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Showering in the Wire and Press Section
In which Direction is the Development Going?

Summary:

1. Continuous Cleaning and Conditioning of
- forming fabrics and press felts
- forming roll covers, suction rolls, grooved rolls
using High Pressure Showers is still a reliable and an efficient method.
Some basic conditions have to be fulfilled:
- proper shower location and solid design
- sufficient number of nozzles fof showering width
2. HP showers have an influence on CMD profiles, especially concerning shower nozzles and shower oscillator (stroke and speed)
Shower nozzles have to meet highest standards regarding
- jet laminarity
- life potential
3. Ecological requirements and economic opportunities do not have to be in contradiction at all: Reduction of specific fresh water flow and power requirements for High Pressure and Vacuum is possible and is economically attractive.
4. Central problem for showers is water quality: A matter of perspective.
5. Low Pressure showers for doctor and suction box lubrication must not be neglected, considering their influence on CMD profiles. Proper nozzle equipment and shower oscillation are indispensable on modern paper machines.

1. Continuous cleaning respectively conditioning of

- **forming fabrics and press felts**
- **forming roll covers, suction rolls, grooved rolls**

using High Pressure Showers is still a reliable and efficient method. Some basic conditions must be fulfilled:

- **Proper location of shower and solid shower design**
- **Sufficient number of nozzles over the shower pipe width, considering the width of the cloth**

Besides the usual HP shower pipes, a number of **travelling High Pressure cleaning systems** have been installed over the years, working with fixed or rotating nozzle systems, partially featuring zone control programs.

Also, steam or air jet cleaning devices are in use on some paper machines.

The suppliers of these systems have reported about their characteristics. The proper choice of HP needle jet nozzles to equip this type of system, concerning jet quality and lifetime, is of great importance. Ruby nozzles – as described hereunder – are in use on this type of equipment

Yet it appears that the conventional **Oscillating High Pressure Shower** defends its position quite well. Moreover: If HP showers as we usually find them in many locations in Wire Part and Press Section are optimised in accordance with latest knowledge, then this technology is good for efficient and economic cleaning and conditioning, even on "world record machines" demanding high efficiency showering. On the majority of machines, only **one** wire shower is sufficient for adequate wire cleaning.

Description of the performance of a HP Shower:

Forming Fabrics:

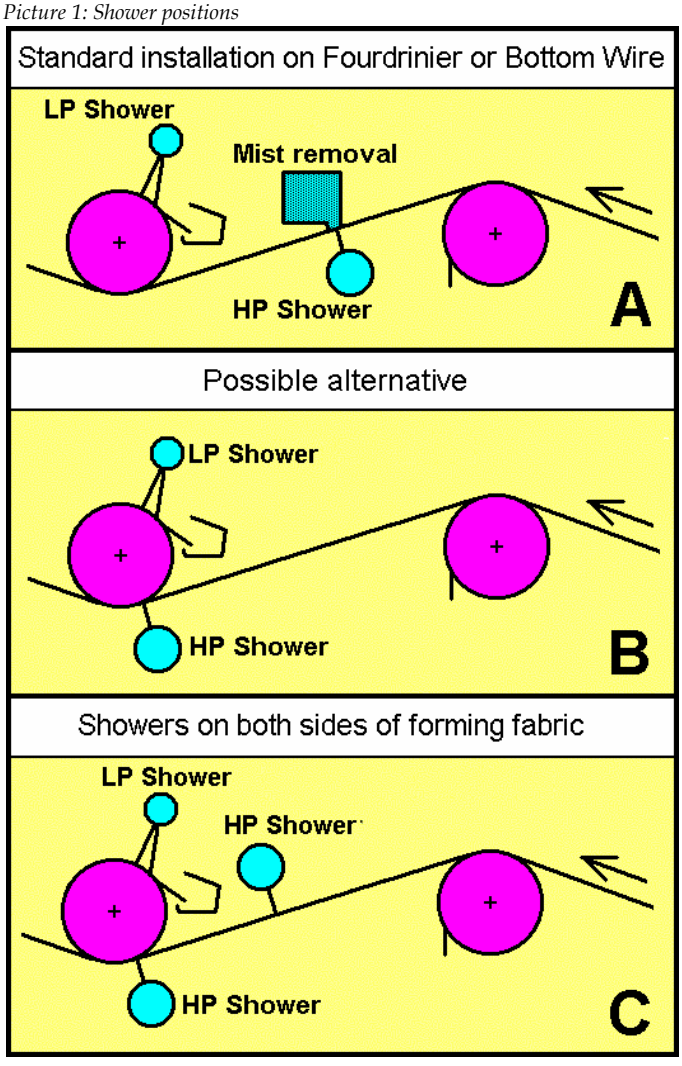
- For cleaning forming fabrics the **kinetic energy of the water jets** (needle jets) is used to **remove** foreign matter which is adhering to the paper side, inside the fabric structure and on the running side.
- Synthetic single layer fabrics have an open area in the vertical projection – double layer fabrics do not. Triple layer fabrics and other complex multi-layer designs have various structures regarding the open area and their inner design. The greater density and the closed structure of such designs requires efficient showering.
- The water jets thus may more or less penetrate through the fabric.
- The paper side of many fabric types may be rather sensitive, as warp and weft thread diameters may be 0.12 to 0.15 mm only.
- The running side of most modern fabrics is rather resistant (weft thread diameter 0.17 to 0.25 mm and more).

Press Felts:

- The needle jets are supposed to loosen or **to condition the fine paper side needled bat layer** of the felt, so that the suction boxes can remove water, fibre, filler particles and foreign matter efficiently.
- The felt design and the properties of the needled bat are to be taken into account. The water management of a press felt and the sensitivity of the bat may play an important role.

Question 1: Where and how is a HP shower installed in the best way?

Picture 1: Shower positions



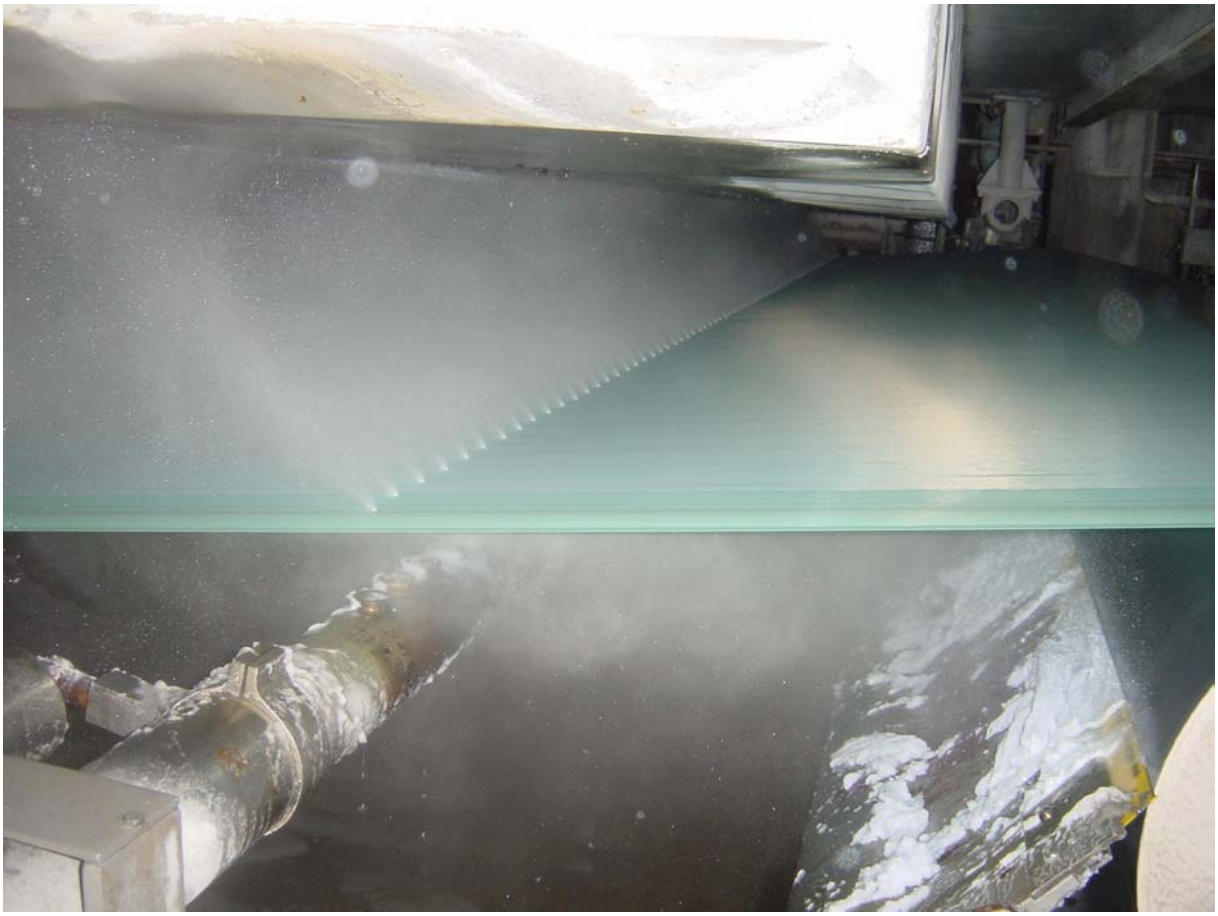
Fourdrinier / bottom wire / inner wire:

Normally, a HP shower is installed in the wire return run, between two guide rolls, on the paper side of the fabric (picture 1A). It should be located as far from the breast roll as possible, so that the following guide rolls can remove the water streaks (table roll effect).

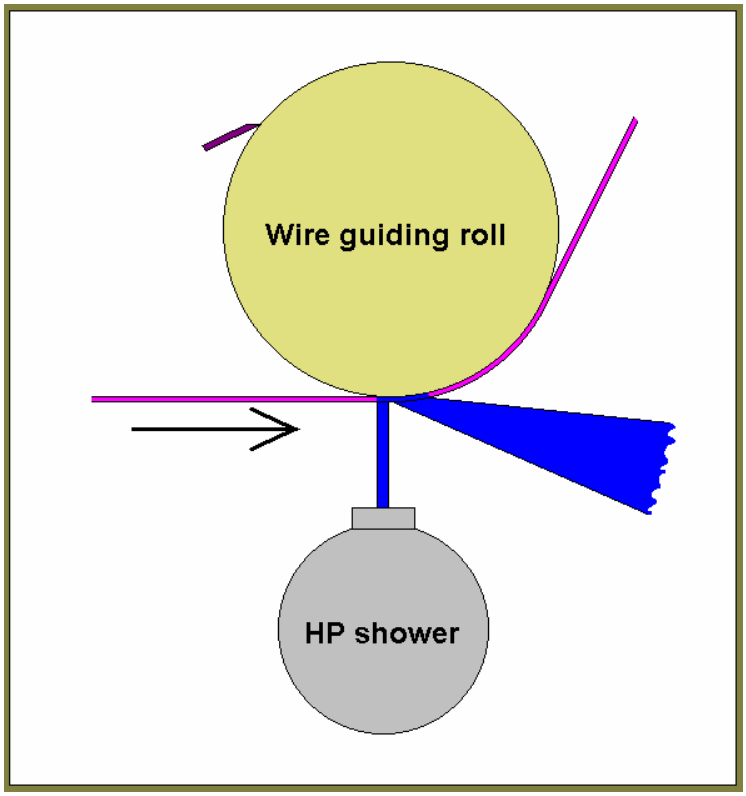
The needle jets hit the fabric more or less vertically. A part of the water is carried by the fabric, another part of the water penetrates through the fabric, carrying matter which is deposited in the mesh away into the wire run. Water mist is created and this makes vacuum boxes necessary on many fast running machines (picture 2). Stock buildup on these boxes may cause difficulties. There are suction systems using integrated HP Showers on one side or on both sides of the fabric which remove mist efficiently.

It has to be considered that a part of the jet energy is absorbed by elastic deformation of the wire filaments. On the other hand local extension may appear favourable, as the relative movement of the threads at the crossing points makes foreign particles come loose.

Picture 2: Water mist in the wire return



Picture 3: Cleaning Shower directed on Wire Roll



Showers are often directed **against a wire guiding roll** (Picture 1B). The jets hit the fabric just before it runs on to the roll. This method appears very efficient. The water penetrates into the void volume of the fabric and through the weave and is pressed back immediately like a pulse. The foreign matter held in the weave and at the linking points of the monofilaments is loosened by a high momentary pressure pulse and flushed out.

A part of the matter is removed by the roll and delivered to the doctor. The doctor has to be in a good condition and should be lubricated evenly by a Low Pressure Shower.

Compared with the shower position in the run between two rolls, it is interesting that this geometry avoids *water and fibre mist* inside the wire run which may create fibre buildup on the machine structure. By this fact, mist removal systems which may have their own particular problems are not required.

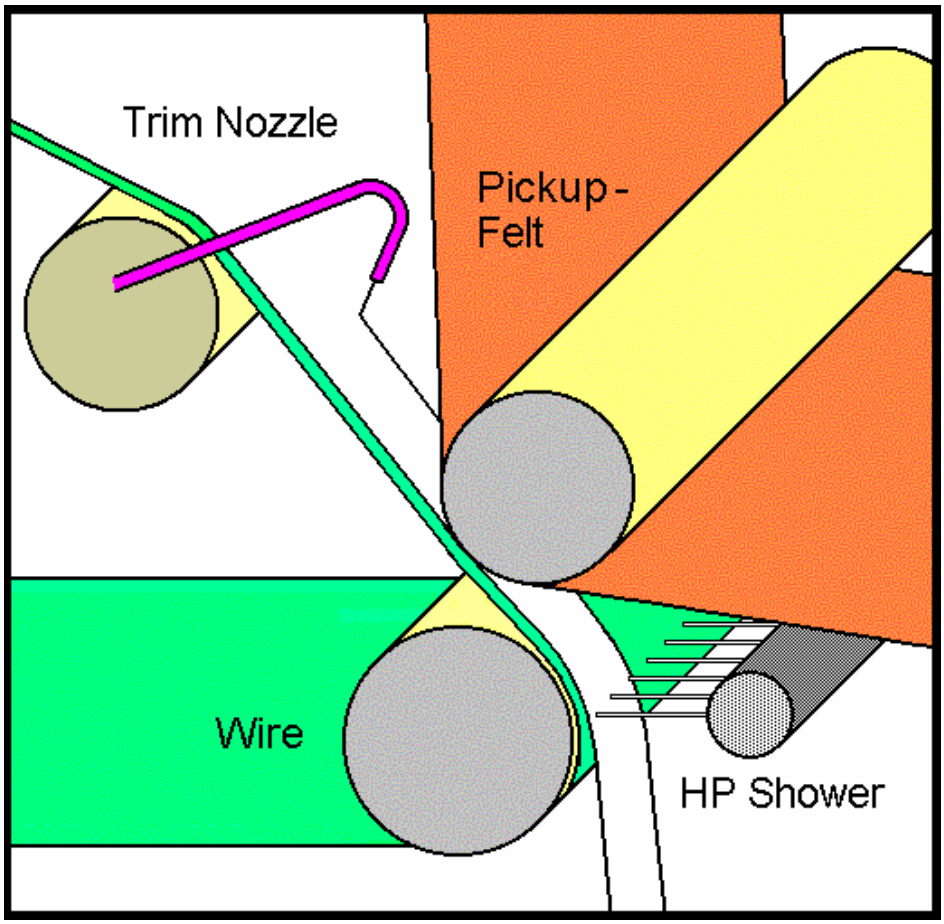
The installation of both an **inner** and an **outer** HP shower may be quite interesting too: many modern multiple-ply forming fabrics are relatively open, and cleaning from both running side and paper side may be efficient (Picture 1C).

Years ago, there was some concern about damaging forming fabrics with HP shower jets, when directing them on the running side, because the normal wear caused to the wire by stationary dewatering elements makes it more sensitive to fibrillation etc..

This does not seem to be considered a great problem any more: firstly, modern nozzles with greatly **improved jet quality** are available, secondly there are more and more modern twin wire machines running at a very low level of wire wear altogether.

On some recent machines, a shower directed onto the **Forward Drive Roll**, under the Pickup, can be observed, frequently in addition to a second shower in the wire return run.

Picture 4: HP shower under Pickup



This may appear somewhat irrational, as the jets will project pulp and filler originating from the trim just coming off the fabric back against it. A possible consequence may be stronger fabric wear in the edge area by more filler particles being present in the edge area.

