6

Paper Analysis and Testing for Paper Machine Clothing Optimization

This chapter describes paper testing that may be performed by paper machine clothing suppliers. The testing is done to provide data for optimizing paper machine clothing performance.

The paper testing provides insight into three categories:

- Paper components: Fibers, fines, ash (inorganic filler)
- Sheet surface and the impact on printing
- Sheet make up in the Z-direction

6.1 Paper Components

6.1.1 Fiber Analysis

Fiber analysis is done to guide the selection of the optimum fabric yarn count in the machine and cross machine directions, the weave design, and the fabric open areas for producing the best sheet characteristics.

FQA/Kajaani

The Fiber Quality Analyzer (FQA) is an optical device which incorporates a special flow cell to orient fibers along the flow axis. The fibers are illuminated by circularly polarized light (Figure 6.1) and a high-speed camera captures the images at high magnification. Image analysis algorithms isolate individual fibers to measure their size and shape characteristics. A typical analysis measures 5000 fibers and is presented as a frequency histogram of fiber characteristics.

FIGURE 6.1. Fiber Quality Analyzer.

Length, Kink, Curl

Individual fibers are described by several characteristic measurements: length, kink, and curl.

- Length: True contour length of a fiber. It can be expressed in several ways:
  - Arithmetic average - presence of fines will significantly affect this value.
  - Length-weighted average - fines do not significantly affect this value.
  - Weight-weighted average - longer fibers will significantly affect this value.

- Kink: The weighted average of four angle ranges characterizing abrupt changes in fiber curvature.
- Curl: The ratio of fiber length to the projected end-to-end length.

Extensive AstenJohnson fiber length analyses of headbox samples have shown that, averaging all paper grades, 65% or more of the fibers are less than 0.40 mm long. See Figure 2.60 for information by paper grade.

Impact of Mesh and OA (Open Area) on Retention and Drainage

Initial fiber mat buildup occurs when individual fibers are trapped by the forming fabric mesh. The paper support surface must have a mesh that is fine enough to trap fibers, but also open enough to allow the water to drain through and out the bottom side.

Figure 6.2 shows three different forming fabrics with the highlighted frame openings in the top surface showing a 0.40 mm length fiber. The size and shape of the openings will determine how well the initial fibers are retained.

Fibers exiting the headbox have a predominantly MD orientation. Therefore, the MD length of each frame is important in determining the trapping efficiency of the fabric surface. Smaller MD frame lengths will result in better fiber retention and a more uniform sheet structure. The small uniform frame openings of the SSB triple-layer provide the best fiber support while still providing adequate drainage area.

Effect of Paper Grade on Drainage Resistance

The fibers used for different paper grades have different drainage properties. Compared to printing paper, linerboard and tissue paper normally have lower drainage resistance. Mechanical pulp fibers normally have higher drainage resistance because there are more fines and fibrillated fibers in mechanical pulp. Figure 6.3 shows the measured drainage resistance of different paper grades when a single-layer design forming fabric (under one, over three) is used.

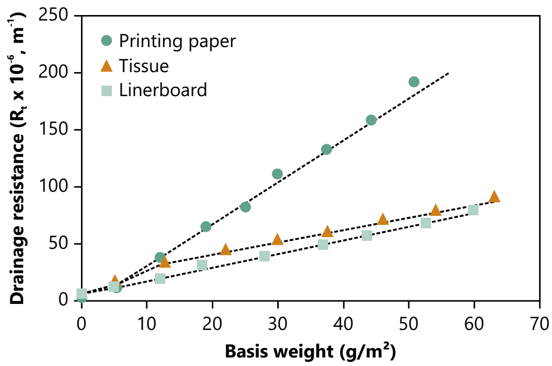


FIGURE 6.3. Drainage resistance of different paper grades.

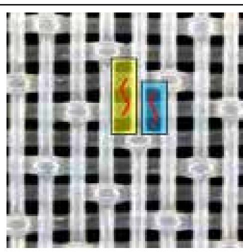
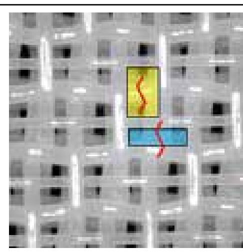
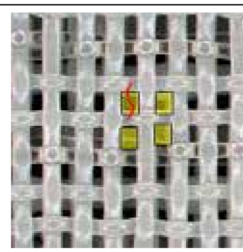
	Single-Layer	Extra Support Double-Layer	SSB Triple-Layer
			
Mesh	70 x 80	150 x 80	72 x 80
Yarn Diameters (mm)	0.15 x 0.17	0.17 x 0.20/0.13	0.13 x 0.13
% Drainage Area	43	39	34
Holes / in²	2800	2570	5760
Max. MD Frame Length (mm)	0.78	0.50	0.17

FIGURE 6.2. Forming fabric design and frame length.

