Variables such as nozzle size, spacing, shower location, and distance from fabric will determine whether a fabric is cleaned or damaged

Needle Shower Review Highlights Best Approach to Setup, Operation

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Needle showering affects fabric performance, so when setting up a needle shower, the consequences of its action must be taken into consideration. A decision must be made on each of the following variables:

- Nozzle size
- Nozzle spacing
- Length of stroke
- Time of stroke
- Shower location (inside or sheet-side)
- Distance from fabric
- Angle of shower jet with respect to the fabric

Needle showering will affect fabric performance by cleaning the fabric, damaging the fabric, and changing surface characteristics. The shower can be set to clean, primarily, the surface of the fabric or the fabric internally. The shower can damage the fabric through batt removal. It can also put grooves in the batt that will mark the sheet.

FIGURE 1: *The most effective cleaning of a fabric occurs when the shower nozzle is 8 in. from the fabric.*

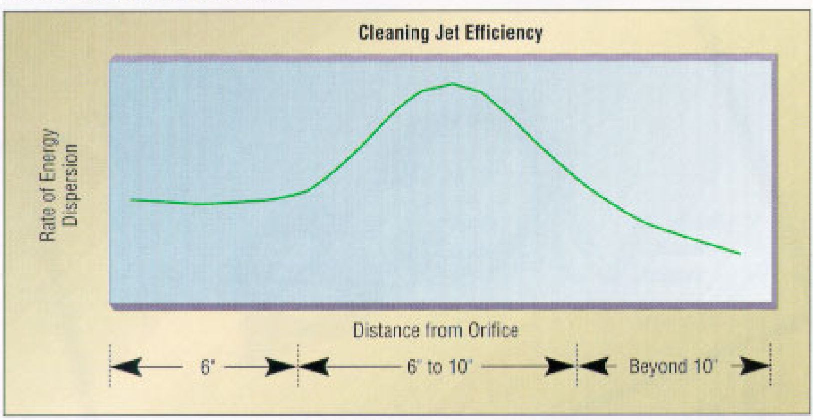
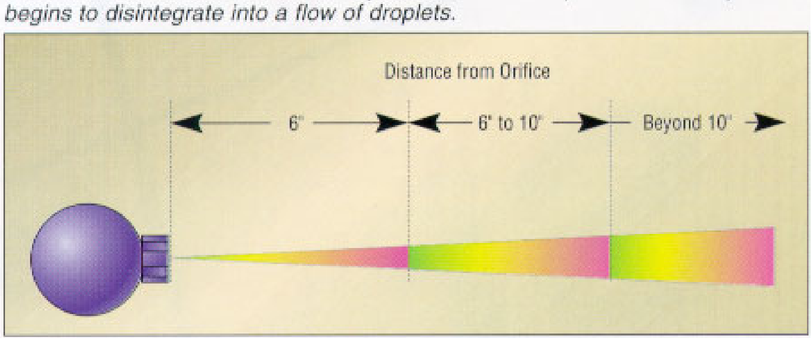


FIGURE 2: *Maximum needle shower performance takes place when the jet begins to disintegrate into a flow of droplets.*



Thus, surface characteristics are influenced by the effect on the batt. If the batt is fluffed, the fabric will more easily release the sheet. Blowing will be enhanced. If the batt is compacted, the fabric will have greater affinity for the sheet and blowing will be reduced.

LOCATION. Needle showers are located ahead of the Uhle boxes and preferably in an accessible location to facilitate nozzle cleaning. Needle showers can be on either the inside or sheet side of the fabric. In rare cases, they are used on both.

Predominately, needle showering is done from the sheet side. Press fabric evolution has been toward heavier fabrics and experience has favored sheet side cleaning as being more effective on heavy fabrics. Showers are operated from 30° into the run to 30° with the run. The distance is from 2 in. to 9 in. from the fabric.

Showers are typically operated continuously but in some cases they are operated on an intermittent basis. Sheet side shower pressures range from 100 psi to 450 psi. Inside shower pressures range from 350 psi to 700 psi. Inside showers are less damaging to fabrics.

NOZZLES. The industry seems to have adopted a standard nozzle size of 0.040 in. Smaller sizes tend to have severe plugging problems. Larger sizes use an unacceptable amount of water and energy.

