Cleaning Guidelines

Introduction
The goal of this paper is to offer a general guideline pertaining to shower usage for cleaning forming fabrics. Specific showering recommendations may vary from this guideline and can be reviewed with your Albany International sales/service representative.

In order to come to as good as possible guideline we not only compare our own experiences, but also looked to the guidelines of other sources such as suppliers from nozzles and other cleaning equipment.

Although we know the Imperial system is still adapted in large parts of the world, we have chosen to only use metric units in this paper.

Principals
There are three major methods to clean a forming fabric while running on a paper machine. These methods are:

- Chemical
- Mechanical (showering)
- Anti-contaminate material or coatings on the fabric

This paper addresses the mechanical or showering method only.

Mechanical cleaning
Mechanical cleaning can be achieved by using showers or alternatively by physically brushing the contamination off the fabric.

The fabric can be contaminated either by plugging of the internal structure or by a build-up of contamination at the surface of the fabric. For each situation a different type of showering method is required.

Beside the question of how to clean the fabric, keeping the machine as clean as possible is also an important consideration. It is evident that the contamination, which is removed from the fabric, will deposit somewhere else in the machine. By correct location of the showers, the areas where the deposits or buildups occur can be effectively minimised or eliminated. For some time, there has been auxiliary equipment available on the market which can “catch” the removed contamination and carry it away from the machine. This has lead to strong improvements in the overall cleanliness of formers.
Common recommendations
For different types of cleaning there are some common recommendations. In all cases it is advised to have the water temperature and pH level identical, or close, to that of the stock. This will prevent the possible chemical or thermal shock precipitation of dissolved salts, which can deposit on the fabric.

The shower nozzle diameter used depends on the solids loading [mg/l] of the available showering water. In the table, there is a overview of the solids loading Vs nozzle diameters that will guarantee trouble free operation.

<table>
<thead>
<tr>
<th>Solids loading (mg/l)</th>
<th>Minimal Nozzle office (mm)</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-50</td>
<td>No limit</td>
<td>Equivalent to fresh water</td>
</tr>
<tr>
<td>60-75</td>
<td>1.0</td>
<td></td>
</tr>
<tr>
<td>75-100</td>
<td>1.4</td>
<td></td>
</tr>
<tr>
<td>100-200</td>
<td>3.0</td>
<td>Brush type shower recommended</td>
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<tr>
<td>200-400</td>
<td></td>
<td>Plungeable showers recommended</td>
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<tr>
<td>500 and up</td>
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</tbody>
</table>

(Note: only applicable for water filtered with a 40 mesh/cm filter).

It is important to regularly check the condition of the nozzles. Worn out or plugged nozzles can yield insufficient flow volume which leads to uneven cleaning. This results in poor paper basis weight or caliper profiles or ridges in the fabric.

Always make sure the High Pressure (HP) showers are interlocked with the stock pump, to avoid the fabric getting damaged by the showers during a stop.

Internal contamination
To clean the internal structure of the fabric a flow of water through the fabric is required. The water flowing through the fabric structure, drags along contamination like grit, fibres and insoluble salts. The main driving force for this type of cleaning is the amount of water flowing through the fabric. Too low water flow will only displace the contamination within the fabric, but not remove them.

Inside fan showers
Inside fan showers can be used to flush out loosely attached contamination. The principle behind this cleaning method is the fact that when a fabric goes over a roll a large vacuum pulse will is created. This vacuum will pull the contamination through the fabric and transfer them onto the roll.

The contamination is removed from the roll surfaces by a doctor blade. The picture shows this configuration, the best cleaning is obtained when this shower is placed on a return roll farthest from the breast roll. As machine speeds increase, the inside fan shower will not effectively remove all the contamination. Additional showering methods need to be utilised.

Recommendations
Pressure: 3 – 7 bar (300 – 700 kPa)
Nozzle:
- orifice: ±3 mm
- spacing: 75 mm
- to fabric: 100 mm
- fan: 45°
- water: Clarified White Water (CWW)
Forming Fabrics

Flooding Nip showers

Flooding nip showers are not widely used as means of cleaning due to the large volume of water required. In most cases, this shower is used on a part time basis for cleaning. Its primary purpose is to knock the sheet of the fabric during a wet end break. For this reason the shower is located just above the nip formed between the fabric and the forward drive roll. The minimal volume of water to fill the voids in the fabric can be calculated by the fabric speed, the width of the fabric and the void volume of the fabric.

