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Separation of lignin and its utilization Technology

Makoto Iwasaki
MIP Consultant Office

Currently, from the viewpoint of preventing global warming, carbon neutral energy and chemicals are highly attracting attention, and many companies want to use them as a substitute of fossil energy and chemicals. Under these circumstances, pulp and paper companies have become more oriented toward biorefinery in which lignin utilization is included. In this article I will introduce the world trend of separation and utilization technology of lignin. I will also outline the method of separating lignin from KP black liquor, which was developed by Sweden and the efforts of North America and Japan centering on lignin derived products.

Development of energy saving and CO₂ saving burner for Lime Kilns and evaluation of on-site kilns

Takayuki Kitamura
Daigas Energy Co., Ltd.

Efforts to reduce CO₂ emissions are accelerating toward the realization of a carbon-neutral society by 2050, but fuel oil C and other fuel oils are mainly used for Lime Kiln in the paper industry in Japan. These emit more CO₂ per calorific value than Natural gas, but they are generally cheaper. Therefore, simple fuel conversion to Natural gas has been a challenging situation. In this problem, we've been working to improve our customers' specific energy consumption and reduce CO₂ emissions by advancing our existing technologies including energy-saving and others.

Gas atomizing combustion is one of the mixed combustion technologies of fuel oil and Natural gas without changing the existing burner. By designing the nozzle and optimizing the flame shape according to the customer's facility, we have succeeded in improving the Lime firing rate, lowering NO_x emissions and so on. Our gas atomizing combustion technologies are already adopted in four Kilns at two customers, and that contributes to approximately 20% CO₂ emission reduction compared to fuel oil combustion.

Regarding gas combustion technology, we have developed a new gas burner that forms a luminous flame by modifying ways to blow out gas. We have pursued gas combustion by either retrofitting the existing burners with our gas burner or combining them with gas burners manufactured by Taiheiyo Engineering Co., Ltd. With these two approaches, we have already achieved approximately 7% energy savings in Lime Kilns.

It is important to steadily promote low carbon emissions by switching fuels to Natural gas through the introduction of gas atomizing and gas combustion technologies. In addition, carbon neutrality can be achieved in the future by methanation to customers that already use natural gas. With these technologies, we'd like to contribute to the realization of a carbon-neutral society in 2050.

Biodegradable Bio plastic resin using Hemicellulose -One stop development & production from Resin to Products-

Jin Nasukawa
Hemicellulose Ltd.

Hemicellulose is an insoluble polysaccharide, 20-30% present in almost all terrestrial plant cell walls. It is the largest underutilized side-stream of pulping. To make use of it, bioplastic resin called "HEMIX™" was developed and manufactured. Our goal is to utilize hemicellulose in functional materials in large quantities, paving the way for the effective use of this underutilized resources by combining natural resources and chemical technology, thus contributing to creation of a sustainable society.

In this paper, various features of HEMIX™ such as biodegradability, good melt flow, and transparency are introduced as well as some examples of mass-produced products made from HEMIX™.

The production technology and its features for world first alcohol beverages made from wood - Aiming to create new industries that will lead to regional development-

Yuichiro Otsuka

Department of Forest Resource Chemistry, Forestry and Forest Products Research Institute

We have developed a wet-type bead milling technology that allows exposing cellulose and hemicellulose packed in the cell walls of wood by physical defibrillation in water without chemical or thermal treatment. It was found that the exposed cellulose was decomposed into glucose by food-grade cellulase enzymes without component separation, and the resulting glucose could be directly fermented into alcohol by brewer's yeast. In other words, by adding water, food enzymes, and brewer's yeast to wood, wood itself can be directly fermented into alcohol, making it possible to produce drinkable alcohol from wood for the first time in the world. This paper will outline the technology for producing drinkable alcohol, "kino-sake," from wood, the characteristics of the produced "kino-sake," safety tests, and efforts to implement the technology in society.

