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Water permeability of press fabrics

Scope

This TIP describes the methods and procedure for the measurement of press fabric permeability to water. The method is suitable for the evaluation of fabrics on the run, without interrupting the operation of the paper machine. This technique could be used to follow changes in fabric permeability, which occurs during fabric life. The method can be used to measure the cross direction (CD) permeability profile and machine direction permeability variation as well as identify localized areas of high or low permeability. Felt permeability data can be used to identify and optimize operating parameters such as felt life, felt cleaning procedures, press dewatering, nature and frequency of chemical cleaning, or electrical power to drive vacuum pumps and presses.

Safety precautions

The fabric permeability tester is designed for use on an operating machine. If using a hand-held instrument, the operator should take standard safety precautions, to prevent entanglement of his clothes or the instrument and its accessories into the moving parts of the paper machine. If the instrument is alimented by a water hose, the instrument operator should have an assistant to take care of the loose end of the flexible hose. For some instruments, water for the measurement is supplied from an air-pressurized container carried by the operator as a backpack or on the belt. A portable water source makes the measurement simpler, as it eliminates the use of water hoses. The water tank, however, requires frequent refills and might be heavy and awkward to carry in narrow catwalks or other crowded areas. If the operator carries a pressurised water tank, care must be taken to avoid contacting any moving machine parts.

Background

To receive water escaping from the compressed web in a press nip, the press fabric must remain permeable to water, even when compressed. Repeated compressions in the press nip eventually compacts the fabric, and substances such as pitch, fines, and fillers fill the void space within the fabric structure. Therefore, water permeability of the press fabric gradually diminishes to the point that water removal from the fabric cannot readily escape into grooves or drilled holes of the press roll, during the short time the fabric spends in the press nip. A high hydraulic pressure, which is created in the press nip under these conditions, can result in sheet crushing, vibration, and inadequate water removal from the web. The poor water removal and irregular CD profile in water permeability caused by fabric filling, compaction or wear are primary reasons for the removal of press fabrics.

Several other TIPs describe measurement of properties, which can influence the performance of press fabrics. In particular, TIP 0404-34 “Wet Felt Void Volume” provides a procedure for the determination of the void remaining in the fabric at a given pressure. This method is not intended for operating fabrics, as it is carried out in the laboratory on small samples cut out of a new or used fabric. The void volume of the compressed fabric is useful information, but it does not necessarily correlate with its permeability to water.

TIP 0404-29 “Porosity Measurement of Press Felts on the Paper Machine (HSPT)” describes a method for the measurement of fabric permeability to air. This method can be used on-the-run, and is suitable for the determination of CD profiles and is often used in mills as a part of the fabric evaluation program. However, the permeability to air under vacuum, as measured with the air permeability tester does not necessarily correlate with

the permeability of a compressed fabric to water. For example, TIP 0404-20 "Characterization of Wet Felts" states: "It should be recognized that similar net results can be obtained on drastically different felt constructions. Air permeability results should not be used without consideration of other parameters." Also "the correlation of press felt air permeability to performance on the paper machine has not been established."

The TIPs related to press fabrics also include TIP 0404-21 "Felt Record Book"; TIP 0404-26 "Paper Machine Clothing Performance Analysis"; TIP 0404-28 "Method for Evaluating Thickness of Wet Press Fabrics"; and TIP 0404-32 "Felt Uniformity Impression Method." The objective of this TIP is to provide a fabric permeability test, the result of which would be closely related to the fabric permeability in a press nip.

Significance

Data on water permeability of press fabrics can be used to identify the fabric type suitable for a given grade, machine type, and press characteristics. Results of regular measurements during the life of the fabric can be used to optimize fabric cleaning practice such as pressure and flow rate in fan showers, frequency of application, and duration of cleaning by needle showers, vacuum level in fabric suction boxes, and the type, frequency, and duration of chemical cleaning (1, 2). Water permeability of press fabrics could also be used to determine the optimum time for fabric replacement.

Principle

Fabric permeability is defined as the capacity of a fabric to permit water to pass through it under specified conditions. Water flow rate can be calculated according to Darcy's equation:

$$dv/dt = (K/L)(AP/\mu)$$

where:

dv/dt = water flow rate
 K = a constant characterizing a fabric
 L = fabric thickness
 A = area of nozzle cross section
 P = water pressure
 μ = water viscosity

Darcy's constant, K , and thickness, L , of a fabric operating on a paper machine are gradually changing, which results in a lower permeability to water. The method is based on injecting water into the paper side of the press fabric (Fig. 1). The water flow rate is proportional to water pressure and nozzle cross section area, and inversely proportional to water viscosity and fabric thickness. If the type of nozzle, water pressure, and viscosity are kept constant, the water flow rate can be used as a characteristic of fabric permeability (1). Alternatively, if the water flow is kept at constant rate water pressure is indirectly proportional to the fabric permeability.