The minimum volume is called the Running Void Volume (RVV). If the exact void volume of a fabric is unknown, the void volume can be estimated by multiplying the new calliper of the fabric by 60%. To insure sufficient water is applied to separate the sheet off the fabric, the RVV has to be multiplied by an additional factor. A safe, but potentially expensive, way is to multiply the RVV by an additional factor of 1.25. In this manner a sufficient amount is always guaranteed.

A more precise method to calculate the volume of water required is using the Speed Factor (SF) which takes into consideration that at higher speeds the centrifugal force increase exponentially. For this reason the minimum volume of water to guarantee a sufficient flow can be reduced by more than 50%, compared to the standard method. The proper SF can be determined based on the shown graph or the table.

The impingement of the shower jet into the fabric - forward drive roll nip is important. The jet should impinge on the roll just before the nip. This insures all the water volume rolls into the nip and floods it, thus purging through the fabric and separating the sheet from the fabric. This is listed as tangential impingement. Equally important is the fan nozzles need to be offset by about 5 degrees to insure the fans do not interfere with each other.
Forming Fabrics

**Recommendations**
Pressure: 6 – 10 bar (600 – 1,000 kPa)
Flow: RVV x Speed Factor
Nozzle:
- orifice: 4 mm
- spacing: 75 mm
- to fabric: 300 mm
- fan: 45°
- angle: Tangential
Wrap angle: ≥ 30°
Water: Clarified White Water (CWW) up to 200 ppm

**External contamination**
Fibres, stickies, ink and all kind of adhesives mostly cause the external or surface contamination of the fabric. These types of contamination cannot be flushed out and have to be removed by other means.

**Outside Oscillating High Pressure Needle Showers (OHPNS)**
The most effective way for removing external or surface contamination is the use of High Pressure showers on the paper side of the fabric. The main principal of these showers is they first loosen the contamination and than drag them along. The optimal cleaning is achieved just when the water jet starts to break apart and entrains air. This creates a scrubbing effect, which loosens the dirt more effectively than a laminar jet.

Depending on the pressure used and the quality of the nozzles, the breaking up of the water jet starts at a distance between 200 and 250mm from the orifice. It is noted that this distance creating the scrubbing effect has the greatest potential to damage the fabric. For this reason many suppliers recommend a distance of no greater than 150mm and accept the loss in cleaning efficiency. However, trials and practice have shown that if the pressure of the jet does not exceed 30 bar (3,000 kPa), the risk of damaging the fabric can be neglected. Pressures up to 40 bar (4,000 kPa) take longer to damage a fabric than is the lifespan of the fabric in the machine based on normal wear.

The location of the shower not only influences the efficiency, but also the level of machine cleanliness. A traditional location is just before the nip formed by the fabric and first inner roll. In this case, a large portion of the water flowing through the fabric will be pushed back in the nip rinsing the internal structure of the fabric. The water trapped in the fabric will be thrown out by the centrifugal forces. The water reflected on the surface of the fabric will drag along the contamination into the wire pit, giving the maximum machine cleanliness.
A more common practice is having the shower placed just before the roll on the paper side with a low vacuum box located opposite the shower on the wear side. This box carries away the mist and contamination to outside of the forming section. This arrangement is used on higher speed machines, 1200m/min and above. These boxes need to be operated correctly to avoid wear as well as build-up of fibres on the outside of the boxes, which can lead to fabric damage. If such a box is used, the jet should hit the fabric just after the leading foil.

The least preferred method is to have the HP showers located just after a roll, because here the centrifugal forces are not present and cannot contribute to cleaning of the fabric. It is recommended the shower jet impinge the fabric perpendicularly or 10 to 15 degrees against or into the running direction of the fabric. This further increases the efficiency of the showers because the jet will chisel or “plow” into the fabric peeling off contaminates. This does create misting which one accepts or installs a misting box. To reduce misting, impinging the shower jet 5-15 degrees with the direction of run is suggested. However, remember this reduces the effectiveness of cleaning.

