TIP 0404-61

ISSUED – 2002
REVISED - 2006
REVISED – 2011
REVISED - 2017

Paper machine shower recommendations

Scope

This TIP outlines basic considerations for the application of showers on paper machines, and specific recommendations for showers to clean and condition forming and press fabrics. Dryer fabric cleaning is discussed in TIP 0404-38 "Dryer fabric cleaning."

The recommendations are presented as starting points to install and evaluate showers on paper machines. It is recognized that all machines are unique, and common sense is needed for specific applications.

Safety precautions

As with all system design and evaluation, standard safety procedures must be followed. When near a paper machine, special care must be taken to avoid unsafe contact with moving fabrics and machine elements, and potentially hazardous chemicals. Modern trends of hotter shower water use can result in very hot surfaces, requiring special care to avoid burns.

Definition of showers

Showers are by definition systems that apply fluids. On a paper machine, there are basically two types of showers: fan showers and needle or jet showers. Fan showers are used to apply fluid, almost always liquid and usually water, evenly across the whole cross machine width of a fabric. Sometimes fan showers are used for the application of chemicals. Needle jets are used to directly apply energy via a high velocity stream of liquid, almost always water, to the surface of a fabric. Even though these showers are both designed to apply liquid, they are very different in design and application.

Fan showers

Fan showers are designed to apply liquid evenly across the width of a fabric. Most often this liquid is water. It can also be water with chemicals to effect contaminants or some other aspect of operation. That water can be used for cleaning or lubrication.

Fan showers do not clean by direct application of energy with the water stream. Rather, water is applied in relatively large volumes and flushes, or floods, contaminants away. A lubrication shower is used to apply a surface film of water between a moving element and stationary element such as a doctor blade. For flooding, chemical, or lube showers, the most important factor to judge efficiency of operation is profile of water volume applied. Ideally, there is exactly the same volume per width applied for every unit width showered.

Showers are conventionally designed with nozzles. The most economical means of even water application is a row of discrete nozzles. For a fan shower, each orifice is produced such that the water is dispersed, or "fanned" out, evenly in the CD. *The quality of CD water distribution is predominantly determined by evenness and efficiency of CD dispersal through each nozzle.* Nozzles must be spaced such that for the standoff of the shower from the target, flow is even and consistent across machine and meets the volume requirements of the application. Alignment of fan showers should be checked often to ensure uniform CD fluid distribution.

Needle jets

While both fan and needle showers are designed to spray water, the mechanisms of their functions are very different. Fan showers deliver water for its own sake. Needle showers use water as a vehicle to apply power to the fabric to dislodge contaminants, usually at or near the surface. The mechanism of high pressure needle jet function is power application. The energy of a stream of water can be determined from the simple relationship

$$E = \frac{1}{2} m v^2$$

where E is energy, m is mass, and $\mathbf{v}$ is particle velocity. Local cleaning is determined by instantaneous energy. Energy over time is power P, which can be calculated as

$$P = \frac{1}{2} \dot{m} v^2$$

For a given orifice of fixed diameter, the operational parameter that determines both mass flow and velocity is pressure. (This assumes other factors such as viscosity are constant, a fair assumption for this system.)

Figure 1 illustrates the four zones of a needle jet. When the stream leaves the nozzle, the stream is clear and flow is laminar. As edge effects begin to become significant, turbulance is introduced into the stream, and the velocity profile becomes more uneven. The stream begins to contract in the second zone. In the third zone, air begins to mix with water and flow becomes two phase, but still remains reasonably concentrated. Eventually, in the last zone the flow begins to disperse and the jet becomes ineffective. Experiments have shown that the most effective point of cleaning is between zones two and three, after the jet has contracted but before it is dispersed, and while the flow is two phase. It is very interesting that laminar high pressure showering is relatively inefficient, as shown in Fig. 1. Particle collisions as droplets of water striking the fabric apparently play a large role in cleaning effectiveness.

