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Fines Management for Tissue Machines

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ABSTRACT

All tissue makers know that good quality and productivity depends upon good creping control, and that this in turn is highly influenced by good control of the Yankee coating. And yet the coating is often at the mercy of significant wet end influences, as described by several other workers in this field. In this paper, BTG will briefly review the theory of coating influence from the wet end and the methods proposed to mitigate it, with a focus on the role of fines in modifying the Yankee coating density. Based upon the well-known principle ‘you cannot measure what you cannot control’ BTG will propose that good control of the Yankee coating can be enhanced by introducing specialized precision wet end measurements. Alternative methods for laboratory determination of fines are reviewed and BTG will also describe in detail how on-line retention control has been applied to the tissue machine. The paper concludes with a number of successful tissue mill case histories, where on-line control has contributed to significant improvements in tissue machine performance via crepe ratio improvement and web break decrease.

INTRODUCTION

Control of the creping process is fundamental to both the productivity of the tissue machine and to the quality of the output. Often the creping process is defined by how well the Yankee coating layer is formed and maintained in a stable film with the correct adhesive and rheological properties for good creping. Once stability of the coating film is lost, it can be manifested in a number of ways:

Productivity:

- Web breaks
- Edge cracks leading to converting burst-outs
- High crepe ratio for low crepe efficiency
- Downtime for machine and clothing cleaning
- Chattermarks
- Regrind
- Quality

Clearly, control of the coating is of paramount importance to the tissue maker, and yet many important influencing factors are often neglected. Of course, selection of the correct chemicals for the grade and thermal condition is very important, and most vendors will give good advice on this. The design of the correct Yankee spraybar, for optimum spray coverage and correct evaporative loading on the Yankee is also important. But consider the fact that the applied Yankee coating chemicals only make up 0.5 to 1.0 % of the coating (Boudreau, 2009) and we quickly see that attention to the machine wet end is equally, if not even more important for good creping control. But many tissue makers pay too little attention to this important issue and thus their Yankee coating is often significantly influenced by factors they do not control, often with some of the results described above.

Three variable wet end parameters stand out as having a significant influence of the development of the Yankee coating film:
pH
The need for good pH control is understood by most mills. The pH will directly influence the rate of reaction, and consequently adhesive power, hardness and robustness of not only the applied Yankee coating, but also other coating components from the wet end, notably wet strength resin. A value of pH 7.0 to pH 7.5 is typically understood to be best practice. A high pH will give a harder coating, leading to loss of bulk and stretch, pinholes, high dust levels, increased crepe blade wear and is a known chatter initiator. Conversely, the coating film is less able to form at low pH, so Yankee protection is compromised, and sheet properties will deteriorate. An on-line pH probe is normally installed in the white water 1 (WW1) loop, and control is implemented with acid and alkali dosage or with dissolved CO₂ gas as an acid substitute.

IONIC DEMAND
Ionic demand or ‘charge’ is less often controlled, but also very important. The measurement is made of the soluble and colloidal charge, with laboratory and on-line instruments available. Charge will impact coating development, but also formation and drainage and the cleanliness of the press felt and its consequent performance. The correct range is less well defined than for pH, but all commentators agree that stability of the charge demand is critical. The wet end charge on a tissue machine is normally negative or anionic. Strongly anionic values will be associated with poor retention, fast-filling felts, and often hard, noisy coating, as well as side effects such as poor wet strength resin and starch efficiency. Weakly anionic values, close to the zero, or iso-electric point or even cationic WW1 values will be associated with thin, streaky coating, a floccy sheet, and high foam levels in the white water flume. Often they are an indication of overdose of cationic chemicals such as wet strength resin or softener. Sometimes the correct and stable charge demand can be achieved by laboratory measurements and careful balancing of the chemical dosages. Some mills have installed on-line measurement to cope with frequent grade changes or fluctuating furnish quality. The best systems use a thick stock sampler at the machine chest position to measure charge demand there, and dose a cationic fixative polymer to a set point; in many situations, a stable charge demand of -50 to -100 µEq/L will give good results.

