

TIP 0404-27

OLD TIS NUMBER 014-55

ISSUED - 1983

REVISED – 1995

WITHDRAWN – 2002

REVISED, TITLE CHANGED, AND REINSTATED – 2006

REVISED – 2013

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Press fabric dewatering and conditioning – suction box (Uhle box) design and vacuum requirements

Scope

Design considerations for dewatering press fabrics to permit selection of slot widths, Uhle box sizing and determination of vacuum requirements are discussed in this TIP. Recommended vacuum factors are provided for calculation of Uhle box vacuum capacity. System design considerations for piping, separation and vacuum equipment are included.

Note: this TIP revision included the partial deletion of press fabric showering recommendations. Showers are discussed in TIP 0404-61 “Paper Machine Shower Recommendations.”

Safety precautions

Follow normal safety precautions when working around paper machinery including use of personal protective equipment such as eye and hearing protection, safety shoes, and safety helmets where required. Loose clothing and equipment must not contact rotating machinery or ropes. Beware of overhead cranes and thermal or slip hazards. Avoid direct contact with hot surfaces.

Introduction

The use of modern press fabrics on paper machines requires proper conditioning and cleaning to maximize machine productivity and minimize operating expense. Fabrics are conditioned to promote dewatering, consistent sheet surface quality, and CD moisture profile management. Uniform sheet profiles can result from proper fabric cleaning and dewatering. These items complement each other because good fabric cleaning requires good fabric dewatering. To properly clean a fabric, any contaminants (cellulose fines, fillers, stickies, wax, etc.) contained in the fabric and batt structure must be dislodged and flushed from the system. Press fabric cleaning is a mechanical and chemical process where showering and Uhle boxes provide the mechanical components and chemical detergents or solvents are used to break bonds between the fabric and contaminants or completely dissolve contaminants. Typically contaminants are dislodged by high pressure showers and/or chemicals applied by showers. Removing contaminants from fabrics requires uniform distribution of water to convey contaminants to the vacuum slot(s). Sufficient dwell time of the fabric over vacuum slot(s) must be combined with correct vacuum induced airflow to adequately dewater a press fabric.

The objective of this Technical Information Paper (TIP) is to provide guidelines for selection of suction box covers, suction box size, and system design basics. Vacuum factors are included to permit vacuum pump sizing.

TIP Category: Automatically periodically Reviewed (5 years)



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Conversion factors

Multiply	by	to obtain
in	25.4	mm
in	2.54	cm
in	0.0254	m
ft/min	0.305	m/min
ft ³ /min	1.669	m ³ /hr
ft ³ /min/in. ²	0.263	m ³ /hr/cm ²
in Hg (“Hg)	3.39	kPa

1. Factors affecting dewatering - dwell time and slot width

The first step in determining Uhle box slot size, Uhle box diameter or vacuum pump selection requires selection of dwell time. Dwell time is the length of time a given point on the fabric is exposed to vacuum over the Uhle box slot (s). Recommended dwell time is 2 to 4 milliseconds (ms). This allows time for airflow to be established through the fabric and remove water and contaminants. Dwell times above 4 ms are not required or recommended because excessive dwell time requires oversize vacuum piping, vacuum pumps and other related equipment.

A suggested approach is to use a single suction box with 2 to 4 ms dwell time unless a single box does not provide adequate fabric dewatering and cleaning. Multiple boxes may be required on some early press positions but are normally not required on later presses where there the fabrics handle less water volume and can become less contaminated.

Dwell time is more critical for early press nips where uhle box dewatering is emphasized and where there are significantly larger volumes of water to remove. Dwell time is less critical in later nips where less water is removed. In these nips minimizing lubrication water volume to the amount required to prevent felt surface wear is important. Uhle dewatering volumes are low because felt designs will be denser with finer batt capping layers. Excess lubrication water can lead to increased rewet.

Note that lube showers are optimally designed to apply water between the fabric and Uhle box surface. Because water takes a finite amount of time to enter a fabric, lubrication water should be applied to the fabric surface as close as the Uhle box as possible to minimize penetration. This water is taken into the first Uhle box slot to which it is exposed. Lubrication for subsequent surfaces depends on water removed by the preceding slot. If lubrication water is improperly applied, if too much water is applied, or if the water is put on the fabric too early, fabric conditioning may be compromised. If that happens between Uhle boxes on a multiple box installation, dwell time may not be strictly additive because of the extra water introduced into the fabric by the improperly operating lube shower.

Tissue machines and higher speed paper machines (>5000 fpm) are an exception to the 2–4 millisecond dwell time “standard.” Many tissue machines operate well with 1.0–1.5 ms of Uhle box dwell time. This is because fabrics on tissue machines often operate at much higher moisture levels than on paper and board paper machines and high speeds run on some tissue machines would require very wide slots to achieve 2-4 ms dwell time.

The following formulas are used to determine dwell time and slot widths.

$$\text{Slot Width (in)} = \text{Dwell Time (s)} \times \text{Machine Speed (ft/min)} \div 5$$

Example A - To determine the slot width with 2 ms dwell time with a machine speed of 2500 ft/min:

$$\text{Slot width (in)} = 0.002 \text{ s} \times 2500 \text{ ft/min} \div 5 = 1.0 \text{ in}$$