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Formation and Ultrastructure of Cell Wall in Wood

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Cellulose is synthesized by rosette composed of 36 cellulose synthases. Thirty-six celluloses are gathered together to form cellulose microfibril of 3nm width. Three to four cellulose microfibrils are subsequently gathered together to form cellulose microfibril bundle. Hemicelluloses are synthesized by the Golgi apparatus and transported to the inner surface of developing cell wall by exocytosis of the Golgi vesicles. The inner surface is covered with sol-like structure composed of newly deposited hemicelluloses and water. Newly synthesized cellulose molecules are released into the sol-like structure. Monolignols are synthesized in the cell, transported toward the cell wall, and polymerized within the cell wall. Lignin accumulation starts at cell corner middle lamella, proceeds toward compound middle lamella. Lignification of secondary wall starts at the outer portion and proceed toward the lumen lagging behind cell wall thickening.

Paper: The history of 2000 years from its Birth
－From Ts'ai Lun's Invention to the Birth of Modern Pulp and Paper Industry－

Kiyoaki Iida

Paper and its making process were invented in China and were introduced eastward to Japan. Westward, they moved to Samarkand, then to Damascus, and through North Africa to Europe. One other route was through Greece to Europe. In Europe, the old technology was revolutionized, and the modern technology prevailed in the world.
Before the industrial Revolution, wood could not be pulped, and only bast plant like hemp, flax and mulberry, and bamboo in its infant age were converted to paper after a lot of hard labor of so many days. In the course of time, every district searched

plant domestically available and modified its product (paper) for satisfying customer needs, good for writing either with pen, mouhitu (brush) or printing.

The paper served the development of civilization as a medium for expressing human wisdom and intelligence.

Chemistry of Delignification in Pulping and Bleaching

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Most of the principal delignification reactions in pulping and bleaching are described in various books related to the field of wood chemistry and published by Japan TAPPI. These reactions are primarily reviewed in this report with being followed by introduction of the recent results on alkaline pulping obtained in our laboratory. An outline of main reactions in oxygen delignification is also introduced.

Fundamental of the KP Chemical Recovery Process

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KP pulping is the most popular pulping method not only in Japan but also in the world. The progress of KP chemical recovery system included with evaporation of black liquor, chemical recovery boiler, causticizing and calcining has played a large part in the development of KP pulping. The KP chemical recovery system has basic functions such as ①Recovery and reuse of the inorganic pulping chemicals,② Burning of the organic material and recovery of its energy, ③Extract of valuable organic by-product chemicals
④ Performance of these functions in an environmental friendly manner. In this report

KP Chemical Recovery Process included with black liquor properties, concentration of black liquor, black liquor combustion, green liquor process, causticizing process, lime kiln operation, NPE problems and the new causticizing process are briefly described.

The Introduction about a Chemical Recovery Boiler

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In paper and pulp mills, a chemical recovery boiler plays two important roles, chemical reactor and energy source. The chemical recovery boiler burns organic matters and recover mineral chemicals in black liquor.

This paper describes features of the chemical recovery boiler. First topic is a chemical recovery process in the recovery boiler. After that, the latest technologies for the recovery boiler are described, such as combustion systems, discriminative structures, anticorrosive technologies, pollution control methods, efficiency upgrading methods, and maintenance methods.

Improving the Efficiency of the Causticizing Process

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The Shimada mill has been operating two fiber lines of NUKP.

However, for reasons such as increasing the cost competitiveness, we came to stop 1 line in 2016.

The efficiency of the causticizing process turned worse while pulp amount of production decreased. Therefore we worked on reduction of the grits discharge and the heavy oil consumption because the efficiency deterioration was particularly remarkable in these points.

About the grits discharge reduction, we paid our attention to the Slaker ability becoming the overspecifications.

On the other hand, about the heavy oil consumption reduction, the Draft fan ability paid its attention excessively.

We think that it is a valuable case that we could modify current facilities to efficient facilities with small investment.

