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THE ISSUES IN MECHANICS OF PULP-AND-PAPER MATERIALS

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STRATEGIES TO INCREASE YIELD AND OPTIMIZE FIBER QUALITY IN RECYCLED FIBER PLANTS

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This paper outlines various possibilities to improve the efficiency of stock preparations and gain better plant performance with low investments in control applications. With the implementation of application-specific, reliable inline technology such as consistency and ash, brightness, charge and retention measurement many of these unit operation bottlenecks can be resolved, best operating ranges can be determined and downstream benefits can be realized. The operating efficiency of the previous step often determines the productivity of the following step and desired parameters may be contradictory.

СТРАТЕГИИ ПОВЫШЕНИЯ ПРОИЗВОДИТЕЛЬНОСТИ И ОПТИМИЗАЦИИ КАЧЕСТВА ВОЛОКНА НА ЗАВОДАХ ПО ПЕРЕРАБОТКЕ ВТОРИЧНОГО ВОЛОКНА

В статье излагаются различные возможности повышения эффективности работы массоподготовительного отдела и повышения производительности установки при низких инвестициях в средства контроля. Благодаря внедрению специальных надежных он-лайн технологий измерения параметров: концентрация, зольность, белизна, заряд и удержание волокна, многие из узких мест в технологических узлах могут быть разрешены, появляется возможность определить оптимальные рабочие диапазоны параметров, и получить преимущества далее по потоку. Эффективность работы оборудования на предыдущем этапе часто определяет производительность на следующем этапе, и оптимальные значения параметры могут противоречить друг другу.

Introduction

Recycled fibre (RCF) plants are comprised of different sequential unit operations including pulping, deinking, deinked pulp (DIP) bleaching, fibre fractionation, screening, cleaning and refining before the fibre they process is finally made into paper. The productivity, efficiency and manufacturing costs of these units are interdependent; the output of a previous stage determines the operating characteristics of the next. If the fibre supply was uniform and predictable, these operations could be optimised with relative ease. But variable and generally poor quality fibre supply, plus higher costs for recycled fibre are industry wide problems. How can these variables be controlled so the process becomes more efficient and costs optimised?

All too often, processes are not well controlled; the installed equipment is either old or not used in the right way. Nevertheless, there are enough ways to improve the fibre recycling process to make up for this. The importance of controlling selected parameters as early as possible in the process is key to success. With the implementation of application-specific inline technology such as consistency and ash sensors, brightness, UV fluorescence and residual ink transmitters many of these unit operation issues can be solved and the downstream benefits can be realised. Control strategies can be established step by step with low investments. The key measurements in a typical RCF process are shown in fig. 1. Several examples of how the measurements can be used to get better plant performance results are reviewed.

