humid conditions. The unique properties of CNFs such as the extremely small fiber diameters are advantageous in preparing

new air filters with high performance.

### **Prioritizing pest control measures based on scientific evidence and evaluating effectiveness**

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With growing demand for prevention of product contamination caused by insects and rat, it is necessary to show that their pest management program is effective and a preventive system that problems hardly occur in the future. Currently, in order to promote preventive management more strongly, the concept of risk management is beginning to be introduced. In risk management, it is possible to allocate costs effectively by implementing measures by prioritizing according to the magnitude of risk analyzed and evaluated on objective standards.

However, in factories engaged in risk management, they are in trouble with the method of prioritizing risks and the method of evaluating the effectiveness of the measures implemented. In order to solve this, it is important to scientifically create contamination scenarios using monitoring data and survey results. We provide various investigations, analytical methods and educational support concerning analysis / evaluation of risk based on this contamination scenario. ESCOEVO, our new service, is a powerful support tool for aggregating and analyzing data, operating and reviewing improvement activities, and communication with factor.

### **Development of failure prediction system for chemical spraying equipment to improve productivity of paper machine**

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System Development Team

MAINTECH CO.,LTD Fuji Technology Development Center

As one of the challenges currently addressed by Japan, there is a population problem and the age population of production (population of 15 to 64 years old) turns to decrease after peaking in 1995 and is estimated to continue decreasing in the future. In recent years, technology fields such as IoT (Internet of Things), BD (Big Data), and AI (Artificial Intelligence) are attracting attention as leading to

these countermeasures. By utilizing these technologies, it is expected analysis and prediction based on data collected by sensors on production facilities would solve this kind of labor shortage.

In our company as well, we consider these technologies to be essential technologies for future business developments, we will utilize IoT for the chemical spraying devices "Mist Runner" and "Shower Runner" as a first step, failure prediction system. In this report we will introduce its purpose and system details.

### **The Effect to Physical Properties of Bamboo Paper with Different Cooking Agent**

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Hand-made bamboo paper was frequently used for printing and drawing since the Tang dynasty (618-907AD) in China because of its features of strength and flatness. Regarding rare books, the share of using bamboo as the raw material for making paper is said to be around seventy percent. Also Japan has been using bamboo paper in for either the collection of rare books or diversified purposes such as painting by importing them from China too. For conservation of these cultural objects on bamboo paper, we are expecting and required use better quality bamboo paper, but cannot get the equivalent quality of paper as in the past. The traditional way of making bamboo paper is to get the raw bamboo shoots to be fermented in slaked lime first. Afterward the cold digestion method and hot digestion method will go through the process without alkali cooking and with alkali cooking respectively. The air dried fermented raw bamboo fiber (*Mosochiku: Phyllostachys pubescens*) which was collected in Jiangxi province, China were cooked with caustic soda (NaOH), soda ash (Na<sub>2</sub>CO<sub>3</sub>) and lime (Ca(OH)<sub>2</sub>), to the result of a cooking rate which was lower in that order. The physical strength of ISO folding number was decreased greatly for lime cooked paper which yields at 84% (L84) because of long cooking hours. The purpose of this research is to study the effect of cooking agent on durability of 5 kinds of handmade bamboo papers. The bamboo papers have been coated with acidic *Dosa* sizing solution (traditional surface size including animal glue and alum for Japanese painting) with normal and higher concentrations. Then the moist heat ageing test was done under the conditions of 80°C+65%rh, from 1

week to 8 weeks. The changes in color, pH, physical strengths (Folding Endurance and Tear Index) were measured. We found that the initial pH of all original papers remained in the range of 8.7 to 9.2 without the acidic *Dosa* sizing. Even the pH stayed above 7.9 when a high concentration acid sizing solution was coated in advance. The changes in physical strength resulting from moist heat ageing were quite small due to the alkalinity of the bamboo paper. The discoloration rate during ageing for lime cooked papers (i.e. L94, L84) were smaller than the other papers at the same pH value. In conclusion, the durability of bamboo paper cooked with caustic soda and soda ash is better than with slaked lime.