Flow Sheets 101

Executive Summary

The purpose of the traditional headbox flow sheet is multifold. Basic functions of headboxes will be discussed.

This paper will touch on the three types of flow sheet geometry: tapered, bullet, and blunt. Also discussed will be headbox flow sheet materials as well as improvements that can be expected from each. Specifically, the Valmet Headbox Sheets family of flow sheets will be described.
Headbox and Flow Sheet Overview

The basic functions of the headbox are to:
- Convert from CD pipe stock flow to a uniform MD flow
- Maintain fiber suspension, dispersion & jet turbulence level
- Establish paper properties (formation, fiber orientation, MD/CD tensile ratio, etc)

Most headboxes in use today were manufactured by a small number of original companies, including Valmet/Valmet, Beloit / MHI, etc. Regardless of OEM, most headboxes share a common purpose and thus their design includes many similar elements, as seen in Figure 1.

The purpose of the traditional headbox flow sheet is multifold. First, they reduce the scale of turbulence from the tube bank to the nozzle. Second, they induce micro-turbulence into the flow, in order to adjust the tensile ratio and improve visual paper/board properties such as formation. In cases of stratified headboxes, they are used to separate plies.

Flow Sheet Geometry

Sheets typically range from 19” to 32” in MD length with a base sheet thickness of 0.04” to 0.12”. This length, combined with the tip style, gives them specific control over both turbulence intensity and scale. For example, a shorter sheet provides low turbulence intensity and high turbulence scale.
Tip styles fall into three main categories:
- Tapered - one sheet side tapers to a point at the end, either continuously from the hinge or starting within 6” of the end
- Bullet - both sheet sides taper to a point at the end, taper starting near the tip
- Blunt - no taper, sheet thickness is continuous for the entire length of the sheet

As mentioned above, the tip style plays a large part in the resulting effect on headbox flow. A sheet with a blunt tip, for example, yields higher turbulence intensity and larger turbulence scale.

**Maximize Product Quality**

Optimizing conventional sheets can be a sensitive, fine adjustment that depends on many parameters, including furnish, rush/drag ratio, flow rate, slice opening and more. This takes significant process knowledge, such as that demonstrated by Valmet headbox experts.

Flow sheets are critical elements in the performance of a headbox. It’s imperative that they are manufactured to exacting tolerances of straightness, flatness and smoothness to insure that their contribution to product quality and efficiency is maintained.

Valmet Headbox Sheet PC (formerly known as PolySheet) (Figure 2) and Valmet Headbox Sheet CF (formerly known as DuraSheet) are recognized as the most widely used headbox flow sheets in the industry. Their proven performance is a significant contribution to product quality and efficiency. Valmet Headbox Sheets PVC and PVC-C (formerly known as ChloriSheet and EasySheet) are more recently developed headbox flow sheets that have proven themselves in specific grade applications.

The benefits of Valmet headbox flow sheets are many, and depend on the sheet chosen and the application. However all Valmet sheets will provide the following improvements:
- Improved sheet formation
- More uniform caliper
- Enhanced edge properties
- Improved CD basis weight uniformity

**Flow Sheet Materials**

Valmet’s supply of headbox flow sheets utilizes its technological know-how with over 40 years of Beloit OEM experience in providing this product. The combined experience now results in four proven flow sheet materials to choose from: PC, CF, PVC and PVC-C (Table 1, next page).
Valmet Headbox Sheet PC and CF are the most widely used flow sheet materials. Headbox Sheet CF is a composite material upgrade with improved design features. It does not have to be removed from the headbox for boil out, and has a longer life expectancy (3-5 years). Headbox Sheet PVC provides good chemical resistance for use in certain paper and board applications. Headbox Sheet PVC-C is an improved version of Headbox Sheet PVC that offers good chemical resistance combined with good thermal capacity. Each sheet is available in various hinge types and thickness (Table 2).

<table>
<thead>
<tr>
<th>Hinge types</th>
<th>Available materials</th>
<th>Available sheet thicknesses</th>
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</thead>
<tbody>
<tr>
<td>OptiFlo, SymFlo</td>
<td>PC, PVC, PVC-C, CF</td>
<td>.120” (3 mm)</td>
</tr>
<tr>
<td>Converflo, BelBaie, Twin wire former</td>
<td>PC, CF</td>
<td>.040”, .080”, .120” (1 mm, 2 mm, 3 mm)</td>
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<tr>
<td>Converflo</td>
<td>PC</td>
<td>.040”, .080”, .120” (1 mm, 2 mm, 3 mm)</td>
</tr>
<tr>
<td>Thin channel or Concept III</td>
<td>PC, CF</td>
<td>.040”, .080”, .120” (1 mm, 2 mm, 3 mm)</td>
</tr>
<tr>
<td>Concept IV BelBaie</td>
<td>PC, CF</td>
<td>.120” (3 mm)</td>
</tr>
<tr>
<td>OptiFlo, SymFlo</td>
<td>Wedge CF (Figure 3)</td>
<td>Tapered</td>
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<tr>
<td>OptiFlo, SymFlo</td>
<td>DuraVane</td>
<td>Tapered</td>
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Table 2. Available sheet types and designs
Valmet Headbox Sheet CF unique properties reduce costs

Valmet Headbox Sheet CF is made of hard-wearing composite carbon-fiber material which has unique and long lasting properties. Special composite material and design deliver a stiff but flexible and thermo-stable sheet with excellent surface smoothness and chemical resistance. The Headbox Sheet CF products do not need to be removed from the headbox for boilout, and have a long life expectancy, with proper handling practices often exceeding 5 years.

Also, Valmet has the capability to repair sheets, which, in the case of the high technology / high ROI CF sheets, can give mill staff peace of mind while saving them money.

Valmet Headbox Wedge CF and DuraVane

Valmet Headbox Wedge CF (Figure 3, formerly known as DuraWedge) is specially designed for OptiFlo II, OptiFlo Pro and ValFlo Pro headboxes. It features innovative composite wedge technology that improves control over the scale and intensity of headbox flow turbulence. It also enhances the hydraulic performance of the headbox and eliminates the need for adjustable sheets. Its innovative wedge is the first and only carbon-fiber headbox wedge in the world. Its mechanical strength and stiffness are superior compared to polymeric (plastic) headbox sheet materials.

Dividing turbulence vanes are an integral part in the delivery of good headbox performance. DuraVane (Figure 3) technology is available for improving all Valmet and Beloit tissue and towel headbox applications. DuraVane provides good formation and layer purity, which in turn provides good quality at lower basis weight. DuraVanes are made of hard-wearing composite carbon-fiber material which have unique and long-lasting properties. Special composite material and design deliver a stiff but flexible and thermo-stable vane with excellent surface smoothness and chemical resistance. DuraVane does not need to be removed from the headbox for boilout, and has a long life expectancy, often exceeding 5 years.

Headbox flow sheets are an important tool mounted in the headbox nozzle to help produce a uniform flow from the headbox slice into the forming section. Most importantly, the flow sheets have a significant impact on the end product quality, affecting overall paper machine productivity.

This white paper combines technical information obtained from Valmet personnel and published Valmet articles and papers.

Valmet provides competitive technologies and services to the pulp, energy and paper industries. Valmet's pulp, paper and power professionals specialize in processes, machinery, equipment, services, paper machine clothing and filter fabrics. Our offering and experience cover the entire process life cycle including new production lines, rebuilds and services.

We are committed to moving our customers' performance forward.