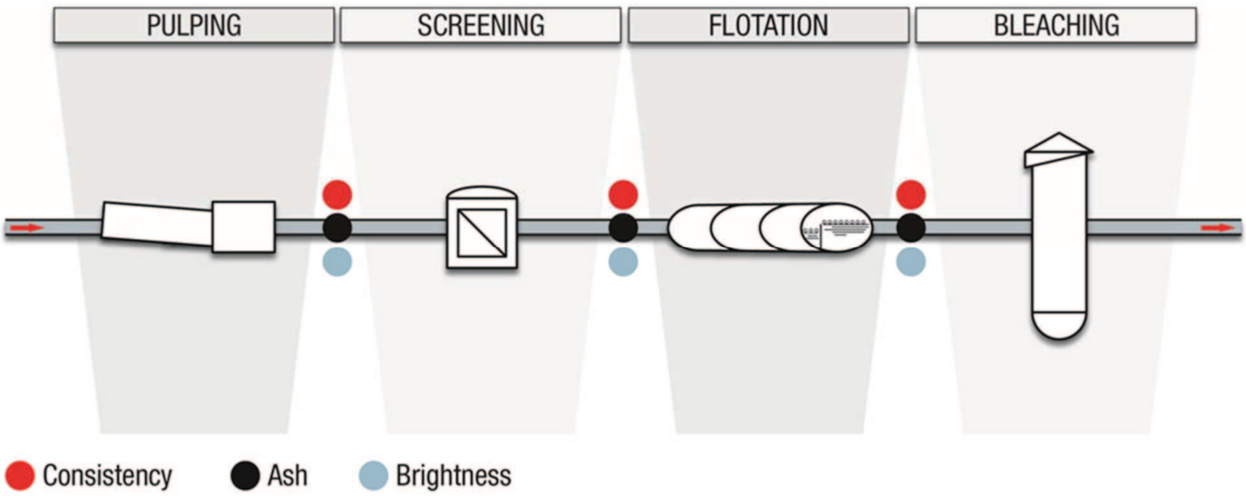

Fig. 1. Important measurement points in a recycled fiber plant

Stabilizing ink removal efficiency

Stabilising ink removal efficiency will produce a consistently bright furnish for papermaking. In one case, a newsprint mill with a furnish of deinked pulp and TMP operated a 500 t/d capacity flotation deinking line with BT-55 series inline brightness and residual ink (ERIC) transmitters installed before and after the flotation line. Both transmitters were calibrated to measure brightness and ERIC. The inlet stock was measured at a consistency of 3.5 % to 4.0 % then diluted to normal operating consistency, whereas the diluted outlet stock is measured at 1.25 to 1.5 %.

The two transmitters are primarily used to measure the ink removal efficiency so that process operators can make timely adjustments to the soap and other chemical feeds to the flotation cells. The objective is to provide a fibre feedstock with low and constant residual ink levels to the following hydrosulphite bleaching stage, thus ensuring the paper machines receive a uniform brightness furnish. This residual ink regulation avoids any slowing of mill production if final brightness targets are not met.

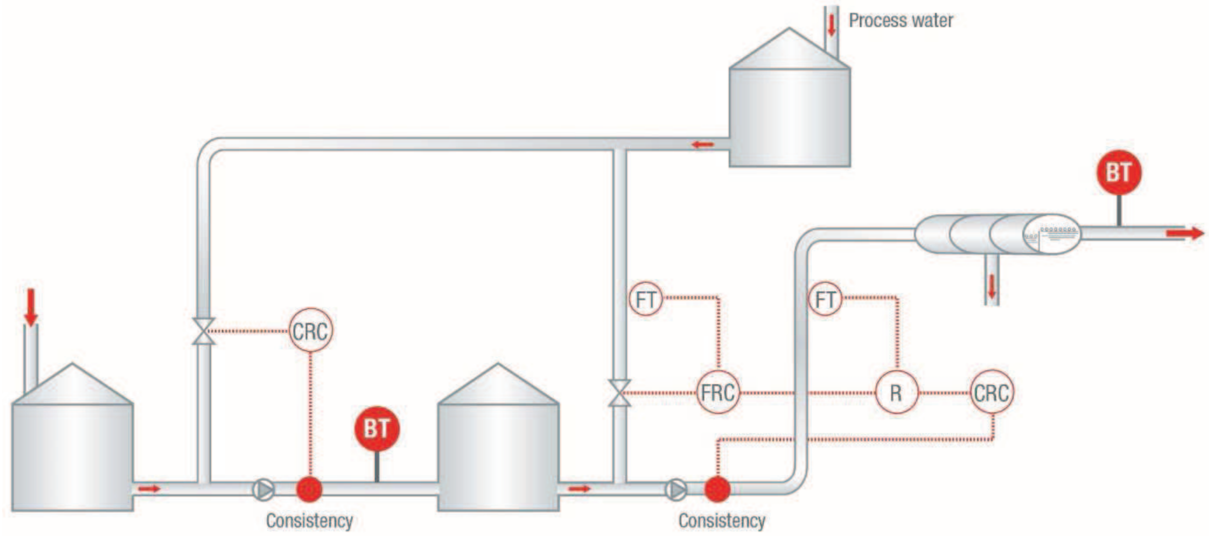

Fig. 2. Flotation cell monitoring with BT brightness transmitters

Saving bleaching chemicals

Bleaching of DIP is costly so efforts should be made to measure and control the effectiveness of deinking operations before the bleach plant. A deinking plant providing furnish to a 110,000 t/y tissue and printing paper mill installed two BT-5400 brightness transmitters with UV fluorescence and ERIC measurements after the first flotation stage and then after the second flotation stage. Both stages operated at 3.5 % consistency. In the first stage, operators manage brightness levels by adjusting the mix of the recycled fibre quality to achieve stable target brightness. With this strategy, brightness variations were reduced. In the second stage, operators managed the residual ink (ERIC) levels by process adjustments. By reducing ERIC, the need for bleaching chemicals was reduced without sacrificing brightness. Access to accurate and real time data about brightness has enabled the mill to maintain its stringent quality control standards while simplifying its process and cutting unnecessary chemical costs. This chemical saving plus the more common use of lower cost recycled fibre has provided a payback of less than one year.

