The importance of consistency

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INTRODUCTION:

In the shadow of the large pulp and paper process components and infrastructures, some transmitters operate 24/7, sometimes in very tough process conditions, and deliver an essential information for process understanding and control: consistency – or the "thickness" of the mixture. Let's shine a light on it.

While energy and raw materials costs are prevailing as well as environmental considerations, pulp, paper, and tissue makers recognize consistency's importance to the process, and its ultimate effect on profitability. An unstable process affects both quality and productivity. Accurate consistency control is fundamental to achieve process stability because it sets the base for measurement and control of so many other variables in fiber lines, stock preparations and wet-end of paper or tissue machines.

This importance is even reinforced with the development of new software-based solutions for control and optimization. Fortunately, these innovations also bring advanced solutions for improving consistency control management.

The thickness of the mixture

All starts with water. As soon as fibers are detached from each other in pulp mills or in pulpers, mixture with water is necessary to process them in fiber lines and stock preparations. The challenge for pulp and paper makers is to be able to know constantly the proportion of fibers -and possibly other raw materials- in water until it becomes a sheet of paper or tissue. Before expressing the rate of fibers as dry content on the pulp dryer, paper or tissue machine, the 'thickness' of the mixture is expressed as consistency.

Consistency is defined as a percentage of solid mass in a pulp slurry. The slurry can include fibers, fines, fillers and water. There are standards (ISO, TAPPI…) which define how to measure it in the laboratory. If these methods are quite simple to execute with suitable equipment, the laboratory measurements require human resources, strictness and time. Whereas pulp and paper mills run continuously by digesting, bleaching, blending, refining, pumping and diluting several tons of costly fibers per hours, it's obvious that more frequent, automatic and online consistency measurements are required to keep control on the pulp and paper process.

Online consistency measurements are achieved through calibrated consistency transmitters installed on pipes in most cases. Frequency and quality of measurement depends on several factors like technology used, installation, type of media, flow conditions, calibration, equipment, and services of transmitter's manufacturer. It is worth noting that all consistency transmitters must be calibrated with laboratory measurements and that there is not a single consistency transmitter technology that fits all applications.

Control of consistency is then achieved by adjusting dilution to the defined consistency setpoint either manually or more commonly automatically with a proper consistency control loop. Its efficiency depends on several factors as well: the online consistency measurement as already explained above, but also the sampling quality for calibration purpose, the mixing and dilution of the pulp upstream, and the PID controller tuning. Typical number of consistency loops can vary from 5-10 in a simple tissue machine to 20-30 in a sophisticated fine paper or board machine, and even more than 50 in an integrated mill. Let's review in detail what make them so important.

Figure 1: BTG Optical consistency transmitter TCR-2511 installed at the outlet pulper

Consistency in Fiberline

In fiber lines, medium consistency can be measured and controlled already from the outlet of digester, setting already the foundation of better stability in downstream stages such as brown stock washing and oxygen delignification. Stabilizing the extracted pulp flow helps also to control continuous digester operations by acting on the other cooking parameters (chip level, cooking liquors, cooking time, H factor, Kappa number).

Process conditions are some of the worst working conditions in the pulp and paper industry for all equipment. It must face outstanding pH, temperature, pressure and with presence of shives, stones, and sand. Nevertheless, solutions exist and are applied successfully, notably with BTG's rotating consistency transmitters.

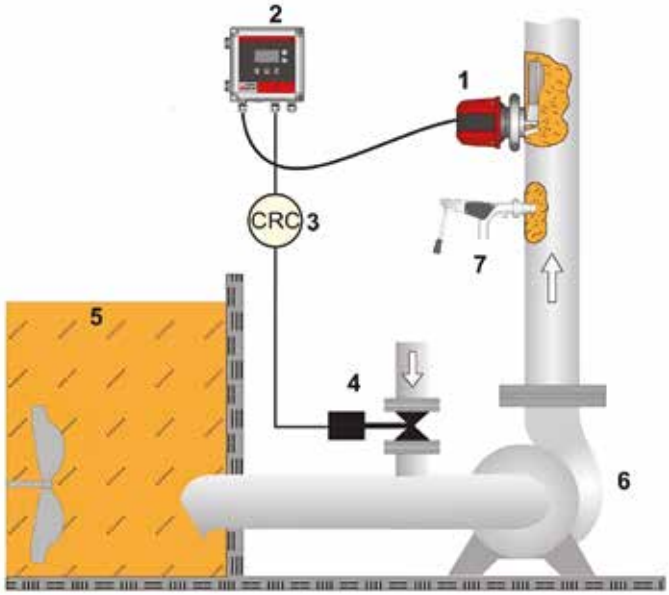
In the bleach plant, bleaching chemicals are dosed typically on mass flow basis. Any variations in the incoming consistency impact bleaching chemical dosage which then directly translates to chemical concentration variation in the bleaching towers, with negative impact on reaction kinetics and thereby bleaching efficiency. Let's consider a 1000 Tpd sulfate hardwood pulp process with a significant consumptions of chlorine dioxide (ClO2) and sodium hydroxide (NaOH) as an example. Consistency variation is reduced by installing rotating consistency transmitter instead of static blade consistency transmitter. Based on the reduction of standard deviation from 0.2 to 0.08, savings on chemical consumption are estimated to approximately €325,000/year.