Self-cleaning nozzles are sometimes used. These nozzles require less maintenance, but stream integrity is usually sacrificed.

Nozzles are normally spaced at 3 in., 6 in., 9 in., or 12 in. Nozzle spacing is determined by a balance between water consumption and energy expenditure against the amount of cleaning needed. The industry norm appears to be 6 in.

DISTANCE FROM FABRIC: Research, as reported by Olsson[1] showed that the most effective cleaning of a fabric was at a distance of 8 in. (Figure 1). The investigation showed that this maximum performance was obtained when the jet had started to disintegrate into a flow of droplets (Figure 2). This produced a hammering and vibrating action. However, experience on press fabrics indicates that operating at this distance is very destructive to batt and can only be tolerated at very low pressures.

If rate of energy dissipation is substituted for cleaning in Figure 1, a clearer understanding of the shower effect emerges. When viewed in this light, it can be seen that, in this 8 in. range, a large amount of energy is dissipated at the surface (the jet stream gives up its energy very rapidly).

If it is necessary to penetrate the fabric and carry energy deep into the fabric, the shower must be set much closer to the fabric. At less than 5 in., the solid stream maintains energy as it penetrates. The modern laminated fabrics generally require deeper penetration for good cleaning.

As a nozzle wears or experiences a partial obstruction, the breakup point will move toward the nozzle. Therefore, to stay safely inside the breakup point, the nozzle should be within 4 in. of the fabric.

FABRIC NAP AND JET ANGLE. The nap of the fabric lies in the opposite direction to the fabric travel (Figure 3). Therefore, the effect of the shower jet on nap is different if it is angled into the run from being angled with the run. When the jet is directed into the run, it will tend to densify and part the nap (Figure 4).

When the jet is directed with the run, it will tend to fluff the batt (Figure 5). Fluffing the batt will enhance sheet release, i.e., the fabric will have less affinity for the sheet. However, fluffy batt will carry air and increase the propensity to blow.

FABRIC MARKING. Needle showers will mark the fabric, and a marked fabric will mark the sheet. Oscillation speed appears to have the strongest effect on shower marking. When oscillation is slow (Figure 6), the cut made on the return stroke will remain in the cut made on the forward stroke for an extended period of time. When the oscillation is set for 100% coverage, i.e., 0.040 in. advancement per revolution, the return stroke cut will stay in the forward cut for most of a fabric revolution.

A high rate of oscillation will tend to break up this pattern (Figure 7). Setting the angle with the fabric run will help reduce the tendency to mark.

OSCILLATION. If a low rate of oscillation can be tolerated (see “Fabric Marking”), then 100% coverage can be achieved by advancing the nozzle 0.040 in. per fabric revolution. However, streaks of no coverage will occur if there is an oscillation in the fabric guide.

The time required for one stroke (one direction) to achieve 100% coverage for a 0.040” nozzle can be calculated by the following equation:

One direction stroke time is seconds =

$$\frac{\underline{1{,}500 \times \text{fabric length in feet} \times \text{stroke length in inches}}}{\text{machine speed in fpm}}$$

The speed of oscillation should be changed each time machine speed is changed. The oscillating mechanism should produce no hesitation at the ends of the stroke.

Stroke length is set at either one, two, or three times the nozzle spacing. At 9 in. spacing and above, the stroke length is usually the same as the nozzle spacing. It should be noted that 1/16 in. to 1/8 in. may be added to the stroke length to ensure complete coverage.

At 6 in. spacing, the stroke length is either 6 in. single coverage or 12 in. double coverage. Double coverage is more desirable than single coverage because it reduces the consequences of a plugged nozzle. At a spacing of 3 in., stroke length is usually 6 in. double coverage or 9 in. triple coverage.

SHEAR ANGLE. Since the fabric is moving, the contact point of each successive layer of fabric is offset for a jet stream entering the fabric perpendicularly. When a jet stream contacts the surface of a fabric, it takes a finite amount of time to penetrate to the next layer of fabric.

In this amount of time, the next layer of fabric has moved downstream an amount depending on the speed of the fabric (Figure 8). Each succeeding layer moves by an equal amount. This produces an angle through the fabric that will be referred to as the shear angle.

