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Organic chemistry of cooking and bleaching reactions

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The basic understanding of delignification reactions was achieved almost half a century ago. However, it was not clarified until recently why the difference of wood species affects the easiness of delignification. Hardwood lignin and softwood lignin are different by the presence of syringyl type aromatic nuclei in the former. In addition, there are wide varieties in the lignin characteristics (structure and amount) depending on wood species, environment of growing site, portion in the wood, portion in the cell wall, and so on. However, clear tendencies were found to be observed in the variety of lignin characteristics by taking the syringyl/guaiacyl ratio as an index. We have shown that the lignin chemical structure has a significant effect on the chemical reactivity such as delignification during chemical pulping. In this report, I review the recent achievements of my laboratory about the quantitative relationships between lignin structure and reactivity.

Application of catalyst technology in pulping process -Application development to“catalyzer-type cooking accelerator”-

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Recycling of waste paper is an important issue for environmental protection. In recent years, decreasing of demand for recycled pulp and shortage of waste paper as raw material have become serious problem due to decrease in the subscription volume of printed materials such as newspapers and magazines. The paper industry needs to consolidate recycled pulp equipment to adjust production volume. Among them, many efforts have been made to close the gap between the used paper collection rate and the used paper utilization rate. Therefore, there are now situations where even poor quality used paper must be used.

There are two significant quality problems in the deinking process of used paper. One is the problem of UV curable ink printed matter. In 2016, we combined surface science and catalyst science, and we proposed a "catalyzer-type deinking agent" that was excellent in miniaturization of the ink.

The other is a problem called pitch (dust, dirt) generated during the paper manufacturing process using used paper. There are many origins of pitch, such as the adhesive for postal slip, back glue and resins in coating agents.

In particular, used paper recycling plants are facing this pitch problem as often as UV curable ink problems. Thus, as the solution of pitch problem, the development of a new generation of pitch control agents has been required for many years in the paper industry.

This time, we have developed the "hydrolyze-type pitch control agent" that can accelerate the dissolution of pitch and prevent it from becoming huge by decomposing the resin by applying the catalytic technology used in the "catalyzer-type deinking agent".

On the other hand, in order to produce pulp from plant lignocellulosic materials such as wood, it is generally treated with alkali or sulfites for cooking. Pulp is produced by the cooking method, which remove lignin or natural resin components from lignocellulose material by dissolving, dispersing, decomposing, and filtering.

However, at present, reckless deforestation of natural resources such as timber is regulated due to environmental problems, and the price of timber is rising. Therefore, increasing pulp production per unit of raw wood and producing high quality pulp products have become more and more important.

As a method for solving these problems, a method using a cooking accelerator that enhances cooking efficiency is known. Furthermore, in recent years, a safer cooking accelerator has been demanded. This time, we have found that this catalyst technology can be applied not only to deinking agents and pitch control agents, but also to pulping processes from lignocellulosic materials.

In this paper, we introduce newly developed “Catalyzer-type cooking accelerator” that has the potential of pitch control effect as well as the cooking promotion effect in the cooking process.

The Keenest Stock Preparation Technologies for Board Paper - Countermeasures for Worse Waste Paper Quality -

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Due to a change in the Chinese recycle paper procuring policy, the amount of recycle paper exported to China from Japan has been fluctuated significantly, decreasing from 2,750 thousand tons in 2018 to 1,283 thousand tons in 2020. There is a marked tendency for recycle paper to be oversupplied in Japan.

On the other hand, from the middle of 2019, the demand from our customer, the paper mill, has been shifting from improving yield to energy saving, but recently, the desire to maintain the paper quality by using low-priced recycled paper has become conspicuous.

There are two ways to save energy, one is to achieve the target by simply reducing energy consumption, and the other is to increase the capacity of existing equipment and improve the power intensity.

Regarding the improvement of the power intensity and the use of low-priced waste paper, there is an overlap of strengthening the dust removal capacity compared to the conventional equipment. I will introduce the process that focuses on the pulpig system, together with some case studies.

Diagnosis of Lime Kiln for Improvement Kiln Operation

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TEC has developed techniques to diagnose more than 100 cement Kilns and to achieve energy-saving and to increase production.

By using the energy-saving techniques adopted in cement plants, TEC has conducted extensive study in Lime Kiln operation, achieved following successful results towards reduction of the fuel consumption and production increase.

- 1) Diagnosis of Lime Kiln : TEC have conducted a diagnosis study on Lime Kiln towards the existing process/operational problems and to found optimal countermeasures for reduction of the fuel consumption.
- 2) Replacement of existing Kiln Burner: By replacing the existing Kiln Burner with Taiheiyo's TMP Burner (Taiheiyo Multi-purpose Burner), has achieved improved burnability efficiency and reduction in the amount of primary air.
- 3) Adjustment of Lime Cooler: For the improvement of heat recovery efficiency of existing Lime Kiln Cooler, Grate Speed Control and Airflow Control was adopted to Lime Kiln Cooler, for better cooling efficiency.
- 4) Adjustment of Kiln Operation: TEC has conducted O₂ concentration control and the of raw meal filling ratio in the Lime Kiln have optimized.

As a result of adopting above countermeasures, 8% to 15% reduction of the fuel consumption is achieved.

History about steels used for equipment in Kraft pulp mills

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Valmet K. K.

Most of Japanese Kraft pulping mills were installed between 30 and 40 years ago. Under the corrosion circumstances, the equipment is easily and gradually corroded and several anti-corrosion materials which are superior than original materials have been selected as a solution to stop further corrosion. For the opportunity of upgrading whole equipment, superior materials can be used as well.