Consistency in Stock Preperation

OCC line

Stable process operations are fundamental to optimized performance of paper or tissue machines. Therefore, stabilizing consistency as early as possible in the stock preparation is welcome. And the first step of consistency control starts at the outlet of the main pulpers. Despite highly contaminated raw materials when disintegrating waste papers, this is possible to get a workable and sustainable consistency signal, with high availability. BTG's optical consistency transmitters with patented Peak method perfectly fulfill this need.

Figure 2: 1 ACT-2500 transmitter 2. Communication platform 3. Controller/recorder (DCS) 4. Dilution water valve 5. Pulp chest with sufficient mixing 6. Stock pump 7. BTG sampling valve type MPS-1000



Stock preparation's operators benefit from valuable information to adjust dilution in anticipation of downstream stages. Indeed, equipment for screening and epuration are designed to work effectively at specific consistency range and there are even best performances at precise consistency target. Without good consistency control, screening and epuration are less efficient, with negative consequences on overall machine operations.

Refining

Generally, and in an optimum way, refining is controlled by specific energy applied (kWh/T). Any uncontrolled variation of consistency directly impacts the energy applied on the fibers by the refining plates. A 1% change in fiber consistency inlet can create 10% change in fiber development, negative effects of sheet strength development and all the machine runnability related with the change. In refining, maintaining the target consistency is critical for treating the fibers to maximize fibrillation and minimize fines generation and cutting.

Chemical dosage

Additives are either dosed as fixed flow or as ratio vs production in the stock preparation. As already described beforehand in the paragraph dedicated to fiberline, it's important to keep mass flow constant while mastering the successive dilution steps, so the correct amount of functional additives is introduced at different process locations at various consistency levels. Overconsumption or underconsumption of chemicals due to wrong mass flow information lead to chemical cost increases and system overdosed, bad wet-end performances and machine runnability, and out-of-specification production. Controlling consistency perfectly enables accurate chemicals dosage with high efficiency. This is fully achievable with BTG's oscillating blade consistency transmitter for example.

Blending

Fiber recipe is determined to meet paper or tissue specifications and to keep cost at a certain level. For example, the mixing chest can collect fibers from softwood line, hardwood line, recovery system and broke line. For the reasons defined before, it's primordial to apply recipe strictly. If one of the fiber mass flow deviates from its setpoint, this will impact the complete fiber mix. In our example, there might be more softwood and less hardwood than planned, and as a consequence it would lead to higher cost and likely to lower quality of paper or tissue. A 0,5% error in blending will impact furnish cost differential of €200,000.

Paper and Tissue Making

Basis weight

Generally, the basis weight of a paper or tissue machine is managed via a control loop with the following inputs: basis weight at the reel from the QCS (Quality Control System), flow and consistency of the thick stock. Any consistency variation after the machine chest is fed forward to the basis weight controller. So, when the consistency increases, the basis weight valve opening is reduced or the feed-stock pump speed is decreased, to maintain a constant amount of fiber flow. In a continuous trend for delivering lighter grammage with same mechanical properties, the closer the actual basis weight is to the lower tolerance limit, the greater the profit. Because of its high accuracy on fiber consistency, BTG's rotating consistency transmitter is often a preferred choice for outlet machine chest.

Retention

The retention at the paper or tissue machine is calculated with consistency at the headbox and consistency in white water. This calculation gives an indication about the percentage of raw material kept in the sheet in the forming section. A high retention means that most fibers, fillers, fines and functional chemicals go in the press section instead of turning around in the short loop. Paper or tissue makers look for stability at an optimum level (not necessarily the highest), and retention aid is often applied for this purpose. Retention control is based on white water consistency only because this value is more relevant than the retention calculation.