New Materials reassembled from wood cell walls using organic acids

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Woody biomass is the most abundant renewable resource. Plant secondary cell walls comprise a heterogeneous aromatic polymer, lignin, and structural polysaccharides, cellulose and hemicelluloses. Hemicelluloses are associated with cellulose microfibrils mainly by hydrogen bonding and cross-linked with lignin by covalent linkages to form lignin-carbohydrate complexes (LCCs). These components form rigid matrices *via* noncovalent bonds, such as hydrogen bonds, van der Waals forces, and hydrophobic interactions. Despite wood's potential as a resource for mitigating environmental impacts, current plasticized wood products depend on petroleum-derived chemicals. Additionally, paper and pulp are manufactured from wood through environmentally high-load processes involving the sulfur reactions at high temperatures to depolymerize the recalcitrant lignin in wood components and subsequent paper making processes using huge amounts of water. We found the dissolution of wood sawdust and chips in formic acid under ultra-mild conditions without any catalysts, and the subsequent production of the plastic-like film comparable to those of acryl resin from the total dissolved solution of *Eucalyptus globulus*, and of paper-like sheet from Japanese cedar. These two types of films were also produced from agriculture wastes. Furthermore, multi-dimensional NMR analyses revealed formylation of lignin, hemicelluloses and cellulose. Substituents of formyl groups broke the hydrogen bond networks among cell wall components, resulted in disintegration and solubilization of wood. Subsequently, the highly affinity molecules were bonded and reconstructed to form film by casting.

Refiner Energy Reduction and Pulp Fiber Modification by Cellulase

Masanobu Hatano

Research Laboratory Technical Dept., Specialty Chemical Div. RIKENGREEN CO.,LTD.

Enzymatic paper strength agents employing cellulase excel in enhancing paper strength. They achieve this by efficiently decomposing cellulose into fibrils.

Using cellulase agents first improves paper strength through fibrillation by the agent. It reduces fibrillation by the machine, which means the refiner load can be reduced, leading to energy savings. In addition, reducing fibrillation by the machine improves pulp quality, and the increase in fineness can be expected to improve water filtration, which saves dryer steam. These effects will lead to a reduction in energy consumption, which in turn will lead to a decrease in CO₂ emissions. Cellulase agents not only improve paper strength but also improve water filtration and reduce energy costs, thus contributing to environmental measures.

It has become clear that improving the strength of the paper with this cellulase can produce other effects. When the beating test is performed with a beater, the tensile strength is enhanced, and the opacity is lowered. In addition, a similar decrease in opacity was observed in the refining test using a refiner tester.

Possibility of applying digester additive in the kraft pulping process

FUJII, Takayuki and FUMIHARA Masakazu
KATAYAMA CHEMICAL, Inc. and KATAYAMA NALCO, Inc.

Virgin pulp production in Japan is dominated by chemical pulping, of which the kraft pulping accounts for the majority. Kraft pulping is a production method in which cellulose fibers are produced with cooking chemical, called white liquor, and heat. While kraft pulp has high fiber strength, it is characterized by lower pulp yield than mechanical pulp. Anthraquinone has been widely used as an excellent digester additive to increase the pulp yield and to accelerate delignification. However it was removed from the chemical list of BfR Recommendations on Food Contact Materials in 2013.

Although virgin pulp production in Japan is on the decline, demand for paper products made from virgin pulp is expected to increase as an alternative to plastic for SDGs and carbon neutrality. Under these situations, we believe there is a need to develop alternatives, such as anthraquinones, that can improve pulp yield and accelerate delignification in kraft pulping. We have developed a product that compensates for the pulp yield improvement that is one of the effects of anthraquinones. In this article, we will report the results of laboratory test under several cooking conditions.

High Consistency Operation for Screening

Takashi Kanda
Andritz K.K. Service Business Department

Screens are used to remove impurities from pulp, and relatively small impurities such as bark and shive are removed during the fine screening stage in the kraft pulp process. Due to the recent increasing energy cost, the industry demands for not only screening efficiency with a focus on high quality but also sufficient capacity securing with lower power consumption. In the history of screening, technical improvements have been made not only in the screen itself, but also in the baskets and rotors that the screen equipment consists of. These improvements enable a large amount of pulp to pass through the screen while maintaining a high-quality standard.

In Japan, especially in the production of kraft pulp, there are many mills which secure sufficient capacity with high consistency while maintaining high screening efficiency for both softwood and hardwood, using the latest screening technology. Being able to operate a screen which could deal with a higher consistency without losing quality means that it would be possible to downsize the screen or to decrease the number of screen units used, thus reducing energy consumption.

