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Fourdrinier drainage performance evaluation – blow test method

Scope

This Technical Information Paper provides guidelines for evaluating fourdrinier performance by blowing stock samples off the forming fabric and catching them for measurement and analysis. Most paper machine clothing companies and drainage equipment suppliers currently use total mass sensors to monitor fourdrinier drainage performance. The guidelines for this method are described in TAPPI TIP 0502-12. However, not all mills have access to this equipment and the procedure described here permits analysis of filler content and chemical additive performance. The procedure described permits study of formation rate and retention distribution over all equipment on the fourdrinier section. It can also be used to compare forming rates for different fourdrinier equipment, furnishes, chemical additives and refining methods. The method used is a mass balance using consistency and ash determinations combined with mass throughput based on reel production data.

Safety precautions

All applicable safety procedures for working around the wet end of a paper machine must be followed. These include standard safety provisions and specific safety regulations required by the mill. The procedure section suggests tying a rope on the catch container to avoid potential damage to the paper machine. The rope should be hand-held and not tied to the sample catcher's person so if the container gets loose, the sample catcher will not get pulled into the machine.

Content

Sampling procedure

Stock samples are taken from the headbox, fourdrinier collection trays, and areas on the forming table that are accessible. Slurry samples of the paper web traveling on top of the forming fabric are obtained by using a pipe with a slot in the end held beneath the wire that uses compressed air to blow slurry off the top of the fabric. The slurry is normally caught in a hand-held plastic or metal container. It is a good idea to secure the container with a rope in case it slips out of the hand of the holder. As noted in the safety section above, the rope should not be tied to the sample catcher person. Stock samples should be taken 12 – 18 in. (31 – 47 cm) inside the fabric edge to avoid edge effects from deckles and headbox cheeking pieces. A long handle dipper is often used to obtain samples in difficult to reach locations.

Blowing samples from the forming fabric normally causes a sheet break on the paper machine. Fourdrinier drainage sampling is normally planned ahead of a scheduled machine shutdown. Samples that can be obtained without breaking the sheet should be gathered before samples are blown from the forming fabric. On machines with a pick-up press section, the pick-up roll should be raised prior to beginning of sampling of the fourdrinier to prevent damage to press clothing or rolls. Sampling should begin at the couch and work back towards the headbox to

minimize equilibrium changes due to upsets in the whitewater system after the sheet breaks. One-quart (liter) plastic freezer containers are typically used for storing samples prior to analysis. The containers must be air tight to preserve consistency samples for laboratory analysis.

The hose supplying the air wand used for blowing samples from the fabric should be equipped with a quarter turn ball valve to permit air flow regulation. Airflow needs to be adjusted based on paper machine speed and basis weight to get a clean sample. In some cases, it may be necessary to use a plastic block with a slot on the topside attached to the end of the blowpipe. The block is shaped with a flat top and angled front to act as a foil. The block can be put against the fabric to aid in blowing a clean sample on heavy basis weights or when available air pressure is low.

Testing

Consistency and percent ash determinations are required for each sample taken from the forming fabric, headbox, and white water return system. Flow of dry material through the forming section is necessary and can be obtained from reel samples. Consistency and ash determinations should be performed according to TAPPI T 240 “Consistency (Concentration) of Pulp Suspensions” and TAPPI T 211 “Ash in Wood and Pulp.” Accuracy of the method depends on accuracy of consistency determination and ash sample analysis and basis weight, moisture content, and reel speed.

Calculations

A material balance around the table must be performed to determine flow rates down the table. Boundaries of the balance must be established. Boundaries can be over individual drainage elements, several drainage elements, or the whole fourdrinier. Where balances across several individual drainage elements are desired, calculations using as many of the described equations that follow are required before proceeding to the next drainage element upstream. Summation of the results of all individual drainage elements defines overall operation of the fourdrinier. Only one solution cycle of the equations is required if a simple balance of the fourdrinier is desired. However this will not provide an insight of how drainage occurs on the forming table.