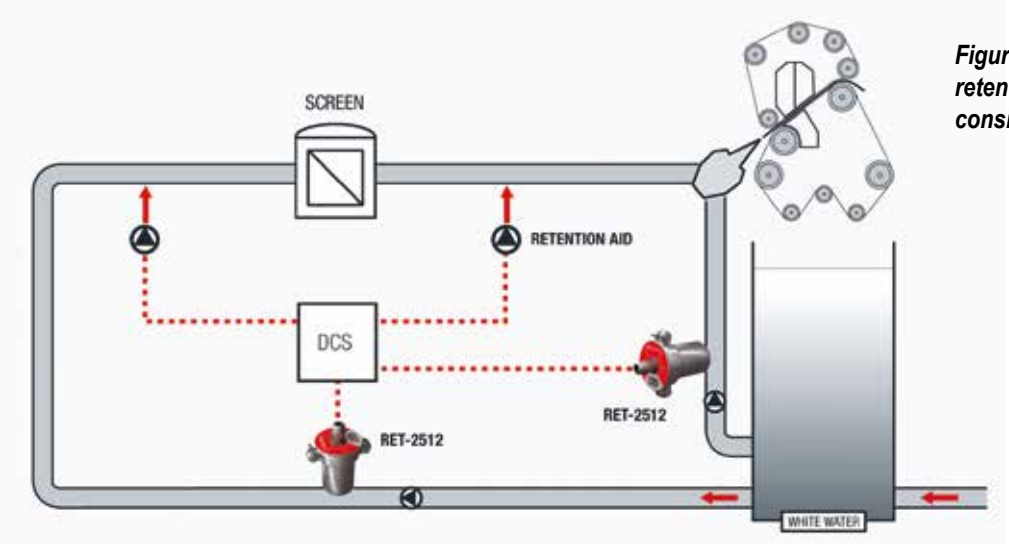


Figure 3: Schematic process diagram of retention aid control with BTG's optical consistency transmitter RET-2512

The dosage of the retention aid is controlled with the information of the white-water consistency measured online with, for instance, BTG's low consistency optical transmitters. The aims are to stabilize the wet-end which is very sensitive for the machine runnability and to reach constant final paper or tissue quality.

Wastewater treatment

For producers who want to leave nothing to chance, consistency measurement is the ultimate value for monitoring the fiber content at the inlet of the wastewater treatment plant. The consistency signal can be then used to steer effluents in storage locations so that the treatment plant does not get overloaded. Polymer dosage before decanter, flotation cell or screw press can be also adjusted depending on the consistency. The water treatment plant runs more serenely and there is no bad surprise at the outlet.

By reviewing all these consistency applications and their related influences on the production steps, we can also realize that by getting an overview of the entire pulp, paper and tissue process, there is room for more efficient solutions of control and optimization.

More recent solutions

The latest developments in IT infrastructures and software associated with large amount of process data collected and available in real time led to advanced solutions of process optimization. Thanks to solutions like VOITH's OnView. MassBalance, fiber streams can be visualized and optimized to save raw materials. Model predictive control like BTG's MACSsuite enables additional profit by anticipating process variations and by managing multiple variables. All these optimizations are possible only when the foundations of the control system are strong. It means reliable online process measurements, including consistency measurements.

Nowadays more data from consistency control loops can be monitored and analyzed as well, like internal transmitter raw signals, dilution valve opening, PID controller data. Software-based solutions like BTG's CONTROLsuite take advantage of available data to determine how healthy are the control loops and to give immediate recommendations for optimization when required. The consistency transmitter itself is able to provide self-diagnosis valuable information to anticipate any adjustment of parameters or maintenance that may be required.

Furthermore, centralizing all data from consistency control loops of a production line will improve consistency and dilution control management as an overview of the entire process in three levels: visualization with dedicated process diagram, harmonization of best practices on all consistency control loops, optimization of the dilution network. These innovations are part of solutions for never ending demand to maximize pulp and paper process performances. BTG is offering solutions for SMARTmonitoring, which permits to have all information available in the cloud and accessible anytime from anywhere.

Conclusion

Consistency is one of the key parameters for stability of pulp and paper processes. From the outlet of digester to the wet-end by way of stock preparation, controlled consistency leads to optimum machine operations and subsequent highest productivity. Further savings can even be generated thanks to development and application of digital solutions in the frame of an industry becoming increasingly smarter and complex.

Fortunately, pulp, paper, and tissue makers can rely on a one-hundred-year experienced partner to deal with such important consistency subject.

Figure 4:BTG SMARTmonitoring concept