Managing pulper brightness for lowest fiber cost

An inline brightness transmitter can be used at the beginning of a batch repulping operation to achieve the right brightness for subsequent stages of ink removal and bleach with minimum furnish cost. For example, a tissue mill that recycles waste paper installed a BT-5500 brightness transmitter on the wall of a batch pulper, about 1 metre from the maximum fill level. The brightness measurement was on a large display above the pulper to emphasise its importance to the operators.

To achieve their target brightness the mill used several qualities of baled waste paper with significantly different price levels. The highest priced bales contained no ink since it is paper mill trim waste. The mill reasoned that with the inline measurement the operators would get an indication about 8 minutes before the end of a 20-minute batch sequence if the brightness was on, above or below target. This would allow them to decide if more high priced, premium baled paper should be used to achieve their target, or, if lower cost bales could be substituted and still achieve the target brightness. This operator-managed strategy with the brightness measurement made at just the right time has saved this particular mill about $250,000 in fibre costs. The strategy used by the operators is shown in fig. 3. The operators aimed for a range of 63 % to 78 % ISO brightness in the batch pulper.

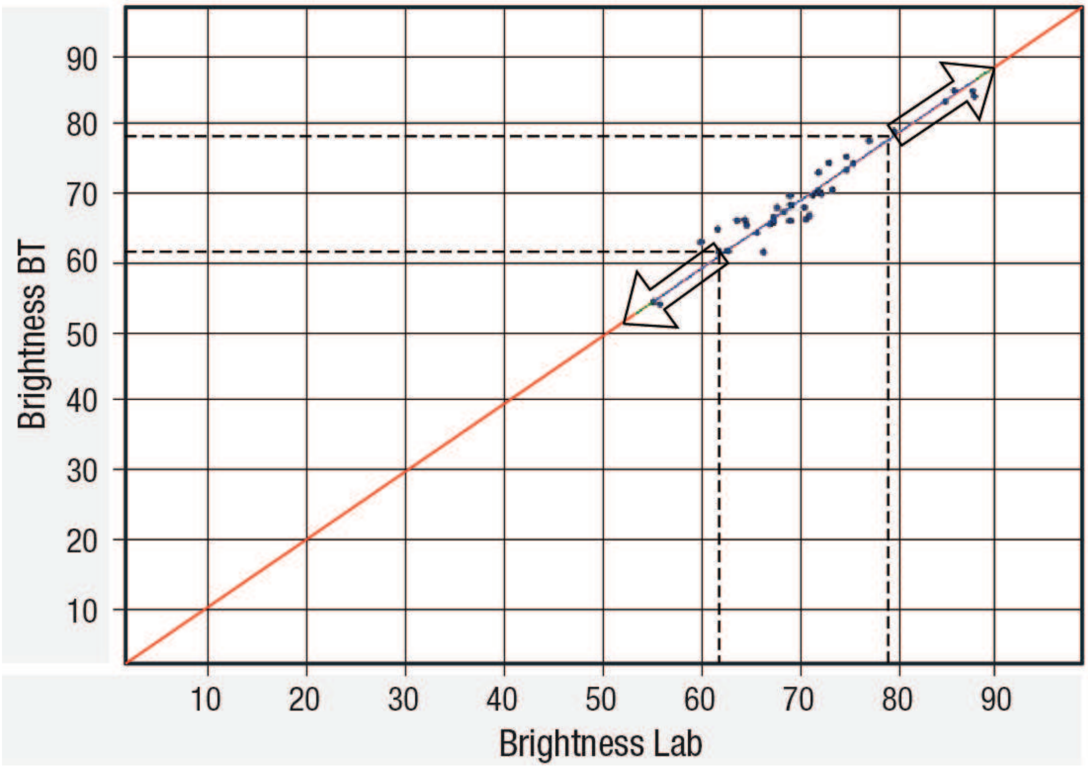

Fig. 3. ISO brightness measured in the batch pulper, BT results versus laboratory