Definitions of Terms and Symbols

S = Solids, lb/min (kg/min)

P = Filler, lb/min (kg/min)

F = Fiber, lb/min (kg/min)

T = Total Solids and Water Combined, lb/min (kg/min)

W = Water, lb/min (kg/min)

G = Water, US gallons/min (L/min)

C = Consistency, lb Solids / lb Solids + lb Water [kg Solids / kg Solids + kg Water]

A = Sheet Ash, lb Ash / lb Solids [kg Ash / kg Solids]

I = Ignition factor, if appropriate

% SRT = % Solids retained by the element

LN = Line number or element number

Numbers used as subscripts:

- 1) Material leaving the boundary area on wire
- 2) Material composing the effluent from the boundary area through wire
- 3) Material entering the boundary area on wire

The basic mathematical relationship for this procedure is obtained by applying material balances for both solids (S) and total material (T) as follows:

$$S_3 = S_2 + S_1$$

and

$$S_3 / C_3 = S_2 / C_2 + S_1 / C_1$$

Since C_1 , C_2 and C_3 are determined in the laboratory from samples and S_1 is obtained from either reel production or calculated previously from the element located downstream, the equations can be solved for S_2 and S_3 . Laboratory analysis data then allows calculation of the mass flows of filler (P), fiber (F), combined solids and water (T), water (W) and the volume flow (G).

Calculation method

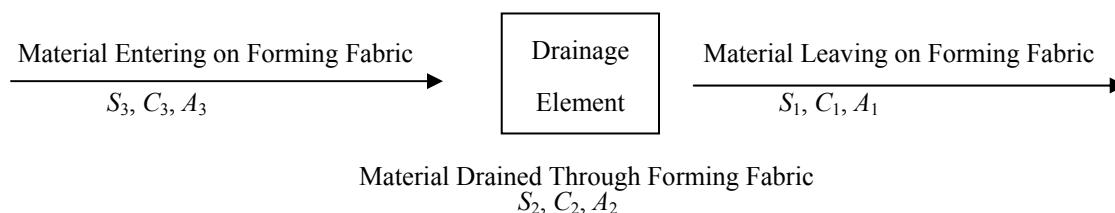
Total reel production is calculated as follows:

$$\text{Total reel production (lbs/min)} = \text{Basis Wt. (lb/ft}^2\text{)} \times \text{Reel Speed (ft/min)} \times \text{Reel Trim (ft)} \times \text{O.D. Solids at Reel (lb, dry material/lb total)}$$

$$\text{Total reel production (kg/min)} = \text{Basis Wt. (g/m}^2\text{)} \times (1 \text{ kg/1000 g}) \times \text{Reel Speed (m/min)} \times \text{Reel Trim (m)} \times \text{O.D. Solids at Reel (kg dry material/kg total)}$$

Material balance relationship

The material balance relationship of the element is schematically represented as follows:



Wet end basis weight must be obtained by deducting size press or on-machine coater pick up, if any, from reel basis weight.

Correct reel production by wet end trim to get S_1

- 1) $S_1 = \text{Reel Production (lb/min)} \times \text{Sheet Width on Forming Fabric (in.)} / \text{Sheet Width into Press Section (in.)}$
- 1) $S_1 = \text{Reel Production (kg/min)} \times \text{Sheet Width on Forming Fabric (m)} / \text{Sheet Width into Press Section (m)}$

With S_1 and laboratory analyses as input, the following are calculated:

- 2) $S_2 = S_1 C_2 (C_1 - C_3) / C_1 (C_3 - C_2)$
- 3) $P_2 = S_2 \times A_2 \times I$
- 4) $F_2 = S_2 - P_2$
- 5) $T_2 = S_2 / C_2$
- 6) $W_2 = T_2 - S_2$
- 7) $G_2 = T_2 / 8.34$ [gpm], if units are lb/min or $G_2 = T_2$ [l/min], if T_2 are kg/min
- 8) $S_3 = S_1 + S_2$
- 9) $P_3 = S_3 \times A_3 \times I$
- 10) $F_3 = S_3 - P_3$
- 11) $T_3 = S_3 / C_3$
- 12) $W_3 = T_3 - S_3$
- 13) $G_3 = T_3 / 8.34$ [gpm], if T_3 units are lb/min or $G_3 = T_3$ [L/min], if T_3 units are kg/min
- 14) $\% \text{ SRT} = S_1 / S_3 \text{ (Final)} \times 100$