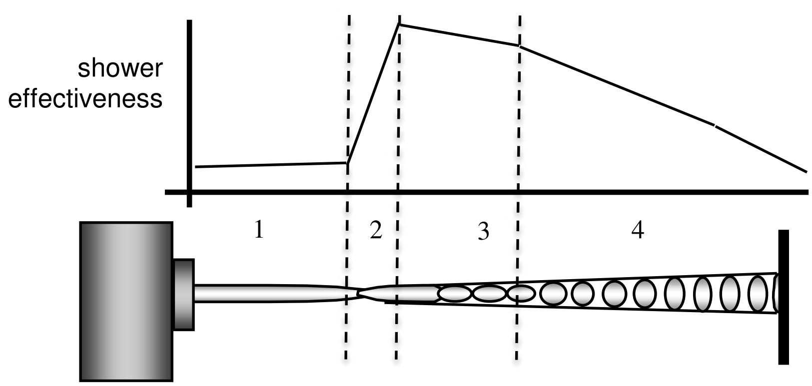

Fig. 1. Shower effectiveness vs. distance from the fabric.

For application, the above translates to an optimum placement of a high pressure shower from 6 to 10 inches from the outside surface of the fabric. Note that nozzle quality has a large effect on the jet character. A poor or worn nozzle will have a very short laminar zone and the flow will disperse immediately. It's easy to tell the condition of a nozzle by looking at the stream. If the flow disperses immediately, the nozzle should be replaced. Some nozzles by either character or quality never have laminar flow zones. A good example of these is a self-purging nozzle. Because the orifice is made up of two pieces of metal it is imperfect, and the flow almost always begins to break up the moment the water leaves the nozzle.

Application of power with a high pressure water stream is an effective way to clean a fabric surface. The "down side" of high pressure showers is that the mechanism that cleans is the same as that which destroys. If a needle jet is directed at a fabric for long enough duration and at high enough pressure, it will destroy the fabric. Therefore, needle showers should *not be run at a pressure higher than absolutely necessary to clean the fabric.* While it is optimum to oscillate fan showers, *it is absolutely imperative that needle jet showers be oscillated.* The stroke length of an oscillating high pressure needle shower should always be an integer multiple of the nozzle spacing. A stroke length of twice nozzle spacing gives double coverage and is useful should a nozzle plug, because "dry" streaks are prevented. Up to four times nozzle spacing is conventionally used for stroke length; the more the better. The speed of oscillation is important for complete coverage and cleaning. Oscillation can be synchronized with machine speed for perfect coverage. Optimally, oscillation rate is one nozzle width per fabric revolution. A .040 inch diameter orifice is the most common size. For machines without synchronized oscillation, it is better to run such that coverage is calculated for the slowest machine speed and reduntantly cover at higher speeds, rather than incompletely clean the fabric. This guideline is generally followed either with continuous motion oscillation or stepper motion.

Sometimes to reduce fabric damage especially for more delicate fabrics, needle jets are placed very close to the fabric. This greatly reduces the effectiveness of power application. It eliminates fabric damage, but it also reduces cleaning while maintaining the expense of pressurizing the water. It is far more efficient to leave the shower at its optimum stand-off and reduce pressure to acceptable levels.

Inside high pressure showers for forming fabrics are also often placed very close to the fabric. These showers are usually used to "flush" contaminants from the interstices of the fabric more than apply energy for surface contaminant removal. Single phase water flow penetrates better than droplets, so short flow spans are desirable.

Forming section shower applications

To achieve steady state operation, cleaning of forming fabrics should be done on a continuous basis, started when the fabric is new, using full-width oscillating showers. Pressures for needle showers should be high enough to clean and low enough to avoid fabric damage. All showers should be designed and placed using the considerations described above. Following are some specific "generic" recommendations, referring to the locations in Figs. 2 and 3. Each shower is described, and Table 1 gives operational specifics.