Frequently, the nozzles in the edge areas are being replaced by plugs, or deflectors are fitted in the edge area, to avoid spraying the stock against the fabric.

In reality, the edge is the area which must be cleaned particularly well, however.

Top wire / outer wire:

Cleaning is performed mostly by a HP shower on the paper side of the fabric. On some new machines, 2 showers operating alternatively or simultaneously can be observed.

Mist removal systems and deflectors are installed on many top wire runs, to avoid fibre mist building up on the machine structure. Some of these mist removal systems have built-in showers on one side or on both sides of the fabric, providing good fabric cleaning without creating mist.

Many modern vertical Gap Formers have the Outer Wire HP Shower installed on the stretch roll, similar to picture 1). This appears to be an efficient method.

Both Bottom and Top Wire showers should be located **as far as possible from the forming zone/ breast roll**, in order to permit the water carrying profile of the cloth to be as uniform as possible (by the run over wire guiding rolls with the table roll effect provided).

Dandy Rolls:

Inside HP showers are usually installed in Dandy rolls and various needle jet nozzle designs, including multiple jet nozzles, exist for these showers.

The showers are positioned before the 12 o'clock position of the Dandy:

Surprisingly, on many Dandy installations it can be found that nozzles and oscillation leave much to be desired. The oscillation is usually performed by a **crank system**, moving the pipe neither with a suitable nor constant velocity. Nevertheless, paper makers state that they consider good dandy work as very important for a fine paper machine.

HP cleaning of forming rolls, suction couch rolls, grooved press rolls:

These showers are often equipped with a simple oscillating system without speed synchronization only. They are commonly operated continuously on forming rolls and suction couch rolls. On other rolls they are operated during downtimes mostly. On modern machines they are operated at relatively high pressure: 40 to 60 bar, using nozzles with a jet diameter of 1 to 1.5 mm. Their water requirements are considerable when running continuously.
There have been newly designed roll shower systems on the market for some time, providing linear oscillation and very uniform cleaning with low water consumption. This is an interesting development, considering the importance of CMD roll cleaning profiles and even water management.

Conditioning of press felts:

Usually, besides a Low Pressure lubrication shower, a HP shower is located shortly before the suction box on the paper side of the felt. This shower should be operated **continuously**, and possibly with an adjustable water pressure, considering age and condition of the felt.

Today, an increasing number of paper machines are equipped with measuring systems monitoring the water flow in press savealls and Uhle boxes in order to allow proper vacuum control, help evaluate runnability and dewatering of felts and also allow control of optimum HP shower water pressure.

General remarks regarding shower location and operation:

- HP showers should be installed as close as possible to the wire or felt surface generally. The closer the better, considering the relative jet quality. The distance should actually not be over 100 mm. For roll showers, the distance should rather be even smaller: 30 to 50 mm. **The suggestion that a needle jet would become the most efficient for cleaning just at that point where it starts disintegrating into droplets, is a legend with tradition, measured at reality.**

- The water pressure of wire HP showers should be at least 20 bar with water jet diametres of 0.7 to 1.0 mm, but should not exceed 35 bar. The question of jet diameter will be referred to later.

- Press felt HP showers should be operated not over 15 bar, when 0.7 to 1.0 mm nozzles are in use.

- The water temperature should be equal to the temperature of the wire/felt.

- The water jets should hit the cloth with an angle of 90° $\pm$ 10°:

    - With a high inclination in MD, cleaning efficiency will be reduced by the smaller speed difference jet/cloth transferring less energy.
    - Showers oriented against the running direction may cause damage to wires or felts. Also, an influence on wire drive power may be caused by the deceleration.

- The showers should be properly dimensioned, and they should be designed so that no deflection occurs. Pipes which are not properly dimensioned may be reinforced by welding a steel strip to the pipe at the 12 o'clock or the 6 o'clock position, across the full width.

- The transmission of oscillation should be free of play, to avoid any dwell time (standstill) at the return points (maintenance).

Question 2: How many nozzles should there be on a given shower pipe?

Mostly, the nozzle spacing on Wire HP showers is 50 to 100 mm. Felt showers mostly have a distance from nozzle to nozzle of between 100 and 200 mm. The distance between the nozzles (i.e. the total number required) depends on the cleaning efficiency required, i.e. on:

- the furnish, considering foreign matter
- the wire or felt length
- the production speed

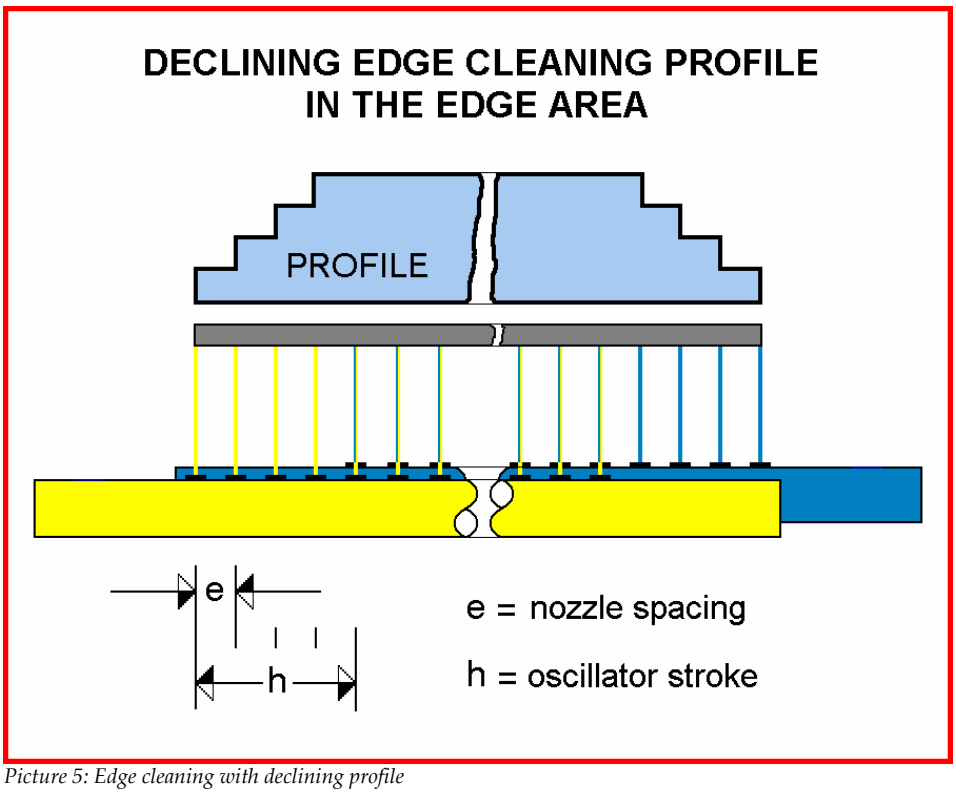
On a fast running newsprint paper machine using waste paper as raw material, the contaminants will make a greater cleaning efficiency necessary than this would be the case on a slowly running fine paper machine running 100 % virgin fibre.

It is of great importance that the water application to the cloth is perfectly uniform over the face width. For this reason, the **distance between the first nozzle on the Front Side and the last nozzle on the Drive Side** has to be:

- **wire/felt width less one nozzle space**, if the oscillator stroke is **one** nozzle space
- **wire/felt width**, if the oscillator stroke is **two** nozzle spaces
- **wire/felt width plus one nozzle space**, if the oscillator stroke is three nozzle spaces
- **wire/felt width plus two nozzle spaces**, if the oscillator stroke is **four** nozzle spaces

To collect the water sprayed beyond the cloth edges, it is useful to install suitable shields.