There are various equipment and machines in Kraft pulping mills and the materials used for such equipment and machines also has a long history. Chemicals used for equipment and machines at fiberlines are generally clarified, thus, the selection of anti-corrosion materials (for example, Titanium alloy) is relatively easy. However, the materials used for continuous digesters has been always the same. That is the steel-based material. In this paper, the history of these steels will be focused and briefly described.

ANDRITZ A-Recovery+ Chemical Recovery Concept

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Andritz K.K.

Over the years, chemical recovery technology suppliers have worked with pulp mills to “close” the chemical recovery loops in order to reduce emissions and effluent – and also to increase recovery efficiency. These loop closures have sometimes led to a build-up of certain chemicals and the creation of side streams that are either ignored or disposed of.

A major target of ANDRITZ’s recent development work has been to innovate solutions for utilizing the side streams of a Kraft pulp mill to unleash the hidden potential for generating profit, as what was once considered “waste” can be converted to valuable raw materials for commercial-grade bio-products. The objective continues to be operating chemical recovery systems as efficiently and environmentally sound as possible while minimizing capital investment and maximizing profits.

-Keep proposing better solution ! -

A breakthrough chemical approach to operational stability with NISSIN-PCM (Nissin Pitch Control Method), which has been inherited since its establishment

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The paper industry is promoting the recycling rate and environmental load reduction to increase the utilization rate of used paper and to closed system, and it is exposed to an environment where pitch troubles due to sticky substances are likely to occur. In recent years, pitch troubles in the papermaking process have tended to increase and become more complicated due to a decrease in the amount of high-quality waste paper distributed due to restrictions on the import of mixed waste paper in China and an increase in the utilization rate of planted trees such as Akashiya. This is one of the troublesome issues for paper manufacturing engineers aiming for stable operation and quality improvement. Since its founding in 1931, we have proposed NISSIN-PCM (Nissin Pitch Control Method) as the most important way of thinking about pitch measures, and have been searching for new proposals for solving pitch problems to this day.

Among these efforts, we consider that it is the most important to take optimal pitch measures in the quality process, and believe that implementing local and necessary pitch measures in each process will lead to improved quality and productivity of paper products. In this paper, we describe our latest approach to pitch problem solving.

Revolutions in the history of civilization induced by paper Part 7: Korean Peninsula, Vietnam and Japan

Kiyoaki Iida

China took the direct presence in Korean Peninsula in the first Century B.C., and the paper which became common in China was introduced there. The successive Korean Dynasties, Goguryeo, Baekje and Silla, received Buddhism along with its manuscripts, and nurtured their cultures written on paper. Though Chinese influence stayed strong, Korean culture progressed and invented Hangul in the 15th Century. Its traditional paper making process is very similar to the old Japanese process.

Japan imported Buddhism and paper by way of two routes (Goguryeo and Baekje). Around 600, it began to contact China in direct.

Vietnam was occupied by China for about 1000 years from 111 B.C. of which influence stayed long. In the 13th Century, it invented a writing system in which Vietnamese language was adapted to Chinese characters, and used it along with an older system. The writing system was standardized in 1945 after the revolution. Its traditional paper making process is very similar to the old Japanese process except it uses inner bark of dó tree.

The paper making process which had arrived at Japan grew to perfection as Washi. It is valued that Japanese culture written on paper expanded a new possibility of the function of paper.

An Essay on Methodology for Innovating “JAPAN TAPPI JOURNAL”
Part 14: Significance of maintaining the diversity in the dual-natured Journal

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An organization of the Japan TAPPI has dual nature: i.e. industrial and academic. Therefore, maintaining the diversity in the management of organization as well as editing the journal is not easy task. The fourteenth article of this series is intended to analyze the problems stemmed from this nature and seek possibilities of maintaining the diversity based on the overseas documents (Finland and UK) and author's past experiences in Canada and France. The overall contents are described as below.

1. Introduction
2. Fundamental sciences vs applied sciences & technologies
3. Fundamental and applied sciences & technologies in the area of pulp and paper (Finland and UK)
4. UK's Fundamental Research Symposium focused particularly on fundamental sciences in the area of pulp and paper
5. The dual nature of the Japan TAPPI as briefly glimpsed from its research meeting business
6. Personal experiences on the relationship between fundamental research and applied research :an example in the area of Wet End Chemistry
7. Author's research experiences in Canada and France
8. Epilogue: dual nature & diversity

Safety Evaluation of Cellulose Nanofibers produced from Soda-anthraquinone Sugi pulp by Enzymatic Treatment and Wet milling

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Cellulose nanofiber (CNF) is a promising new material used in a wide range of industries. The application of soda-anthraquinone cooking of sugi (Japanese cedar) and subsequent nanofibrillation of the enzymatically treated pulp by wet milling enabled us to establish a simple integrated manufacturing process to obtain sugi-CNFs. However, there are concerns that the sugi CNF might be mutagenic or cause skin irritations; therefore, we tested these hypotheses. Acute oral toxicity test using mice showed no abnormality, with an LD₅₀ value of over 2000 mg/kg. Also, the sugi CNF was found to be non-mutagenic in the bacterial reverse mutation test. In addition, no anomalies were detected in the *in vitro* chromosomal aberration test using Chinese hamster lung fibroblast cells. Moreover, the CNF treatment of rabbits in dermal irritation or corrosion tests did not produce severe dermal irritation or corrosion or distinctive signs of toxicity. Erythema was observed in the site of 5wt% CNF application in all the tested animals one hour after the CNF application ended; however, erythema disappeared by the 48th hour. As a result, the sugi CNF was evaluated to be in the non-irritating category. According to the results from the guinea-pig maximization test, which predicts skin sensitization, the effect of the sugi CNF was classified as the weakest grade. In conclusion, the sugi CNF is unlikely to cause mutagenicity in organisms. In addition, the level of skin irritation caused by the sugi CNF is within the normal range of handling.