![Diagram of jet and fabric velocities](image)

The nozzle orifice is recommended to be 1mm. This is the best compromise between minimising the risk of nozzle plugging and maximising the amount of flow through the nozzle.

**Recommendations**

| Location | At the paper side, hitting the fabric just before a roll. |
| Pressure | 25 – 30 bar (2500 – 3000 kPa) |
| Angle | Perpendicular or 10° to 15° into running direction |
| Nozzle: |  |
| - orifice | 1.0 mm |
| - spacing | Depending on the stock used, 75 or 150mm at the ends eventually a baby shower can be installed. |
| - to fabric | 200 - 250mm |
| Oscillation | Even, without dwell time at the end of the stroke. The stroke length should be  |
an exact integer of the nozzle distance. The speed should be synchronized to the fabric speed. See formulas below for the proper calculation of the Stroke speed and the minimum cleaning time.

**Stroke speed** $V_s$:

$V_s = \frac{V_w \times 2 \times D_n}{L_w}$\[mm/min\]

$V_w =$ Fabric speed \[m/min\]

$L_w =$ Fabric length \[m\]

$D_n =$ Diameter nozzle \[mm\]

**Cleaning time** $T_c$ [min]

$T_c = \frac{L_w \times S_n}{V_s \times 2 \times D_n}$

$S_n =$ Nozzle spacing \[mm\]

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**Inside Oscillating High Pressure Needle Showers (IHPNS)**

Location of a high pressure needle shower on the wear side or inside of a forming fabric may be used. This normally occurs due to a restriction of placing a shower on the paperside of the fabric or as supplemental cleaning where there is heavy contaminates in the system. Since you wear the CD monofilament strands, high pressure showering can easily damage these strands. Thus, the pressures must be reduced. Pressures should be kept less than 1700kPa. Distance should be less than 150mm to prevent break up of the shower jet. If the shower jet breaks up and entrains air, this creates a scrubbing effect, which in turn can rapidly fibrillate and damage the worn monofilament strands.

**Recommendations**

Location: At the wear side, hitting the fabric just before a roll.

Pressure: 7 – 317bar (700 – 1700 kPa)

Angle: Perpendicular or 10° to 15° with running direction

Nozzle:
- orifice: 1.0 mm
- spacing: Depending on the stock used, 75 or 150mm at the ends eventually a baby shower can be installed.
- to fabric: 100 - 150mm

Oscillation: Even, without dwell time at the end of the stroke. The stroke length should be an exact integer of the nozzle distance. The speed should be synchronized to the fabric speed. See formulas below for the proper calculation of the Stroke speed and the minimum cleaning time.
Forming Fabrics

Auxiliary equipment
More and more paper machines are equipped with auxiliary equipment to improve the overall cleanliness of the machine. The main goal of these tools are to minimize the mist formed by the HP showers, because all the contamination removed from the fabric is trapped in this mist and will deposit on, or in, proximity of the machine.

Mist deflector
The mist deflector is the easiest and least expensive method to help control the mist formed when cleaning the top position of a gap or hybrid former with HP showers. The main idea is that the contamination is deposited at the deflector, which is placed just after the HP shower. Fan showers immediately wash off the deposits from the deflector, leading them back into the nip again. Since they are so diluted and loosely attached to the fabric, these deposits will merge in the stock again without a problem. This method requires a sufficient flow of water onto the deflector to avoid build up of stock. However, this method will not prevent the contamination of the inner loop.

Vacuum boxes
Vacuum boxes placed at the wear side of the fabric, directly opposite the HP shower are the best way to avoid contamination of the inner loop. This method can be used equally well on bottom and top positions. The water and mist, which leave the fabric from the wear side, are caught in the box and transported outside of the machine. To get the best result the jet should hit the fabric just after the first tip of the suction box. Proper operation of the boxes is required in order to avoid the build up of fibers at the leading foil.