Pulper total consistency stabilizes process

Being able to accurately and repeatedly measure consistency after a pulper in a recycled fibre process is very challenging. Firstly, trash and fibre clumps from the pulper are major problems for blade-type shear force transmitters. Secondly, mixed waste paper is comprised of many different fibres, and contains fine materials and fillers that are not measured by shear force. An absolute inline total consistency transmitter is needed after the pulper; that is the basis for total mass flow at the beginning of the process and the accurate calculation of overall process yield in the mill. This need can be filled by a TCR-2501 total consistency transmitter that uses an optical signal peak detection method. The transmitter measures the total mass of fibres of all types – small, fine particles and ash.

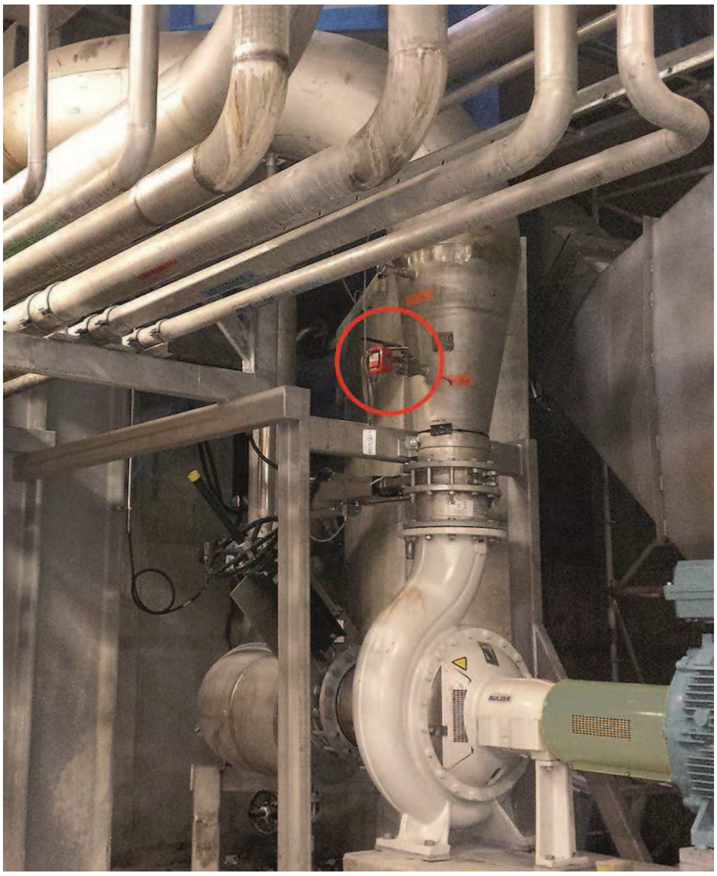

Fig. 4. TCR-2501 total consistency transmitter installed after a pulper

A recycled fibre linerboard mill using this transmitter confirmed that the pulper exit consistency measured by the new transmitter is more varied than that indicated by the previous consistency transmitter. Having this knowledge, the mill implemented a consistency control loop using the conveyor speed and dilution water in order to control the consistency at this point. This had the additional benefit of stabilising the entire downstream process. Yield calculations became accurate and further improvement steps could be taken at the right point in the process. As the consistency in the pulper is stable at 5%, enough pulp is available to run the paper machine at full speed. The pulper sets the initial consistency level. From here on the consistency is reduced in all chests that are between the pulper and the linerboard machine. Furthermore, low consistency pulp that comes from a side stream does not disturb the process.

At another testliner mill, a TCR transmitter was installed after the RCF pulper (pictured in fig. 4 above) and before high consistency cleaners operating at 3 %. Before the control loop implemented with the new transmitter, the consistency varied between 2 and 4 %. When the consistency was too high, the cleaners plugged. Also, at very high consistency the pulper motor load was high and some pulp did not pass through the screen plate. When the consistency was too low, the efficiency of the cleaners was poor. These problems have been solved now that the consistency is maintained at 3 % to 3.5 %. Managing to avoid the cleaners plugging once (and thus risking a shutdown of the machine) paid off immediately for the TCR measurement.