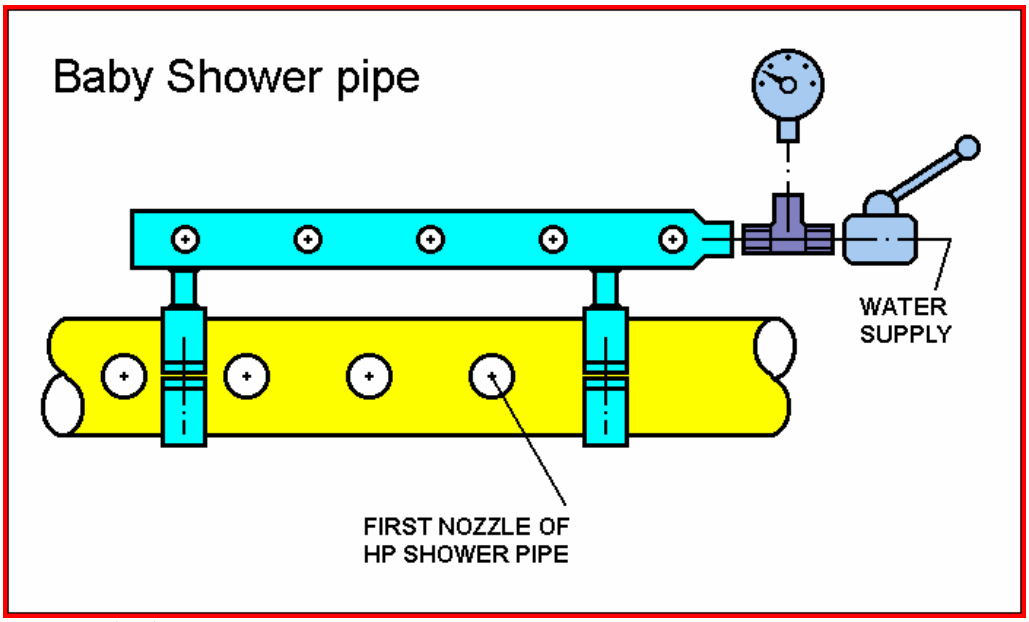
If the total number of nozzles, i.e. the showering width is less than what is required, then a typical WATER/TIME PROFILE as shown is created **(and this can be observed on the majority of modern, fast running paper machines!)**. The cloth is cleaned **less efficiently** in the edge area than in the body.



Picture 5: Edge cleaning with declining profile

The fact described here has not (yet) been paid much attention to. It will have to be taken into consideration more seriously, when what many papermakers commonly call **"Edge Problems"** undergoes a more thorough examination.

Usually, it is possible to weld additional bushings for nozzles into the shower pipe, or fit short "baby shower pipes" to the main shower, to extend the showering width.



Picture 6: Edge shower

2. HP showers have a great influence on CMD profiles!
This concerns especially
- **shower nozzles (identical properties across the machine)**
- **shower oscillation (oscillator stroke and speed)**

Shower nozzles have to meet highest standards regarding

- **jet laminarity**
- **life potential**

Oscillators must be programmed for proper oscillation speed and stroke adjustment.

A paper machine features dozens of "profile destroying systems", to put it in a rather casual way.

From the first moment on (the stock jet coming from the headbox slice) there are numerous elements on a paper machine which may have an influence on the uniformity of CMD profiles. All the way along the machine until the Pope Roll.

The showers definitely belong to them.

Example:
If the forming fabric of a Fourdrinier machine (or twin wire former with a pre-drainage area) has an uneven water regime created by showers with a non uniform water application, then it can be assumed that the fabric carries

- water
- air
- fines and filler

in a non uniform way, **into the sheet forming zone**. As the stock jet hits the fabric on the forming board, the initial forming and dewatering conditions will suffer an influence affecting formation, retention, dewatering etc., which may be underestimated.

Needless to say that many papermakers know: What has been damaged in the early stage of the papermaking process, i.e. in the forming section, can not be improved by the size press or the calender; it rather shows up right there.

It is a requirement to render the work of **all showers** – high pressure or low pressure – as **uniform** as possible, to avoid negative influences on the **cross machine profiles**.

Many paper mills have already started optimising and the results are very considerable on SC, LWC, Newsprint and Fine Paper Machines. It may be expected that this positive trend will also become apparent in the production of packaging papers with waste paper as raw material.

Two key elements have to be considered when optimising showers:

A The nozzles, regarding their properties and condition
B The oscillation (for HP and also for LP showers)

Regarding A:

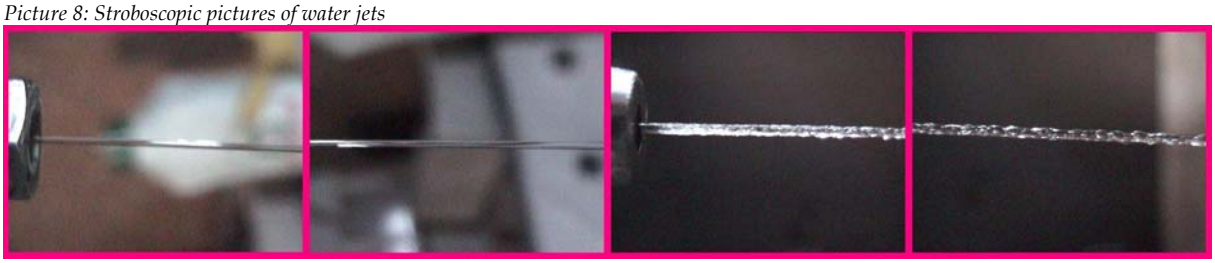
There is consensus today that particularly **High Precision Ruby Nozzles** meet the requirements of modern paper machine operation. These nozzles have a **jet quality** which is unmatched by any other design (laminarity) and they have an unequalled **lifetime** as well. Both properties are the result of the use of the world's second hardest mineral: **Ruby** (monocrystalline aluminum oxide).

The Mohs hardness scale indicates ruby hardness in comparison with other minerals:

Mohs Hardness of various minerals and other material

Name	Chemical formula	Hardness
DIAMOND	C	10
CORUNDUM (**RUBY**,SAPPHIRE, PADPARADSHAH)	Al2 O3	9
CHRYSOBERYLL	Al2 Be O4	8,5
TOPAZ	Al2 Si O4 (F, OH2)	8
CERAMICS		7 – 8
ZIRCONIA	Zr Si O2	7,5
ROCK CRYSTAL	Si O2	7
TUNGSTEN CARBIDE		7
AGATE	Si O2	6,5 – 7
GLASS		5 – 6
HARDENED STAINLESS STEEL		5,6 – 5,8
STAINLESS STEEL AISI 316		4,8
CALCITE	CaCO3	3
GYPSUM	Ca(SO4).2H2O	2
TALC	Mg3((OH)2 Si4O10)	1

Picture 8: Stroboscopic pictures of water jets

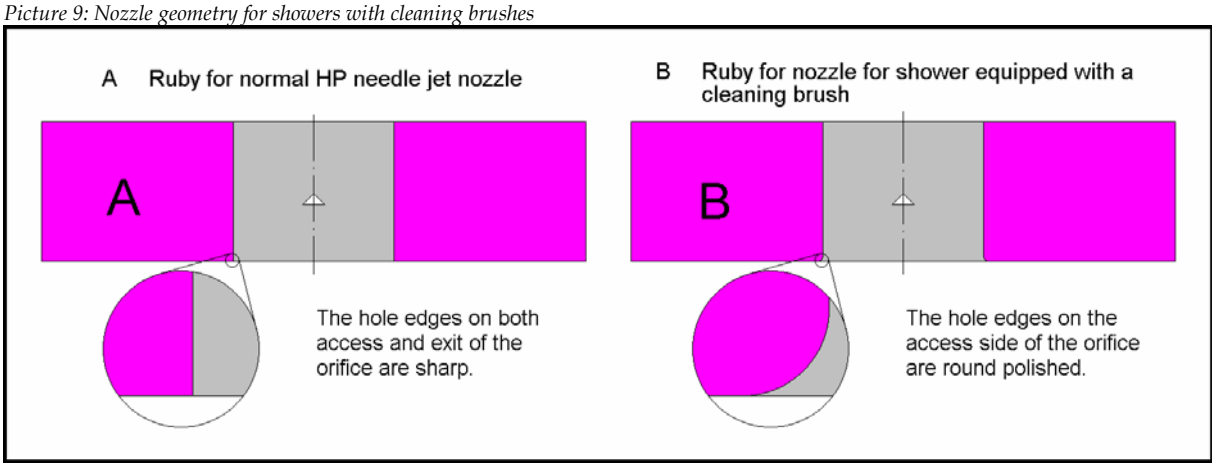


Laminar (at jet exit) Laminar (after ~ 100 mm) Turbulent (at jet exit) Turbulent (after ~ 100 mm)

Ruby inserts for needle jet nozzles are manufactured with greatest precision concerning the mirror polished plane surfaces, mirror polished inner cylinder and faultless edges of the orifice. For highest jet quality the orifice has to be perfectly circular, with continuous razor-sharp edges.