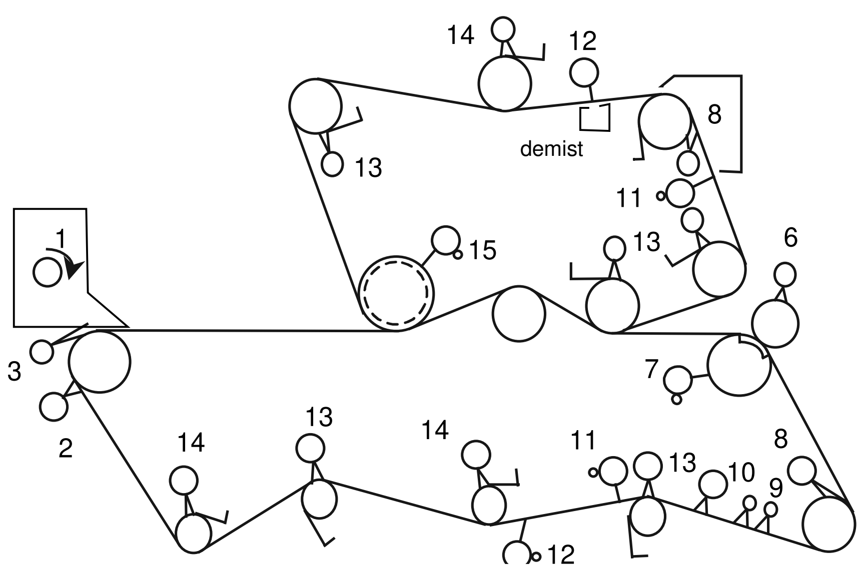

Figure 2

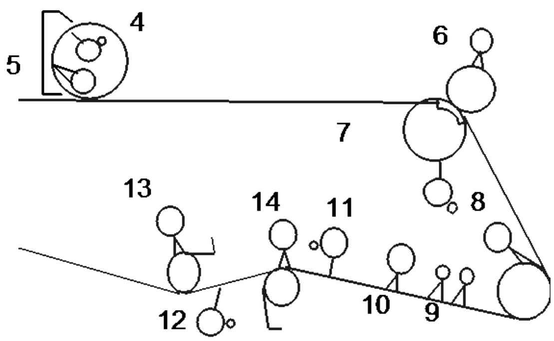

Figure 3

Headbox – Shower 1

A swing shower is used for atmospheric or open headboxes, not hydraulic headboxes. Its nozzle pipe rotates over a 180° arc. A pressurized or closed headbox uses a shower rotating a full 360° and is furnished with seals at each end. This shower thoroughly cleans the inner headbox using low pressure fan nozzles, preventing fiber build-up and knocking down foam on the pond. Sometimes small rotary tank wash units can be used for this application for reduced water consumption.

Breast roll - Shower 2

Located on the outside of the forming fabric and directed toward the center of the breast roll, this shower fills the void volume of the fabric to retard drainage immediately following the headbox slice. Using white water prevents thermal and pH shock.

Headbox apron - Shower 3

This shower, located on the headbox outside the forming fabric, directs water to the underside of the headbox. Its application minimizes stock build-up on the headbox apron, eliminating "drop offs" that compromise runnability.

Dandy roll - Shower 4

The dandy roll requires an oscillating needle jet shower on an extended header. Whenever possible, it is mounted inside the dandy roll with nozzles spraying upward, toward the headbox. The extended header positions the nozzles close to the roll surface and is most effective in keeping the face wire clean and fiber free. See TIP 0404-53, “Dandy Roll Applications,” for a more detailed discussion.

Dandy roll - Shower 5

This stationary air knife, located inside the dandy roll, is used to remove fiber and water from the dandy roll cover. This is not a common application and is rarely seen.

Lump breaker roll - Shower 6

To eliminate sheet stealing and fiber picking, this is a very low volume stationary fan shower designed to keep the lump breaker roll clean and moist.

Couch roll - Shower 7

To keep the couch roll functioning efficiently and to minimize corrosion, an oscillating high pressure shower is located outside the roll with needle jet nozzles directed at the centerline. High pressure water jets penetrate and scour all holes and countersinks. Double doctors on couch rolls have also aided in these functions.