This document introduces ANDRITZ's latest technology for screens, rotors, and baskets which enable high consistency operation in screening.

Improvement of steam consumption by suitable washing -TwinRoll Press & Pressure diffuser -

Yoshiro Nishihara
Pulp & Energy, Services business Line, Valmet K.K.

In the pulp and paper industry and other industrial sectors, energy saving, including the reduction of greenhouse gases, is the most important issue for sustainable development in the future. In the Japanese pulp and paper industry, energy conservation at pulp and paper mills is being considered in order to meet the 2030 GHG emission reduction target, and Valmet has a comprehensive global sustainability business that helps mills save energy using Valmet's technology.

Good examples of energy saving in the washing stage is the introduction of DiConn™ with a pressure diffuser (PDW) at digester blow line and Valmet TwinRoll Press at brown washing stage. The former results in washing at higher temperatures in the digester washing zone and the PDW, which increases the temperature of the C8 extraction liquor as well as washing efficiency, leading to increase of steam generation in the flash cyclones. The latter is installed in the final stage of the unbleached washing stage to reduce the amount of washing liquor used while improving or maintaining washing efficiency, and to reduce the amount of black liquor sent to the evaporator, which results in a reduction in steam consumption at evaporation process. The improvement of washing efficiency of the BSW and POW line also has the effect of reducing the chemical consumption of the bleaching plant in the subsequent stage.

Overview of Containers and Packaging Recycling System in Japan -Regarding paper containers and packaging-

Masayuki Nagatsuka
Director, Manager of Planning and Public Relations Division
The Japan Containers and Packaging Recycling Association

The Containers and Packaging Recycling Law (Officially called the “Law for Promotion of Sorted Collection and Recycling of Containers and Packaging”, hereinafter called “CPRL”) prescribes the recycling of Paper containers and wrapping, Plastic containers and wrapping, Glass bottles, PET bottles for "containers" and "packaging" purposes discharged from households. It was enacted in 1995, as the first recycling law according to the characteristics of individual goods in Japan.

The background of the enactment of the CPRL is the increasing amount of waste generated and the shortage of final disposal site. After a period of high economic growth, waste increased due to mass consumption, and treatment plants were also strained. The CPRL, by transforming “waste” into “resources” once again through recycling system, to achieved reduction of the volume of domestic waste and effective use of resources.

The features of the recycling system based on the CPRL are as follows:

-Consumers, municipalities, business entities, and each of these and every person all have a role in the recycling system.

Consumers separate and dispose of container and packaging waste, municipalities separate and collect the waste, and businesses entities fulfill the obligation of recycling.

- Implement of EPR: Extended Producer Responsibility

EPR is the concept that business entities’ responsibility shall be extended not only to the production and usage of products, but also to the disposal and recycling. Business entities are obligated to recycle the amount of containers and packaging of above 4 materials used, manufactured, or imported in their business by themselves or by outsourcing the recycling to the designated association (Containers and Packaging Recycling Association) and paying the prescribed commission. In fact, outsourcing method is used in most cases.

In this seminar, I will explain the background to the enactment of the CPRL , the scheme, and an overview of its results.

The latest pulper & detraging technology

Satoshi Orido
Voith IHI Paper Technology Co., Ltd.

For the detraging system of pulping stage, more effective machine is required because the contaminants ratio of raw material is getting increase recently. The IntensaMaXX and IntensaScreenDrum is the detraging machine which fulfills the request for better detraging operation. The IntensaMaxx is rotor and screen plate are located at the top of the tank, and this layout prevents wearing and jamming by heavy contaminants. The rotor axis is located as eccentric against the center axis of the vat. This layout prevents strong centrifugal flow and also growth of long contaminants. The piping layout is also considered for the better reject removal. The IntensaScreenDrum is equipped with powerful cleaning power and rotation speed control by INV. By controlling the INV, it is possible to set the cleaning and dehydration performance as desired. The introduction of the latest detrag enables more efficient and stable operation, and it is possible to aim for optimal power consumption and wear rate.