Only one restriction has to be accepted for nozzles used on showers with **internal cleaning brushes**: the inner hole edge needs to be shaped slightly rounded to avoid that it gets damaged by the steel bristles.

Picture 9: Nozzle geometry for showers with cleaning brushes



The nozzles need to be shaped in such a way that the brush bristles will not be **deformed** by the nozzles. The brush should move peripherically over the nozzles, with no level difference to the inner wall of the pipe.

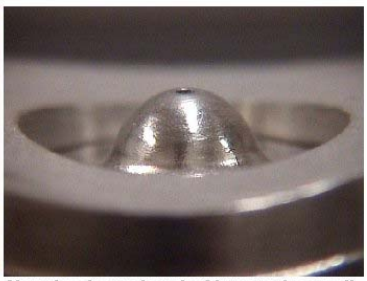
Deformed bristles will result in **inefficiency** to clean plugged nozzles any longer.

Picture 10: deformed bristles due to nozzle shape

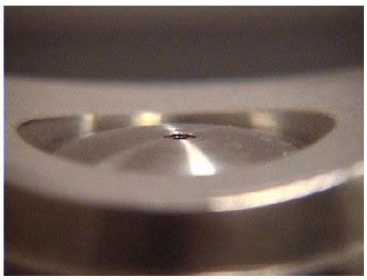

Shower brush (Finland)

Shower brush (Canada)


Nozzle above level of inner pipe wall


Nozzle above level of inner pipe wall


Nozzle above level of inner pipe wall


Nozzle matching inner wall level

Besides the risk of permanent deformation, there is a chance that bristles are being caught in the nozzle orifice, torn off, and stay blocked in the nozzle permanently.

It also has occurred that debris of brush bristles caused damage to clothing.

Some years ago, steel wire particles coming from a HP shower brush were found stuck in the paper rolls of an on-machine super calender, causing holes and calender breaks in a mill in Ontario.

Recently, machind builders have made efforts to introduce plastic bristles on shower brushes. Plastic bristles must be wear resistant and must not come off the brush.

The Ruby inserts of high quality PMS nozzles are made with exceptional precision and are pressed into the nozzle body with high force (no adhesive).

They resist very high pressure, applied in either direction (over 140 bar/2200 psi). High pressure may occur when cleaning shower pipes with HP cleaning equipment during machine washup. This safely avoids loosing Ruby inserts, as has occurred in some cases in the past with some similarly designed nozzles. Also, these nozzles now are perfectly resisting to possible attack by cleaning chemicals and they may be cleaned without any problems, using ultrasound equipment.

Nozzles must be tightened correctly. Threaded nozzles are fitted with teflon sealing tape or sealing liquid, normally. Disc type nozzles need a flat gasket. The best solution has been a sealing gasket made of virgin teflon.

PMS disc type nozzles are made with an integrated highly resistant O-ring.

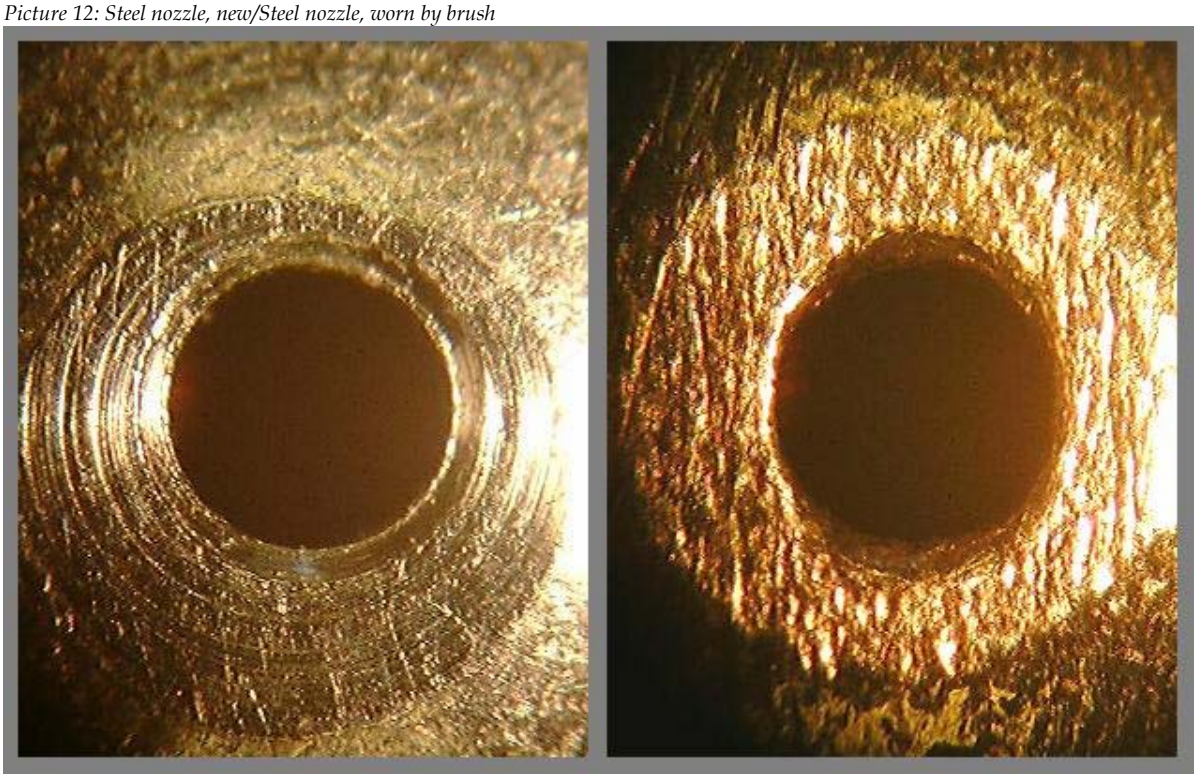
Picture 11: Ruby nozzle

Flat gaskets made of rubber tend to become brittle. Fibre gaskets stick and leave debris when changing nozzles. All this may lead to untightness and to difficulties.

Conventional nozzles have a relatively poor jet quality even when new. The wearing action of the cleaning brush leads to an increasingly turbulent jet, to the point where the jet which is intended to be a needle jet has become a kind of flat jet in reality, because the holes have become oval in the meantime.

Each of the nozzles on the pipe is in a different condition commonly. Showering efficiency and CMD uniformity will deteriorate. Replacement of nozzles becomes necessary, mostly after a running time of less than a year.

Picture 12: Steel nozzle, new/Steel nozzle, worn by brush



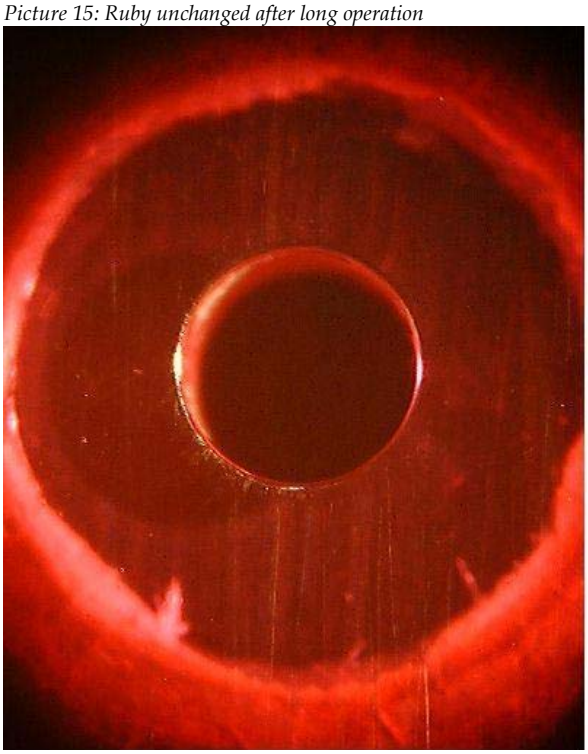
Picture 13: Poor jet quality resulting from nozzle wear by cleaning brush

Picture 14: HP shower with good nozzles

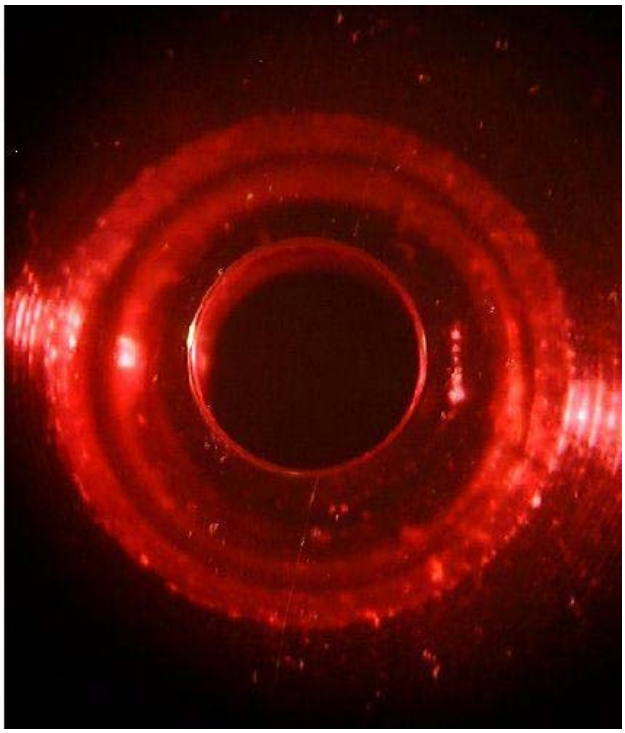
Good nozzle equipment will result in **perfectly laminar** and, particularly, **identical jets** across the width.