FIRST PASS RETENTION
This is less frequently measured or controlled in tissue mills, yet poor or variable fines retention can have a devastating impact upon process efficiency and Yankee protection. With no retention agent present, the natural retention of a tissue machine may be around 50 to 60%. Thus we can have fines rich backwater, up to 1200mg/L, in the partially dewatered sheet as it impacts the Yankee. This will be in direct contact with the cationic polymer plasma which constitutes the Yankee coating at the press nip, and the anionic fines will have a natural affinity for this coating. Typically, we will see a hard white, often dusty coating, with significant Yankee edge build and noisy creping. Often the ability of the coating to generate soft tissue at a good crepe ratio is compromised by the poor fines retention on the machine wet end. Modern micro-particle retention aids and similar, which do not over-flocculate the thin tissue web, can improve tissue machine fines retention enough to over-come these issues. In fact is not so much retention which is important per se, but the value of the WW1 consistency. BTG’s experience is that values of 500mg/L or less will give fewer web breaks, improved doctor blade life, lower crepe ratio, and if measured, lower blade vibration and hence lower chatter risk. As with charge demand, it is also important that this value is stable and controlled; the key to this is good measurement technology of the fines rich WW1.

HOW TO MEASURE FINES CONTENT?
The weight percent fines content of a pulp suspension is traditionally taken out with a Britt Dynamic Drainage Jar following TAPPI Method. A sample of pulp is diluted to a certain consistency (0.1%) in order to enable efficient fractioning through a 200 mesh screen. With this screen opening (holes of 76µm diameter) only fines, go through the screen. After several dilution and drainage steps to enable all fines to go through the screen, the weight of remaining fibers is measured, and consequently fibers or fines content are calculated.

By considering fractionation, remaining fiber collection and drying steps, about 10-15 minutes are needed for
each measurement (without taking time of oven drying in account). Consequently a stock preparation survey with several sampling points may take easily 1 to 2 days.

A new relative method is now available with the Mütek™ DFR-05 (Drainage Freeness Retention) lab device. Thanks to an integrated automatic consistency measurement via optical sensor, fines consistency of the diluted sample is given quickly. Once sample is ready and DFR-05 calibrated, only 30 seconds are needed to get the result of fines consistency!

To measure the weight percent fines content of a pulp suspension, the following procedure is applied with DFR-05: first of all the optical consistency sensor must be calibrated following a process that takes about 30 minutes (and the time needed for drying in oven). Once the first step is accomplished, the DFR-05 is able to measure fines consistency accurately. The stirring vessel must be filled with a sample diluted to 0.1%. And then the following steps occur automatically: stirring at 750 rpm, screening, immediate consistency measurement of the filtrate and display of result.

Adding then time for vessel cleaning and drying in order to restart a new measurement, one measurement takes about 5 minutes (without waiting anymore for pulp drying in oven).

Despite there is no washout procedure using DFR-05, results obtained with the two methods are very well correlated (as shown in figure 1). DFR-05 results are consequently enough accurate for relative comparisons.

Furthermore, using the DFR-05 for fines content measurement is much easier and faster than the traditional method.

![Figure 1: Comparison of fines measurement with the DDJ vs. DFR-05](image)

**Figure 1: Comparison of fines measurement with the DDJ vs. DFR-05**
HOW TO TAKE BENEFITS OF THIS LAB MEASUREMENT?

By using DFR-05 method we are able to establish quickly fine fraction at different steps of the stock preparation process, and consequently the importance of their influence.

In the example shown in figure 2, fines content has been measured from pulp chests (short fibers, long fibers, broke, machine chests) to headbox and white water.

**Figure 2: Content of fines in % at various sampling points**

It is interesting to evaluate that fines creation at the finale refiner exists but is relatively limited (from 15.1 to 16.8%). Whereas white water contains mainly fines (92.8%), the headbox measurement shows the part of fines going on former.

A complementary calculation enables to evaluate the origins of fines: how much comes from the stock and how much comes from the white water (recirculating)?

**Figure 3: Contribution of fines from stock and white water in the headbox**
With 71% fines in the headbox coming from the recirculating white water, we are clearly in a case where fine retention should be improved, and down to maximum 50%.

In summary, the laboratory survey should indicate the main sources of fines into the system: native furnish, inappropriate (cutting) refining, or fines return from the disc filter or DAF unit. The technician should check both the absolute amount in the white water; if this is >90% fines and above 700ppm, it may well be problematic. Finally, a fines content in the headbox which is greater than 50% contribution for recirculating white water indicates a dangerous tendency for the fines to cycle up in the short loop. If this is happening, there is a strong case for further action.