Maintenance Digital Transformations for Stable Operations -Improving Efficiency and Quality of Maintenance Work-

Takuto Sumiya
Yokogawa Solution Service Corporation

We have developed compact wireless sensors, the Sushi Sensor series, for maintenance. The XS770A integrated wireless vibration sensor, which is robustly designed to be used for digital transformations. This battery-driven sensor can monitor the vibration and surface temperature of manufacturing facilities for a long period, significantly reduces the cost of monitoring. This paper describes the feasibility of condition-based maintenance (CBM) in plants. We believe Sushi Sensor achieves high standard of monitoring and data analysis for maintenance work in pulp and paper plants.

Using Data to Drive Future Initiatives in the Pulping Process -Mill Digitization-

Hisanori Bando
Valmet K.K. Automation Systems Business Line

Valmet offers products for the optimization of entire mills, processes, and pulp to facilitate the digitalization of pulp mills and take them to the next level for the future. Making Data Valid and Meaningful, the unification of the control room is also a key factor. As factories are built in the future, it will be important to make them easy for everyone to understand and to communicate intentions quickly and easily.

Profit improvement program by utilizing pulp digester additive

Yukinori Enomoto
KATAYAMA CHEMICAL, Inc.
Masakazu Fumihira
KATAYAMA NALCO, Inc.

Virgin pulp production in Japan is dominated by chemical pulping, of which the kraft pulping accounts for the majority. Kraft pulping is a production method in which cellulose fibers are produced with cooking chemical, called white liquor, and heat. While kraft pulp has high fiber strength, it is characterized by lower pulp yield than mechanical pulp. Anthraquinone has been widely used as an excellent digester additive to increase pulp yield and to accelerate delignification. However, it was removed from the chemical list of BfR Recommendations on Food Contact Materials in 2013.

Kraft pulp production has become less profitable due to recent increase in energy costs, including electric power, and raw material chip costs. Under these situations, we believe there is a need to develop products that can be alternative to chemical like anthraquinone, which can improve pulp yield and accelerate delignification in kraft pulping. We have developed a product that compensates for the pulp yield improvement that is one of the effects of anthraquinone. In this article, we will report the results of various tests, including lab tests, field trials, and profit improvement programs.

EcoBright™ - The latest Pulp Bleaching Technology, improving Cost, Quality and Environment

Yusuke Aikawa
Imerys Minerals Japan K.K. / Imerys Specialities Japan Co., Ltd.

Pulp bleaching technology showed a significant improvement in terms of environment, safety and health, after the introduction of "TCF/ECF". On the other hand, bleaching chemicals were replaced with higher value substances, and the reaction mechanism became complicated, which brought quite a high load to the pulp operations. The pulp bleaching technology is not necessarily beyond the partial improvement of conventional methods, since the introduction of TCF/ECF around 20 years ago in Japan.

EcoBright is a Magnesium Hydroxide slurry produced in the proprietary stabilizing process, which is made from severely selected high purity crude material, and will deliver Mg^{++} and OH^- ions. $Na(OH)$ will be partially replaced with OH^- from EcoBright, and it was successful for EcoBright to derive the maximum performance of H_2O_2 and ClO_2 with controlling pH at the optimum level. Concerning Mg^{++} ions, it is well published that it will protect cellulose and increase the pulp yields which is quantified as a pulp viscosity, and this effect enables the significant reduction of "COD" and "hard Limescales by the presence of Ca / Si ". Thus, Mg^{++} and OH^- ions are very important in the pulp process, and EcoBright as a single substance will provide both ions.

The effect of EcoBright is remarkable in Chemical and Mechanical pulp process, and Anionic charge in the process water is reduced under the controlled pH by EcoBright, thus there are a lot of success cases where Cationic Polymer in the paper machine section was significantly reduced.

The references for DIP is still limited, however, it was reported that foaming conditions in the deinking "Flotator" are optimized by $Mg +$ fatty acid(metal soap), and that the pulp yields were improved by reducing rejects of fibers and mineral fillers.

Lastly, Ecobright enjoys good success in EMEA according to the expansion of the references, and it is expected to be broadly implemented in Japan, as the supply position is being established in Asia at the end 2022.