Summarizing, a maximum of precision will result in perfect jet quality and uniform showering over the machine width. This is guaranteed by the characteristics of Ruby and its wear resistance will make the nozzles maintain their properties for many **years**. Proper nozzle design allows trouble free service over a long running period.

Picture 15: Ruby unchanged after long operation



Ruby of nozzle having run for over 6 years in a fast SC machine outer wire HP shower (Finland)



New Ruby

Regarding B:

The **shower oscillation** has a great influence both on the showering efficiency and the showering uniformity on fabrics and felts.

Frequently observed problems are:

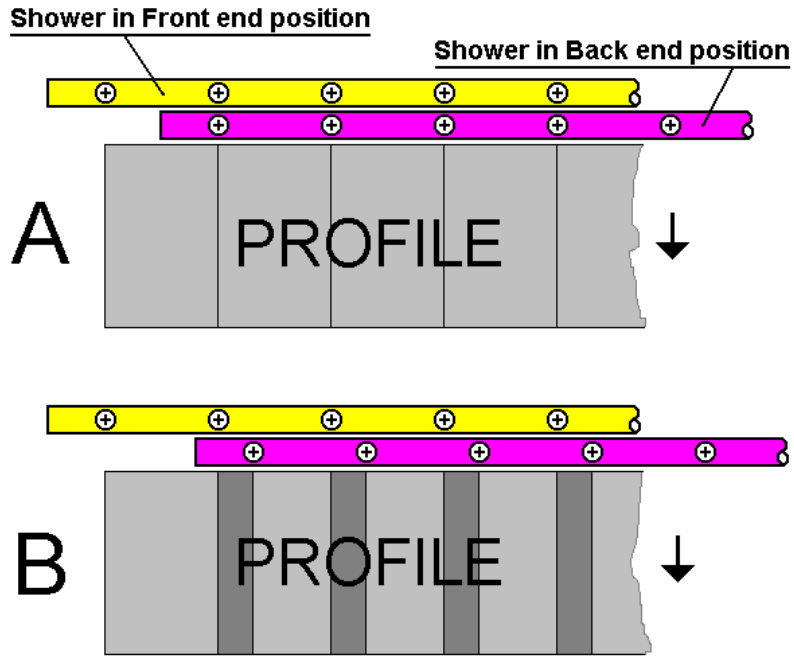
- wrong stroke adjustment (stroke not matching nozzle spacing or a multiple of it)
- wrong and/or non uniform oscillation speed
- standstill at the return points

Picture 16: Streaky Top Wire on Fine Paper Machine

This picture shows clearly how strong the streaks can be, when oscillator and nozzles are ready for maintenance, respectively replacement.

Picture 17 shows the relation between nozzle spacing and oscillation stroke. Example: At a nozzle space of 75 mm, the oscillation stroke must be exactly 75, 150, 225 or 300 mm (A), otherwise a partial overlapping will result in streaky water application (B).

Picture 17: Relation of nozzle spacing and oscillation stroke



Furthermore, the shower action will be non uniform when the **oscillation speed** is not uniform, not adjusted properly, or when it is not synchronized with the machine speed. There will be a negative influence on both showering efficiency and CMD uniformity.

The correct oscillation is calculated using this formula:

$$V_{osc} = \frac{\text{PM speed (m/min)} \bullet \text{Jet diameter (mm)}}{\text{Cloth length (m)} \bullet 60} = \text{mm/sec}$$

To summarize, the following features must be expected of a state-of-the-art oscillator:

- perfectly constant oscillation speed
- speed to be synchronized to PM speed in the correct ratio
- no standstill at the return points
- stroke perfectly adjusted to nozzle spacing
- programmed zero point variation
- quick return stroke in one running direction
- low maintenance requirements and reliable performance in paper machine wet end environment

There are electronically controlled stepping motor driven oscillators on the market, fulfilling these requirements.

If these two components of a HP shower are right: **Nozzles** and **Oscillator**; then the positive influence on CMD profiles will become visible, and the highest standard of efficiency is reached.

3. Ecological requirements and economic opportunities do not have to be in contradiction at all: Reduction of specific fresh water flow and power requirements for High Pressure and Vacuum is possible and is economically attractive.

The **reduction of fresh water use** is a predominant task for the paper industry. Not only for economical reasons – fresh water is expensive and its use requires extensive equipment – also for ecological reasons, a reduction of the use of fresh water is required.

At the beginning of the 21st century, it appears reasonable to say that it becomes a general human duty to improve our relationship to the life maintaining and endangered good WATER.

1. Wire HP Showers:
Nowadays, in Europe, but also increasingly in other countries, nozzles used on **Wire Showers** have a jet diameter of **0.9 mm**, with the trend going towards **0.8 mm** dia. Nozzles. This means a flow reduction of 25% or 40% respectively, compared with 1 mm nozzles as were used until now, i.e. until the **Ruby nozzle** started its career.

Picture 18: Flow at different jet diametres

Jet dia. (mm)	Water pressure (bar)						
	5	10	15	20	25	30	40
0,3	0,10	0,14	0,17	0,20	0,22	0,25	0,28
0,4	0,17	0,23	0,28	0,33	0,36	0,41	0,46
0,5	0,25	0,36	0,44	0,51	0,57	0,64	0,72
0,6	0,36	0,51	0,63	0,73	0,81	0,91	1,02
0,7	0,49	0,69	0,86	0,99	1,10	1,23	1,38
0,8	0,63	0,89	1,10	1,26	1,41	1,59	1,79
0,9	0,80	1,14	1,39	1,59	1,80	2,03	2,28
1.0	1,00	1,43	1,75	2,00	2,30	2,58	2,87
1,1	1,24	1,79	2,15	2,48	2,85	3,18	3,58
1,2	1,50	2,18	2,58	3,00	3,45	3,90	4,36

2. HP Showers on Forming Rolls, Suction Couch Rolls etc.:
These showers very frequently are equipped with nozzles of too great jet diameter. If these showers are operated with suitable oscillation speed and if they are equipped with high quality nozzles, water flow quantities can be reduced significantly by the use of **0.8 to 1.0 mm dia. nozzles**, without any compromises regarding cleaning efficiency. Advantages regarding the water carrying uniformity of the rolls are likely, too.

3. Press Felt HP Showers
Felt showers today are equipped with **0.7 – 0.8 – 0.9 mm dia. nozzles**, against 1 mm being usual only a few years ago.

Today many modern graphic paper machines run a specific fresh water consumption for wet end HP showering of rolls and clothing of less than 2 m³ per ton of paper production!

This is accomplished with showers optimized in respect to **nozzles** and **oscillation**. Usually it is found that the necessary investment pays back in a very short time.

An example:

Fine paper machine with gap former and 3 presses, trimmed width on reel: 8.4 m, production: 850 t/24h.
Conventional shower oscillation, conventional nozzles with a jet dia. of 1 mm:

- Specific HP warm water flow for wire and press section: **2.100 m³/24h**
- After optimizing: Water flow reduced to **1.340 m³/24h**, that is
- A reduction of **760 m³/24h**

It is apparent that the **water saving** is very considerable: it equals the average consumption of **approximately 1.500 German households of 4 persons.**

Also, there will be an **energy reduction** proportional to the water quantity. It can be figured that to provide a flow of **1.5 m³/h at a pressure of 25 bar, approx. 1 KW** has to be installed.