Apparatus

The hand-held instrument (Fig. 2) accepts filtered water which travels through a pressure regulator and a flow sensor into a special nozzle from which it is injected into the fabric. The mechanical pressure of the nozzle and the water pressure compress the fabric batt at the point of water injection. The signal from the flow sensor is sent to a built-in computer where it is conditioned and displayed. Powered by rechargeable batteries, the measuring head is a self-contained unit, which requires water supply at a pressure ranging from 0.33 MPa (50 psi) to 1.00 MPa (150 psi).

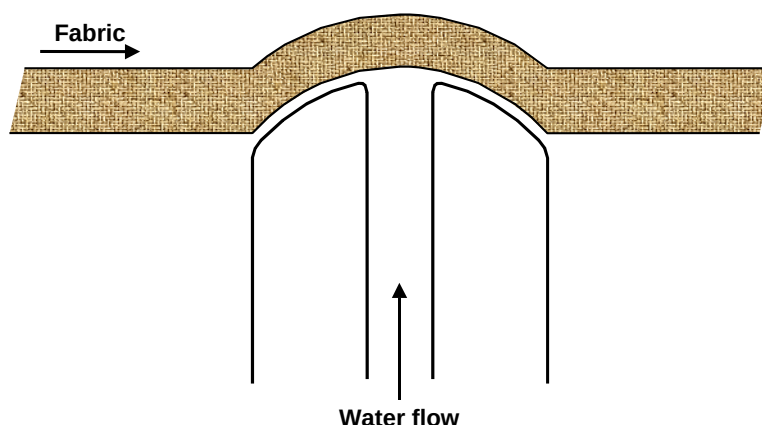


Fig. 1. Water flow from the nozzle into the fabric.

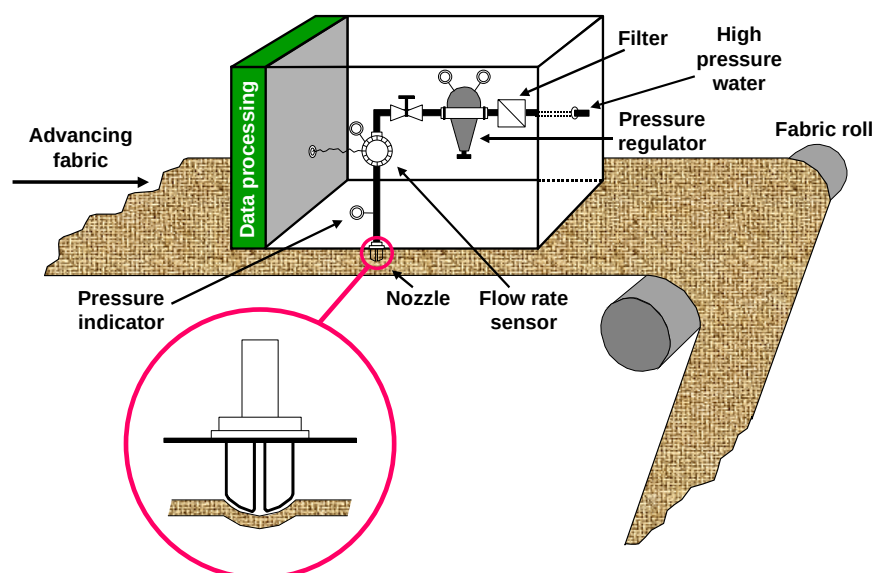


Fig. 2. Instrument for measuring the water permeability of press fabrics.

The measurement can be carried out on a moving fabric, and is rather insensitive to fabric speed in a range of 400 to 2000 m/min (1270 to 6400 ft/min). While fabric speed has little effect on the instrument reading, measurement on a stationary fabric would give incorrect results. The measurement should be performed only on the sheet side of the fabric.

Although the viscosity of water varies significantly with its temperature, experiments have shown that the results are influenced little by water temperature in the range of 23° to 80°C (1). These results were interpreted by the large mass and thermal capacity of the press fabric when compared with the small incoming water jet. The commercial instrument can use water with a temperature up to 50°C.

Compared with the methods, which measure fabric permeability to air, the present method has several advantages. It measures the permeability under conditions, which resemble those found in a press nip. While air permeability results might be influenced by fabric moisture, the present method yields results independent of press fabric moisture. Consequently, some heavy basis weight fabrics, which have low permeability to air, are found to have adequate permeability to water. Since press fabric permeability to water is insensitive to fabric moisture content (1) the measurement can be carried out at any point along the fabric loop where the fabric is not in contact with the wet paper. For example, similar readings are obtained on either side of a press fabric shower or a suction box.