Fundamental Knowledge of Bleaching Chemicals

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Among bleaching chemicals used for paper pulp breaching process, we will explain functions and precautions for using hydrogen peroxide and sodium hydrosulfite. Breaching chemicals are roughly divided into oxidizing breaching agents and reducing breaching agents. Oxidizing breaching agents are widely used in chemical pulp and mechanical pulp while reducing breaching agents are mainly used in recycled pulp and mechanical pulp. In chemical pulp field, the usage of hydrogen peroxide as breaching chemical has expanded due to environmental issues which enforce conversion to ECF (Elementary chlorine free) breaching.

In this study, outline of common breaching chemicals will be explained initially, followed by detailed explanation of hydrogen peroxide and sodium hydrosulfite. Characteristics of agents, precautions and remarks in breaching process will be explained in details for each hydrogen peroxide and sodium hydrosulfite. Hydrogen peroxide which is oxidizing breaching agent is used for breaching chemical, mechanical and recycled pulp. Sodium hydrosulfite which is reducing breaching agent is used for breaching mechanical and recycled pulp. In addition, the characteristics, manufacturing method, strong points as well as usage examples for peroxymonosulfric acid will be introduced. Peroxymonosulfric acid has been popular in the market as new breaching agent by resolution method for the discoloration problem ,cost performance and increase production.

Stabilization of KP O_3 generator

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The bleaching sequence was changed from C-E-H-D to ECF (elementry choline free) due to environmental problems such as dioxin, chloroform drained from KP bleaching process. D-Ep-D was mainstream, but ZD-Ep-D was installed in our mill. The ozone bleaching plants is installed at the first among Nippon Paper Industries.

We had various problems in a few years from January 2001, and now it is stable and becomes important on pulp quality, cost and environment side.
However, the ozone generator performance could not be kept appropriately for the first time installation at KP bleaching plant, and gas production rate was down to approximately 60% after 13 years from setting. In this presentation, I will report about the construction of the ozone plant which recover the gas production rate in September 2016 and importance of the periodical maintenance.

History of Mechanical Pulping and Recent Trend in China

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In this paper, there are two topics regarding mechanical pulping. As the first part of this paper, the history of mechanical pulping will be briefly described from the view point of equipment. The birth of stone grinders for GP (Groundwood Pulp) as well as recent disc refiners for TMP (Thermomechanical Pulp) will be explained. In 1844, the first grinder for GP was founded in Germany and USA. About 130 years later, the PGW (Pressure Groundwood pulp) as an improvement of GP's stone grinder was developed in 1977. The current type of disc refiners originated from a vertical reject refiner which were used in GP process in 19th century. There were 3 important developments in the history of disc refiners.; the invention of pressurized disc refiner by Dr. Arne Asplund in 1931, the change from low consistency to high consistency as refining consistency in 1960's and the birth of TMP (Thermomechanical pulp) as an improvement from RMP (Refiner Mechanical Pulp) in 1970's. The era of mechanical pulping finally reached at a booming of BCTMP (Bleached Chemi thermomechanical Pulp) in China in 2003. As the second part of this paper, the recent trend in China regarding BCTMP will be introduced. By showing a flow sheet of newly installed BCTMP plant, the comparison between nowadays and future on paper grades, sources of raw material, waste water treatment and energy consumption will be described. By knowing the history of mechanical pulping as well as current BCTMP plant, the future prospect of mechanical pulping will be also given as a conclusion.

