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Contribution to Carbon Neutrality through Optimization Technology「Part II」 -Challenges and Solutions in Utility Plant Operation Optimization-

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Last year, we introduced energy conservation by optimization technology and demand response solution to support the clean energy transition towards carbon neutrality. This year, as the second report, we will focus on utility plant operation optimization by Azbil's optimization solution, which has a large effect for energy conservation and CO2 emission reduction.

Firstly, we realize utility plant operation optimization by using Multivariable Model Predictive Control (MPC). A hybrid system consisting automatic control and guidance built by using MPC provides flexibility that enhances receptivity among operators on-site. Additionally, our optimization solutions also utilize soft sensors, digital twins and AI technology to solve problems often occurred in utility plant operation optimization.

In this paper, we classify the problems that have been solved through our optimization solutions in many industries such as Pulp and Paper, Refinery, Chemical, into several topics which are "Boiler steam pressure control", "Building and updating model for MPC", and "Receptivity among operators on-site", and report the solutions for challenges indicated in these topics.

In particular, regarding "Building and updating model for MPC", which is directly linked to the effectiveness of implementation of MPC on-site, we will introduce in detail for the utilization of digital twins in building model expressing the equipment property which represent the actual behavior of the utility plant, and the newly developed automatic model updating function through AI technology to update the model for MPC according to changes in equipment property due to reasons such as aging and maintenance.

TMEIC product and technology that can contribute to DX in the paper industry

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In recent years, the prices of all kinds of things have soared resulting in squeeze profits in the paper industry as well. In the future, optimizing the usage of all kinds of things will be inevitable with full use of AI and IoT technologies to promote digital transformation. Furthermore, the trend toward carbon neutrality is growing around the world, and we are now in an era in which companies are required to contribute to the realization of a sustainable society. This paper introduces six of our new products and technologies that enables to support initiatives aimed at further improving productivity in such circumstances.

Learning from Other Industries,　Four Points for Success in Manufacturing DX from an Instrumentation Viewpoint

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The environment surrounding the manufacturing industry is changing dramatically in recent years. To adapt this situation, almost all companies are required to transform under the keyword "DX". However there is no methodology that guarantees success of the manufacturing DX. Yokogawa Solution Service has analyzed the situation of manufacturing site, and defined the elements of manufacturing DX through collaborations with customers in wide variety of industries, such as chemical, oil, pharmaceutical, etc.

In this paper, we describe four points for success in manufacturing DX, and provide case study from other industries that Yokogawa Solution Service conducted workshop for site staffs to help their transformation.

Importance of Data Utilization and Environmental Measures at Manufacturing shop floor

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The world now faces the crisis of global scale of environment, society and economy. Climate change poses a "survival crisis" for mankind and many other organisms, and global warming has progressed during the past 10 years, causing the retreat of glaciers, the death of coral reefs, and abnormal weather in various parts of the world. In addition, various social issues such as poverty, human rights violations, and the aging of the population continue to be major challenges. In addition, the components of the value chain, such as the novel coronavirus pandemic, geopolitical crisis, and currency fluctuations, are exposed to unprecedented uncertainty. In this uncertain and unstable age, this paper outlines points requiring attention in the promotion of manufacturing DX, while it mentions the arrangement of problems in the paper and pulp industry, challenge themes for the solution of problems, data utilization in manufacturing shop floor, and the importance of environmental countermeasures. It should be noted that the interpretation and consideration of the regulations in this paper are not absolute, because they are discussed in part based on the judgment of our company based on the interpretation by the government and industry groups.

Visualize and Reduce Fiber Losses by OnView.MassBalance

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Voith is promoting the digitization of the papermaking process under the name of PM4.0. While increasing the number of digital products delivered to the papermaking process worldwide, we are also developing digital products for the raw material process as a full-line supplier. This article introduces a product called OnView.MassBalance that visualizes fiber loss in the OCC line.
Generally, fiber loss in the raw material process is known only on a monthly or weekly basis, and it is difficult to pinpoint the location of the process in which the loss occurs. By using OnView.MassBalance developed by Voith, the flow rate of feed, accept, and reject of each process is clearly displayed in a chart format called Sankey diagram, and it is possible to identify the place where fiber loss is high in real time.

Steps into the future as seen in global digitalized plants

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The degree and speed of change in our business environment today is significantly faster than it was a decade ago, making it imperative for any company to increase its competitiveness through industry digitalization. This article explores the concept of digitalization and hints for the Japanese manufacturing industry, with examples of digitalized factories overseas.