Energy savings for **vacuum** may have to be added and this may be just as interesting.

Paper mills obviously calculate their **cost for a cubic metre of fresh water** in many different ways. If the water price paid by the author to his local town water supplier was applied (4.10 EUR per m³) then the savings made by a reduction of 760 m³/day, for 330 days, will add up to an amount of almost exactly **One Million EUR.**

Similarly, the price a regular citizen pays for electricity is not the same as a paper mill pays…

Anyway, the investment (replacement of some 700 nozzles against Ruby nozzles, installation of 5 modern oscillators and improvement of 4 more oscillators) required for our example paper machine will be less than 180.000 EUR.

No doubt, the measures are justified from the point of view of sound business management. Additionally, the resulting productivity and quality upgrade from a papermaking aspect must be considered.

Future perspective:

It appears that even further **improvement of cleaning efficiency** may be possible by further decreasing jet diameters – maybe down to 0.5 mm – with higher water pressure – 30 to 60 bar, – concerning wire and felt showers. Ruby nozzles will make such solutions possible. **Fresh water requirements will be further reduced.**

One fundamental condition has to be recognized however: a **suitable water quality**. This leads us to the next chapter.

4. Water quality is a central problem for showering. A matter of perspective.

High Pressure Showers are usually fed with warm water of fresh water quality.

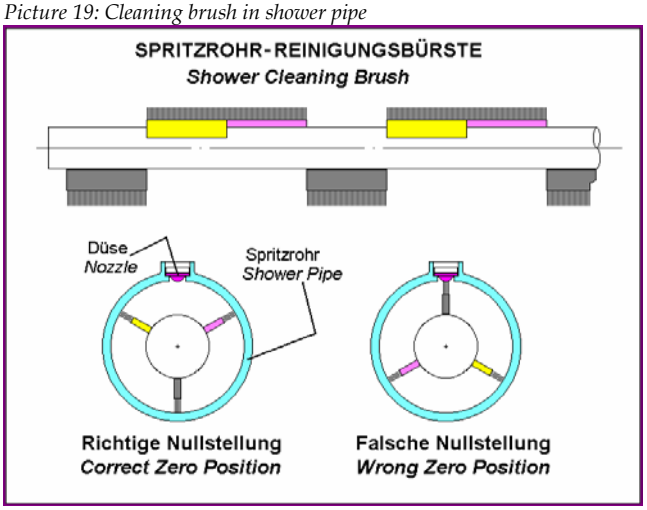
Clear filtrate process water, mostly used for Low Pressure showering, is used more and more for HP Showers, on packaging paper machines in particular.

To use process water, heavy requirements regarding **treatment** and **filtration** have to be fulfilled. A solids content of 15 ppm or less is desirable. Disturbances will affect the production, so secondary filter systems will have to be used. Maybe in the future, each shower pipe will be equipped with a local filter system.

The suppliers have developed various filter systems which allow trouble free use of super clear filtered water for High Pressure showering. The cost situation apparently is interesting, because besides water quality improvements, savings are possible regarding fibre recovery and circuit closure.

Deposits, which are specific to the mill location and its water characteristics, may cause plugging of pipes, shower nozzles etc. Suitable water treatment will be required.

Picture 19: Cleaning brush in shower pipe



Frequently, shower pipes have built-in **cleaning brushes**, mentioned above already. These have some negative aspects:

1. Nozzle wear (when using conventional nozzles).
2. Bent bristles: brush becomes inefficient.
3. Contaminant will be retained by bristles, collects and causes nozzles to plug.
4. Brushes often are in the wrong zero position, and by that affect the nozzles' water jet properties.

In many cases, cleaning brushes were removed from HP shower pipes, to the advantage of operation. During machine shutdown the pipes are opened on FS (full section ball valve) and cleaned with a rotating HP pipe cleaning nozzle, which may even be done during production.

It has been tried – **successfully** – to connect the showers to the water supply and to high vacuum, by a 3-way valve. The pipe can thus be flushed by suction in regular intervals, to remove contaminants.

So-called "self-cleaning nozzles":

These are nozzles with a piston system which open up below a certain water pressure, thus flushing contaminants blocking the orifice. Unfortunately, these nozzles have some negative points:

- **very** poor jet laminarity
- **particularly** high flow rates
- sealing problems in operating position

Thus, they have almost disappeared from the market and are not used on modern rebuilds or new machines today.

5. Low pressure Showers for doctor and suction box lubrication lubrication must not be neglected, considering their influence on CMD profiles.

Proper nozzle equipment and shower oscillation are indispensable on modern paper machines.

Low Pressure Showers equipped with fan type nozzles are in operation in many locations in the Wire and Press Sections:

- Lubrication of doctors on wire and felt guide rolls
- Breast roll showers
- Cleaning pipes on headbox slices
- Before Suction boxes in Formers and before high vacuum boxes
- Knockoff showers in the nip between wire and drive roll
- Internally in suction rolls, for seal strip lubrication
- Before press felt suction boxes
- Before doctors on hard press rolls
- Lubrication of press transfer belts
- in coaters and size presses

These showers are frequently operated with clear filtrate water. They are equipped with so-called fan or flat jet nozzles.

The fan angles usually are 20°, 40°, 60°, 80° or 110°.

Depending on the type of application, the water quantity to be applied and the nozzle spacing, the nozzles will have a flow capacity in the range of 0.8 to 3 l/min; these showers are mostly operated at a water pressure of 3 to 6 bar.

The knockoff shower or flooded nip shower installed in the nip between the wire and the forward drive roll is an exception: this shower should be operated with high pressure (15 to 20 bar) and with a sufficient flow volume.

The required water quantity for the knockoff shower is approx. 1 l/min per m^2 of wire, i.e. at a PM speed of 1000 m/min, approx. 1000 litres (1 m^3) of water are required for a safe sheet knockoff.

Again, the requirements for lubricating showers generally (and for certain showers in particular, example: double doctor lubrication shower on center press roll and 4th press), the following must be considered:

The water application should be **as uniform as possible** in CMD. This means that the nozzle properties must not be underestimated.

It is a fact that many further parameters must be observed: doctor blade angle, blade pressure, blade material, geometric and dynamic properties of the doctor beam such as deflection, torsion, alignment, vibration, doctor oscillation and last but not least the shower water quality.

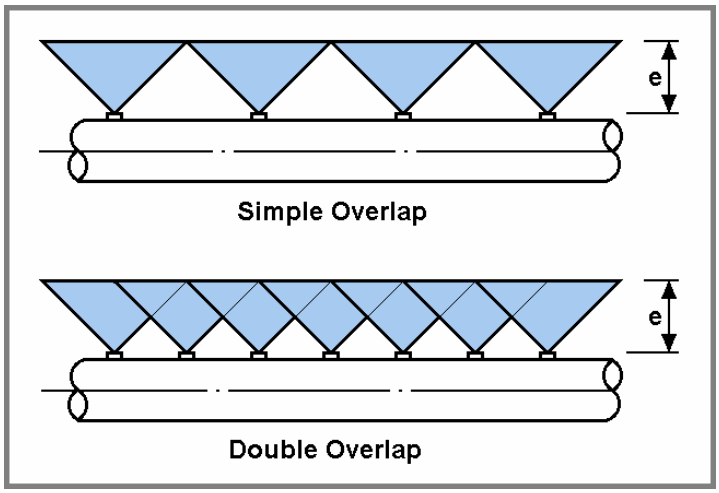
The water quantity required is determined by the type of application. Some examples:

- Center press roll lubrication doctor for ceramic roll on a fast running SC machine (before 1st blade: approx. 4 to 8 l/min/m width
- Wire guiding roll on fast running paper machine: approx. 6 to 10 l/min/m width
- Pickup felt suction box on fast running newsprint machine: approx. 6 to 8 l/min/m width

Fan showers should be positioned so that they provide a single or double overlap of the fans.

The distance **e** from the pipe to the reference impact surface and the fan angle enter into the consideration.

Picture 20: fan overlapping



The nozzles should have a perfectly even distribution of liquid in respect of both **water quantity** and **droplet size** over the width of the fan and keep this property for a long running period.