Optimum fiber fractionation

The fibre fractionation processes required for a multi-ply forming process requires precise separation of long and short fibres so the right level of refining is applied. The sheet plies are then formed to give the optimum drainage on the formers, and to ensure the required fibre-to-fibre bonding and sheet strength properties can be achieved. Accurately measuring the consistency at each stage is extremely important since the right consistency entering a stage will determine its fibre fractionation effectiveness, and avoid plugging if the consistency is too high.

ACT-2500 transmitters measure the amplitude of oscillation of a specially designed active blade oscillating at its resonant frequency. The measurement is sensitive to both the shear forces and the viscoelastic properties of the fibre matrix in the pulp slurry. Its measurement range is extended down to 1.0 %. The transmitter has a higher accuracy than a standard blade transmitter with a price point below an optical measurement. A typical fibre fractionation instrument layout is shown in fig. 5.

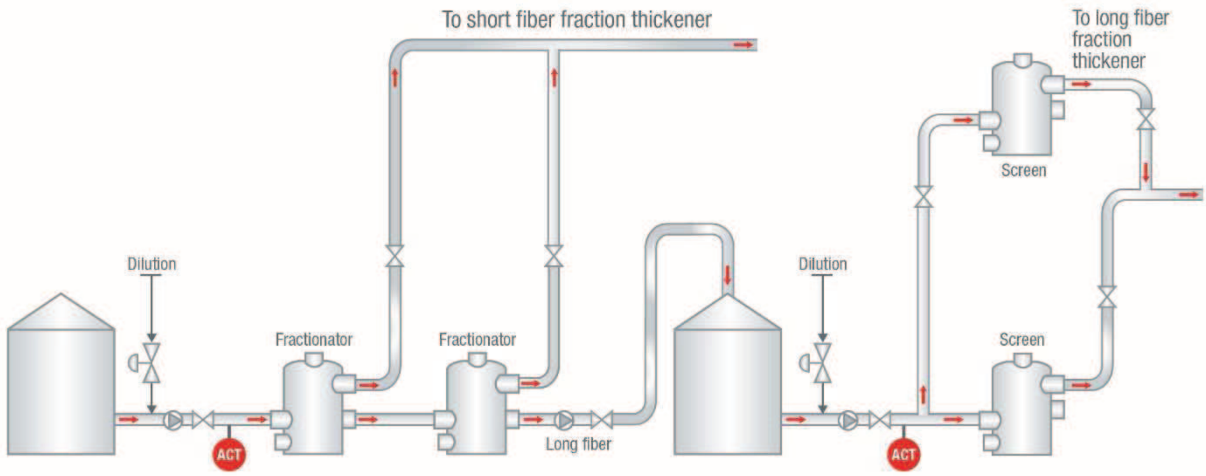

Fig. 5. A typical fiber fractionation instrument layout

More precise consistency control will improve the operation of many of the unit operations in a fibre fractionation plant. Fibre consistency and ash control audits can reveal where improvements in stability can be made in screening, cleaning, disc filter operation and dilution. These audits also measure long and short fibre separation, fines, and fibre morphology as well as process operating conditions.

For instance, screen feedstock consistency requires very tight control since it influences screen throughput and runnability (screen blinding) and can also determine the quality. An increase in consistency will increase throughput but can increase the risk of blinding. A large variability in consistency can upset the screen reject rate and cause disturbances to efficiency, fibre quality and freeness. In one case with variations in consistency of 0.9 %, the screens act as fractionators and unexpectedly remove long fibre from the process, resulting in lower efficiency and lower strength.

Conclusions

Strategically applied inline measurements within a recycled fibre operation can yield many benefits including stable product quality, even throughput, increased yield, lower furnish costs and lower chemical and bleaching costs for DIP. These measurements can form the basis of operator managed controls or simple single loop controls that are inexpensive to implement. The return on investment is excellent. Multi-variable controls (APCs) have shown promise as a way to control RCF plants – however, they must be based upon reliable and accurate process measurements of controlled and manipulated variables. The message is clear: a stable and efficient RCF operation must be well measured.