Effect of Fiber Length and Fine Content on Drainage Resistance

Fibers used for papermaking are normally refined to different degrees. After refining, fibers become shorter and there will be more fines in the stock. Figure 6.4 (a) and (b) shows how fiber cutting with a blender can affect the drainage resistance of printing paper (a) and linerboard (b). With increased cutting time, fibers become shorter and drainage resistance goes up accordingly.

6.1.2 Fines Analysis

Fines are defined as all furnish components, both fiber and filler, that will pass through a 200-mesh screen (<76 microns). It is important to understand the percentage of fines contained within incoming furnish and how they are managed through the process:

- They hinder drainage.
- They reduce chemical strength efficiency.

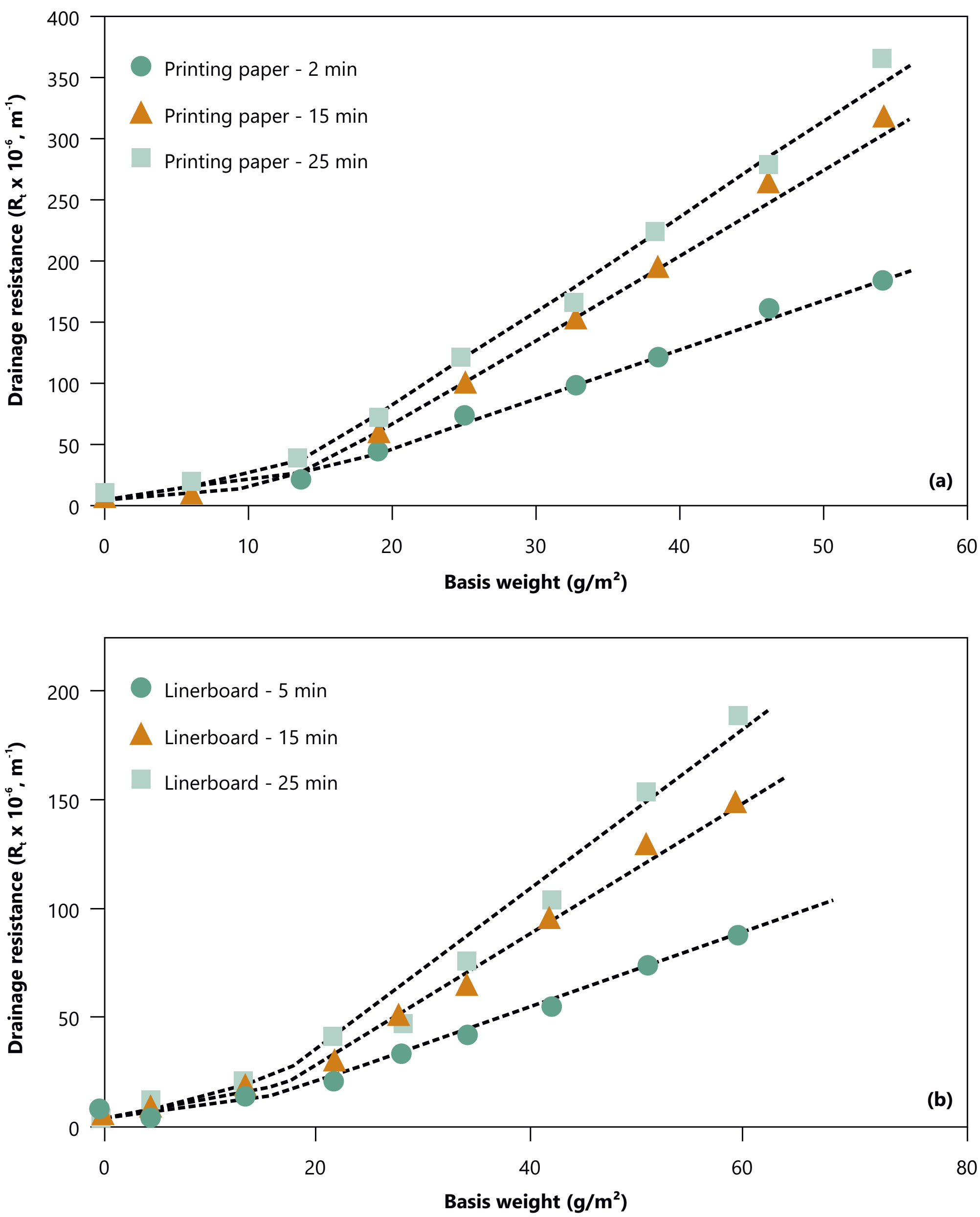


FIGURE 6.4. Drainage resistance of the fibers after cutting for different length of time; (a) Printing paper, (b) Linerboard.