Unfortunately, a great number of showers are not matching these requirements at all. Even on very modern machines a very non uniform performance of Low Pressure Showers may be observed, with an influence on profiles.

Picture 21: streaky water application by non uniform fan jets

Due to the design of these nozzles the fan jet is stable only above a certain water pressure.

The fan jet created has a rather uneven profile concerning the water quantity distribution: the edges are much stronger than the center of the fan.

At low pressure the fan becomes instable and collapses in width: a streaky water application will be the consequence.

In the paper industry there are a couple of "profile hunters". These are production people who search for possibilities of improvement in a systematic way, in all locations where influences on profiles may be supposed.

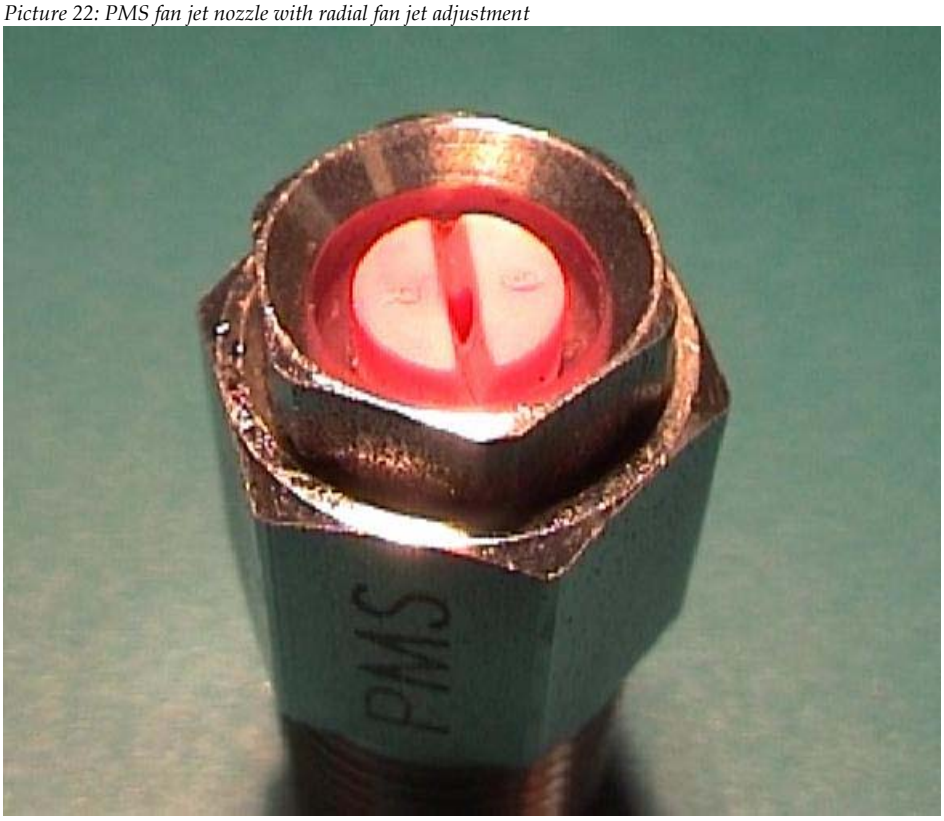
These "profile hunters" have recognized that the above mentioned showers deserve a lot of attention, particularly the ones before suction boxes in the press section and those for press roll doctor lubrication .

Measures taken by these people have led to significant improvements, such as:

- uniform dewatering, better CMD profiles
- improved runnability of wires and press felts, more uniform wear pattern
- more uniform doctor blade wear pattern, better paper run in presses

Today, a new generation of fan nozzles has appeared on the market, nozzles which – similar to Ruby nozzles – have a greatly improved fan jet quality and which have a far greater life potential than conventional nozzles, due to the choice of material.

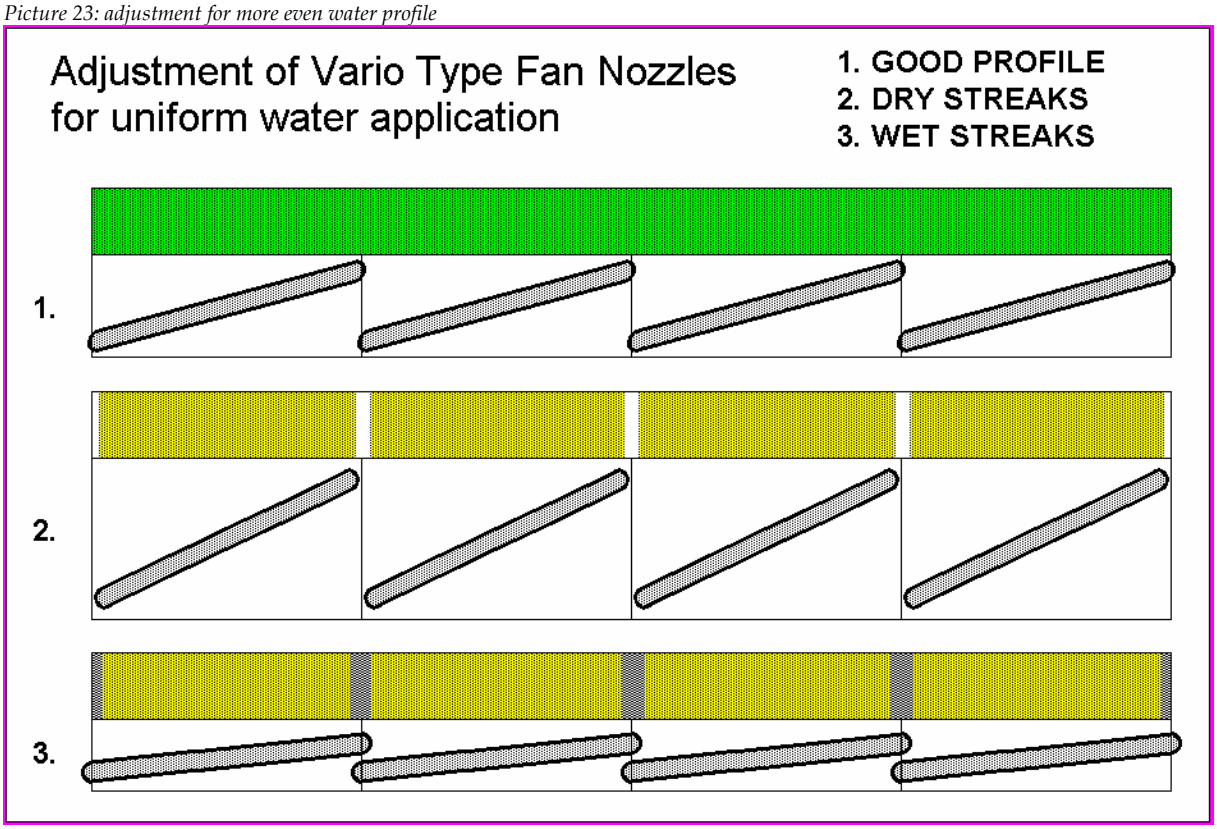
Picture 22: PMS fan jet nozzle with radial fan jet adjustment



These nozzles have inserts made of very fine grain ceramic material produced in a mould burning process to obtain parts with great precision, uniformity and reproducibility for an even water distribution and long life.

The nozzles are designed in a way that the jet orientation may be adjusted at any time, in order to obtain a most even water application.

Picture 23: adjustment for more even water profile



An additional step which has been made on a number of new machines is the design of **Oscillating** Low Pressure Showers. This has very positive consequences and it will be an increasing requirement in the future.

For felt showers, the pipe will be mechanically connected to the HP Shower. If the shower has its own oscillator the speed will be 1 to 2 mm/sec, with a stroke of one nozzle space.

Finally, it has to be mentioned that in many cases, edge fan nozzles are installed before and also between the felt suction boxes to moisten the press felt edges in the area of the suction box deckles.

6. Final Observation

- Today, safe knowledge of the **influence of shower conditioning** on clothing runnability exists.
- Optimizing High Pressure Showers results in better **CMD profiles**, increased **production** and improved **economy**. Also, optimizing Low Pressure Showers has a positive influence.
- On a great number of graphic paper machines, such improvements can be proven.
- Optimization concerns **nozzle equipment** and **oscillators** primarily, besides water quality improvements.
- A continuation of this trend can be expected, even on smaller machines, on Tissue machines and especially on machines in the packaging sector.

hjs 06/2004