Toward Data-driven Factory Automation as seen from Recovery Line Optimization

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In pulp and paper mills, automation of each process has been introduced worldwide, but further mill automation has been proposed to optimize operations throughout the entire mill.
This optimization of factory-wide operations is called "Operation 4.0," and is the next step in optimization technology that is attracting worldwide attention.
In conventional optimization technologies for each process, optimization control is added to the issues and areas that can be improved in each process to enable more efficient operation of the process. This has resulted in reduced chemicals, reduced energy consumption, increased production output, improved quality, and reduced emissions.
Optimization throughout the mill, with a special focus on the inter-processes, can reduce losses between processes and further improve efficiency.
As a manufacturer capable of providing equipment, machines, automation products, and services for pulp and paper mills, Valmet has developed this mill-wide optimization with the support of its experts. Valmet offers this solution as "Mill Wide Optimization".

Effect of introducing the boiler combustion control optimization system

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In Hokuetsu Corporation Kanto Mill (Katsuta site), the No.2 biomass boiler (2B) and No.2 steam turbine generator (2T/G) generate steam and electric power for the whole facilities, and the surplus electricity is supplied outside for sale. The 2B mainly uses wood chip derived from construction waste, coal, and paper sludge and waste plastic generated inside the mill. On calorie basis, about 90% of the fuel is wood chip and paper sludge, about 1% is waste plastic, and the rest of around 10% is coal.

Fuel supply is controlled by DCS automatically, under the condition of keeping the amount of power generation constant due to power selling. As a result, the main steam pressure fluctuates greatly, reducing the combustion efficiency of the boiler. Therefore, this time, we introduced the boiler combustion control optimization system (ULTY-V plus), which has a proven track record in coal boilers. By suppressing pressure fluctuations with this system, we worked to improve the combustion efficiency of the boiler and reduce the fuel consumption.

Comprehensive Solutions for Utilizing Recycled Paper by KURITA

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Failures such as defects and paper breakage originating from recovered paper materials can be caused by a variety of factors.

We have developed a highly accurate analysis method that can quantitatively and quickly estimate the causes of these problems by using continuous water quality measurement with the S.sensing® system and DX for data analysis.

This method can also be used to predict future problems that may occur in the future.
Because this analysis method can be universally implemented quantitatively by anyone, we believe that it can supplement the transmission of empirical knowledge due to manpower shortages and the retirement of veteran operators, which is expected to be a problem in the future.

By appropriately combining the various countermeasure methods, including our own water treatment chemicals, for the highly influential factors related to water treatment derived from this analysis method, we will be able to implement highly accurate countermeasures against failures.

Proposal to control color quality and to reduce the loss in the production line by high precision color sensor

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It is very important to manage the color of paper as well as the other factors which need to be under control.　It seems not to be discussed enough how to manage the color.　This time I will explain about the importance of the color sensor as an input device with some examples.

DX Initiatives for In-house Power Generation Facilities

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As our company, where the necessary factory energy is provided by in-house power generation facilities, one of our major challenges is to control breakdowns, as boiler breakdowns have a significant impact on production. However, with experienced employees retiring every year, it is difficult to pass on technology through paper-based information exchange alone, and occurrence of similar breakdowns and a decline in on-site capabilities are becoming apparent. Under these circumstances, it is close to the limit to run the stable operation of aging facilities with only the knowledge and experience possessed by a few individuals.

Therefore, in this theme, I would like to introduce some of our efforts to break away from the operation method based on personal knowledge and experience by utilizing digital technology, focusing on the digitalization of operation information and changes in operation monitoring methods.

Pulping of Mitsumata by using Twin Screw Extruder

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The bast fiber of Mitsumata(Edgeworthia papyrifera Sieb. et Zucc.) has traditionally been used as a raw material of paper. Mitsumata belongs to Thymelaeaceae family, and the paper made from its bark is known to have hue of egg yolk color and unique texture. Mitsumata pulp for paper making is manufactured as follows. Mitsumata branches are steamed and barks are taken off, from which its epidermis and cuticle are removed. Then, the residual white bark is cooked with an aqueous alkaline solution in the digester. Compared to the chemical composition of wood, the white bark contains more amount of pectin and less amount of lignin. So, pulping of Mitsumata primarily aims to remove pectin that works as a binder among cells, and pectin in the white bark can be removed by alkaline solution under heated.

In this research, we used twin screw extruder to produce Mitsumata pulp from its white bark. Twin screw extruder consists of two co-rotating screws in a cylinder barrel, and it is widely used in the manufacturing industry for material processing such as shearing, kneading, heating and mixing. The white bark is impregnated with an aqueous solution of sodium hydroxide before defiberizing by twin screw extruder. The process of twin screw extruder is continuous and its processing time is short compared to normal cooking process.

The effect of processing temperature and addition rate of sodium hydroxide on defiberizing of Mitsumata fiber was investigated. We found that Mitsumata fibers could be defiberized by twin screw extruder at lower temperature than cooking process.

Handsheets were made from the pulp produced by twin screw extruder, and their optical and physical properties were studied. The ISO brightness of the handsheet produced by twin screw extruder was high compared to the handsheet produced by normal cooking process. The pulp yield produced by twin screw extruder was also higher than the yield by cooking process. The side chemical reaction is considered to be suppressed during the extrusion process because of the low processing temperature and the short processing time.