Recommendations
Slot width: 50 – 75mm (for machines over 1000m/min use 75mm)
Vacuum: 0.05 – 0.10 bar (5 – 10 kPa)
Flow: 250m³/m² slice/min
Jet impingement: Just after first foil

Where the HP shower is placed in a horizontal part of the fabric loop, the mist deflector and the low vacuum box can be combined, in order to give optimum cleaning.
New equipment

The new generation high-speed gap formers are very sensitive to fabric cleanliness as well as overall machine cleanliness for operating efficiency and CD profiles. Equipment suppliers and machine builders have developed new cleaning techniques that combine water and air under pressure to both remove contaminants and trapped water within the fabric structure.

Two examples are the Voith Jet Cleaner and the Metso Hi-Dri Cleaner. The Jet Cleaner sprays a fan jet onto the fabric from the inside, which is blown through the fabric by high pressure air. Proper fan nozzle set up and maintenance is essential as fibre or dirt build up on the ceramic blade ahead of the air jet can quickly score and wear out the forming fabric. This set up is common on the bottom position of most recent Duoformer CFD installations. It is also possible to install this arrangement on the top position. It can be difficult to install on other machine configurations due to the roll geometry required.

The Metso Hi-Dri cleaner uses a combination of inside vacuum slot to remove the mist from the paper side needle shower and high pressure air to blow out any entrapped water towards the face side. The inside run following the box is very clean and dry. Again, care needs to be taken to ensure fibre and dirt to not accumulate on the leading edge of the ceramic blades or fabric damage can result.

The Hi-Dri seems to be preferred over the Jet-Cleaner due to the fact that it has fewer restrictions regarding the installation and that it also contributes more effectively to the cleaning of the paper side of the fabric. However, some mills have experienced some water streaks in the fabric after the Hi-Dri. It seems altering the positions where the jets impinge the fabric can solve this problem. By moving the impingement position from just after, to onto the tip of the first blade, gives a more uniform water level in the fabric. This can result in the elimination/reduction of the water streaks.
Traversing High Pressure Showers
In addition to the oscillating HP showers, traversing showers like the *Duo Cleaner* from Voith and a Metso variation can be applied. The showers work with very high pressures (up to 250 bar), but due to the very small nozzle diameters applied (0.2mm) the fabric will not be destroyed. Application of traversing showers will in most cases not eliminate the application of high-pressure shower, but on machines with a high level of contamination this can be a very useful method of focused cleaning.

**(Possible) Benefits:**
- Can target specific areas to clean.
- Low water consumption (6 – 10 l/min).
- Very effective against small particles.

**(Possible) Down sides:**
- Higher risk of mechanical malfunction due to the traversing system and rotating head (Voith).
- Only fresh water or very clean CWW can be used due to the small diameter nozzle orifices.
- Long time between cleaning actions at a given location, due to the fact that the jet has to traverse over the full width of the fabric (stroke length = fabric width!).

**DuoCleaner (Voith)**
The DuoCleaner from Voith consists of a rotating head with 10 small nozzles. The pulsating water jets impinge on the fabric loosening the particles. Due to the high pressure even very fine particles can be removed. A portion of the water penetrates through the fabric, contributing to cleaning the internal structure of the fabric. In the case of heavily contaminated fabrics, it is advised to place a low vacuum box underneath the fabric (acting as a dirt trap).

**EasyCleaner (Metso)**
The Metso variation has no rotating parts, but a combination of needle and fan showers. This arrangement maybe a bit less vulnerable for mechanical malfunctions, but remember it cannot replace the normal HP shower on heavily contaminated machines.

**Recommendations**
Distance to fabric: 40mm
Nozzle:
- Number: 3 needle + 3 fan
- Orifice: 0.2 mm
Pressure: 100 – 150 bar (10,000 – 15,000 kPa)
Water quality: Filter fresh water
Oscillation: Synchronised with machine speed
Additional showers
Besides the showers needed to clean the fabric, showers are also required for lubrication of rolls, counter blades and high vacuum boxes.

For these showers no general recommendations are given by any of the suppliers, but it seems more a question of experience how to set these showers most effectively.

For showers lubricating high vacuum boxes it is evident that the applied amount of water never should exceed the RVV of the fabric. Further more it is required to have an even distribution of the water to avoid profile problems.

Many machines have experienced good results by adding water to the edges of the counter blades in a Hybrid former. A good lubrication of the stationary blades at their edges will reduce the wear of the fabric in this area.