Role of Deinking Agent and its Challenge

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Wastepapers are recycled as raw materials to produce the paperboard such as a corrugated board and the paper such a newsprint. In the former case, pulps after disintegration are mainly used for the contents such as the corrugated board. In the latter case, pulps after disintegration are deinked and used to produce the paper.
The total wastepaper availability of 2015 reached to 64% and achieved the aim of the industry. When each wastepaper availability (wastepaper consumption / amount of production) of paperboard and paper was calculated, the availability of the paperboard was around 99% and that of the paper was around 40%. This means that there are some kinds of printed matters which are hard to be deinked. The representative examples are printed matters printed by UV ink and inkjet ink.
In this seminar, the basic deinking process, the role of the deinking agent and the good condition for deinking are reviewed. Then, the present conditions and the future problems of printed matters printed by UV ink and inkjet ink are provided.
UV inks were hard to be detached from the pulp and detached inks were too large to be rejected out in the flotation process. Recently, recyclable UV inks were developed by the effort of the ink company and the related association. Although wastepapers printed by the old UV ink are still left in the wastepaper market, the problem will disappear in near future.
In commercial printings, the transition to on-demand printings is in progress. Especially, the inkjet printing has attracted attention in terms of its printing speed. Therefore, it is thought that the wastepapers printed by inkjet ink should be used as raw materials in pulp manufacturing in near future.
Water-based pigment inkjet inks can be detached easily from the pulp. But, detached inks are too small to be rejected out in the flotation cells. For increasing the efficiency of the flotation, it was found that the weakened shear in the ink-detaching process and the combined use of the aggregating agents such as fatty acids in the flotation process were effective. However, by this method, it is considered that ink-detaching will be not enough in the deinking of old newspapers or electrophotography prints.
It is necessary to establish the deinking method of mixed wastes of inkjet prints, electrophotography prints, and old newspapers by adopting the suitable deinking systems and/or improving the inkjet inks.

The latest technology of DIP system

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For the past decades, the situation surrounding paper industry has been changing dramatically. To enhance the production efficiency is one of the most important concerns. A DIP production process has an affect on the cost of raw material, energy, and chemical etc. In this paper, we will introduce the latest DIP technologies related to DIP system.

The History of Technological Developments of the Paper Industry in Japan after World War II

Part5　Recovered Paper for Newsprint and Printing paper（2）

The second breakthrough for further DIP consumption

Kiyoaki Iida

From around 2000, the concept of recycle-based society was established and 3R (Reduce, Reuse and Recycle) was promoted as a national guide line. LCA evaluation was introduced after the COP Kyoto protocol, and Forest Certification System internationally prevailed. Those efforts induced an incentive for using more amount of recovered paper. The technology of producing DIP good for printing paper was developed by adopting high consistency dispersion and high brightness bleaching. Then, newsprint contained DIP up to 80% of its total furnish. In the printing and communication sector, the DIP use ratio was probably about 20% as a whole. In 2010, recovered paper's utilization rate reached 63%. These goals were accomplished by technological development not only in deinking but also in modernizing equipment in general, coping with severe demand for product quality and volatile nature of recovered paper quality.

The conversion in pulp sources of this scale affected wood chip supply. Imported softwood chips for mechanical pulp declined. Hardwood chips for LBKP., imported as well as domestic, was also less consumed.

The next issue will be on the use of recovered paper in the world.

Accelerate Ageing Test of Naturally Aged Paper
－Effect of Humidity, Amount of Oxygen and of Organic Acids on the Degradation of Paper in Sealed Tube Method－

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Research was conducted to clarify the relationship between natural ageing and accelerated ageing of paper using paper naturally aged for 80 to 130 years. Following a previous report on the degradation behavior of naturally aged paper by sealed tube method (80℃), samples were artificially aged by sealed tube method in conditions of different humidity or amount of oxygen to clarify their physical and chemical ageing behavior.

In the closed condition of a sealed tube, hydrogen ion concentration, which causes hydrolysis, was higher than in suspension method. This is because organic acids do not escape from the system in sealed tube method. On the other hand, oxidation of cellulose was higher in suspension method than in sealed tube method. This is because available oxygen for reaction is limited inside a tube. Regarding the behavior of organic acids in sealed tube method, it was found that the composition ratio of oxalic acid and glycolic acid, major and second major organic acids in paper, before and after accelerated ageing remained similar in spite of the changes in humidity or amount of oxygen. Thus it was confirmed that sealed tube method simulates the natural ageing of paper better than suspension method.