MACHINE SIDE APPLICATION

The lab technique to make a fines balance in the system, whether by Britt DDJ or the automated Mütek™ DFR-05 from BTG will help the process engineer determine the need for a fines management strategy, and suitable application tactics, as both devices lend themselves well to laboratory evaluation of chemical treatments. Normally, the treatment is applied in the short loop, commonly between the fan pump and screen. Single component cationic emulsion retention aids and anionic micro-particle working as part of a two part system have both given excellent results on the tissue machine. The latter treatment works especially well on wet strength grades, where the wet strength resin itself forms the cationic co-factor.

The treatment is generally introduced slowly to avoid a sudden retention shock, and stabilized at the desired level; 600mg/L WW1 consistency would be a good starting point. In the most successful applications, maintaining a stable WW1 consistency has been a critical success factor. It is hardly practical to manually measure %FPR or even just WW1 consistency with the frequency needed to do this, so use on an on-line instrument is preferred. BTG would recommend their RET-5503 analyzer which is based around the same optical sensor platform as the DFR-05 laboratory instrument. RET-5503 actually has two light sources, laser and LED and can be calibrated to determine total and fines consistency in the white water loop.

CASE HISTORIES

In our first case we look at a crescent former operation, running virgin fibre and making mostly napkins and hanks. Their issues were excessive web breaks, slow grade transition and high crepe ratio. They wished to run high performance ceramic crepe doctors, but the performance benefits they might give were masked by the other process issues.

First pass retention was low and variable, in the range 50 to 60%, with WW1 as high as 900mg/L, especially after a web break, when broke was returned to the system, setting up a vicious cycle of new Yankee contamination and web breaks. Installation of a retention aid polymer and RET-5503 on-line control was agreed, and the results closely monitored. In fact web breaks decreased by 40%, crepe ratio was reduced and ceramic blades could be used to their full potential. The net impact was a 2% improvement in machine efficiency, and a project return of less than four months payback time for the capital investment.
Our second case concerns an older twin wire tissue machine, running mostly toilet and premium toilet grades, with a mix of virgin and de-inked pulp furnish. This machine had multiple issues: very high crepe ratio, excessive web breaks, high consumption of high performance crepe doctor blades to name but a few. All this impacted significantly upon machine efficiency.

Following extensive surveys, BTG proposed a suite of operational and process chemical improvements, backed up by significant instrument investment to upgrade this older production asset. This included installation of an automated retention system, using a cationic emulsion polymer suited to the mostly toilet grades. The previously high WW1 consistency of 1200mg/L was stabilized to 600 and then 500 mg/L. The impact was clearly visible on the Yankee and in press fabric performance and overall system cleanliness. The project results on the agreed KPI’s were mostly positive: reduced crepe ratio on two out of three grades, web breaks reduced by 33%, blade life improved by 60%, itself a major cost saving.

![Figure 4: RET-5503 analyzer installed in a European tissue mill](image)

![Figure 5: Results on twin wire machine before and after retention control](image)
CONCLUSION

For tissue makers looking to improve directly the machine performance in terms of productivity, quality and efficiency, wet end process control is an essential requirement. Control of pH is mostly well understood and many mills have studied charge demand control.

The importance of determining the fines balance on the tissue machine has been less well understood, despite several excellent publications in recent years on this subject. This may have been due to the difficulty of determining the true fines map of the mill. The traditional TAPPI standard method for measuring tissue machine fines is accurate but very time consuming and needs a high level of technician skill. New automated systems, such as the DFR-05 from BTG allow quick access to this important data, and can help a process engineer quickly determine if further intervention is needed.

The introduction of new retention polymers tailored for the light tissue web, plus accurate on-line control systems then gives the tissue machine process engineer new options for stabilizing the wet end influence on their Yankee coating. The installation of both chemical system and instrument control is straightforward, and the relatively low investment required, and easily measured productivity improvements resulting, means the payback time is normally quite short.

Further information on developing a fines management strategy for your machine is available from the authors or from www.btg.com.

REFERENCES


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