Consistency Control Optimization

Why Control Consistency?

Consistency is the foundation that papermaking is built on. Proper consistency measurement and control can have a significant impact on both product variability and manufacturing costs. Even slight improvements in the measurement and control of consistency throughout the mill can result in cost savings of $100,000 annually. Although consistency is almost universally recognized as the most important variable in the manufacture of pulp and paper, it is often the most neglected. Good consistency control requires that the entire system be engineered and designed correctly. Each of the following components must be considered if the system is to provide the level of control that is required in order to achieve optimal performance:

- Measurement – the consistency transmitter must be of the correct type for the process and must be installed and calibrated correctly.
- Dilution water – must be of constant and appropriate pressure and should be added so as to minimize system deadtime.
- Mixing and agitation – is the key to reducing high frequency variability.
- Sampling – must be performed correctly at the appropriate locations.
- Control valve – should be appropriately sized and have control resolution of better than 1%.
- Tuning – should be appropriate for all operating conditions.

Consistency Measurement

The term “Consistency Transmitter” is in fact a misnomer. In actual practice all consistency transmitters measure a secondary property of the stock and infer consistency from that secondary property. For example shear force type devices measure the force required to separate fibers in a stock slurry. The higher the consistency, the greater the shear force required. However, any number of other factors, not related to consistency can affect the shear force. These factors include, but are not limited to, temperature, pH, wood species, and freeness. There are a large number of technologies available today for measuring consistency. These range from shear force to microwave.

Each technology has its own set of limitations. Choosing the right technology and implementing it correctly is the key to designing a consistency control system that will work.

Dilution Water

Providing a stable source of dilution water is key to reducing consistency variability. Upsets in dilution water pressure are translated directly into consistency variability. Because of the interactive design of most mill white water systems, variability generated in one location is often propagated throughout the system. How the white water header is designed and controlled can have a dramatic impact on overall system variability.

Mixing and Agitation

Improving agitation and mixing in stock chests is often the single most important improvement that can be made to reduce overall consistency variability. Stock chests behave as high frequency filters. The better the mixing, the better the better the removal of higher frequency variability. It is imperative to measure the mixing time constant of the stock chest so that the capability of the system is understood. Since the control system is only capable of attenuating low frequencies it is important to maximize the mixing capabilities of the stock chest in order to achieve the lowest level of variability possible.

Control Valve

Incorrect control valves are one of the largest sources of consistency variability. An oversized control valve limits control resolution and accentuates any mechanical non-linearities present in the valve. Undersized valves limit the controllability of the system. It is important that the valve have maximum rangeability. Because of the unique requirements of the pulp and paper industry this almost always means the use of an equal percentage ball valve. However, Variable Frequency Drives are fast becoming the preferred option in applications where optimal control is required.

Sampling and Calibration

Correct sampling is the key to good calibration. The sampling port must be designed so that a representative stock sample can be obtained in a safe consistent manner. The repeatability of the sampling and testing is highly dependent on the method and design of the sampling apparatus and technique. If correct sampling procedures are not followed, the entire process of sampling, testing and calibration becomes worthless.

Control Loop Tuning

The tuning of the control system is the final piece of the consistency control puzzle. While tuning can not make up for an improperly designed system, it can destroy a good system. Loop tuning is often approached in a haphazard "seat of the pants" fashion. While this approach can sometimes lead to adequate results when controlling other variables, this is not the case with consistency control. Consistency control is unique in that the dynamics change dramatically as operating conditions change. The process gain, process deadtime and process time constant all change whenever operating conditions change. It is not unusual to see the process gain change by a factor of 3 to 5 and the deadtime to double or even triple. This can cause instability and cycling if not taken into account. It is important to tune the loop for the worst case operating conditions and to use a non-oscillatory method of tuning such as "Lambda tuning".

HOW CAN PRONAMICS HELP?

The principals and associates of ProNamics have been involved in the design and analysis of consistency control systems for many years. ProNamics can provide a complete independent analysis of the consistency controls in your mill. Since ProNamics is not associated with any vendor we can provide you with an unbiased evaluation of your system. This evaluation includes:

- Sensor evaluation – is the sensor the correct technology for the process. Is the sensor installed and located properly?
- Dilution Water – is the header designed correctly? Is the header pressure appropriate for the application? Is the velocity appropriate?
- Mixing – is the chest mixing adequate. What steps can be taken to improve the level of mixing.
- Sampling – are the sampling ports located properly? Is the sampling and testing methodology appropriate?
- Control Valve – is the valve correctly sized? Is the valve the right type. Is the valve's dynamic performance acceptable?
- Tuning – is the tuning appropriate? If not then the loop is retuned using "Lambda Tuning "techniques.

The on-site survey is followed up with a report detailing current baseline as well as improvements and savings that can be expected from implementing the recommendations. ProNamics will also follow up and help with implementation and design in any capacity that is required.

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