The shear angle is a function of shower pressure (jet stream velocity) and fabric speed (Figure 9). The jet stream will meet minimum resistance when set parallel to the shear angle.

The tests by Olsson[1] showed that optimum cleaning was achieved on a stationary sample with the shower set at perpendicular. He then suggested that to achieve this condition on a high-speed fabric the needle would have to be set at some angle downstream.

SHOVELING. Shoveling is sometimes used to remove surface contaminates. Shoveling is accomplished by sharply angling the shower (Figure 10). Shoveling is normally done into the fabric run. However, since there is little penetration, this imparts a large amount of energy to the batt and may remove batt. The energy is increased by the speed of the fabric (see “Equivalent Shower Pressure”).

EQUIVALENT SHOWER PRESSURE. When a shower stream contacts a fabric at any angle other than perpendicular, there is a force component either positive or negative due to the fabric velocity. In Figure 11, it can be seen that the shower is angled into the fabric run. Fabric velocity is broken into its appropriate vector velocity for the angle of the shower.

Collision velocity is the sum of fabric vector velocity and jet velocity of the shower. The equivalent pressure is the shower pressure that is required to produce a jet stream velocity equivalent to the collision velocity.

Figure 12 shows that for a machine running 3,500 fpm with the shower turned 30° into the fabric run and having a needle shower pressure of 300 psi, the equivalent pressure is 430 psi.

FIGURE 3: *The nap of the fabric lies in the opposite direction of the fabric travel.*

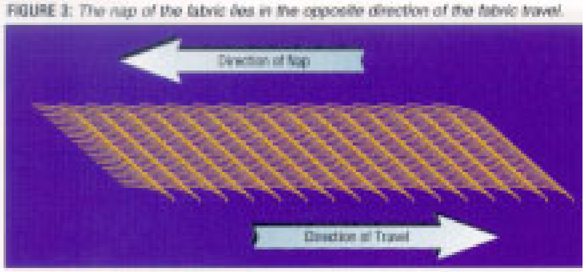


FIGURE 4: *A jet directed into the run will tend to densify and part the nap.*

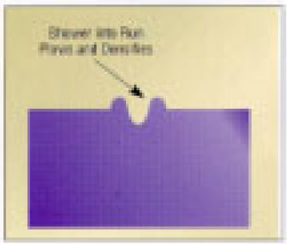


FIGURE 5: *A jet directed with the run tends to fluff the batt.*

FIGURE 6: *With slow oscillation, the cut made on the return stroke will remain in the cut made on the forward stroke for an extended period of time.*

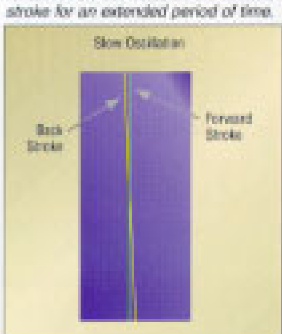


FIGURE 7: *Fast oscillation will tend to break up the single marking pattern.*

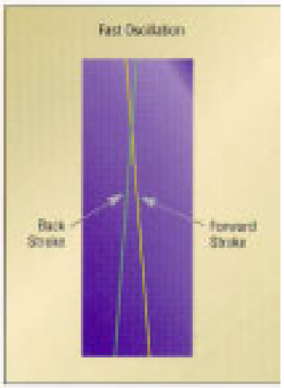


FIGURE 8: *It typically takes a finite amount of time for a shower to penetrate from the surface of the fabric to the next layer. In this amount of time, the next layer of fabric has moved downstream an amount depending on the speed of the fabric.*

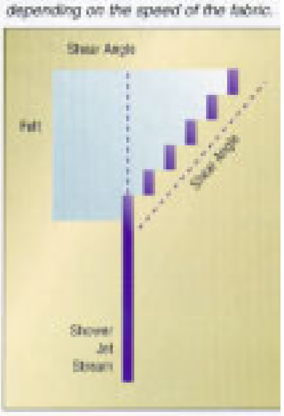


Figure 9: Shear angle is a function of shower pressure (jet stream velocity) and fabric speed. The jet stream will meet minimum resistance when set parallel to the shear angle.

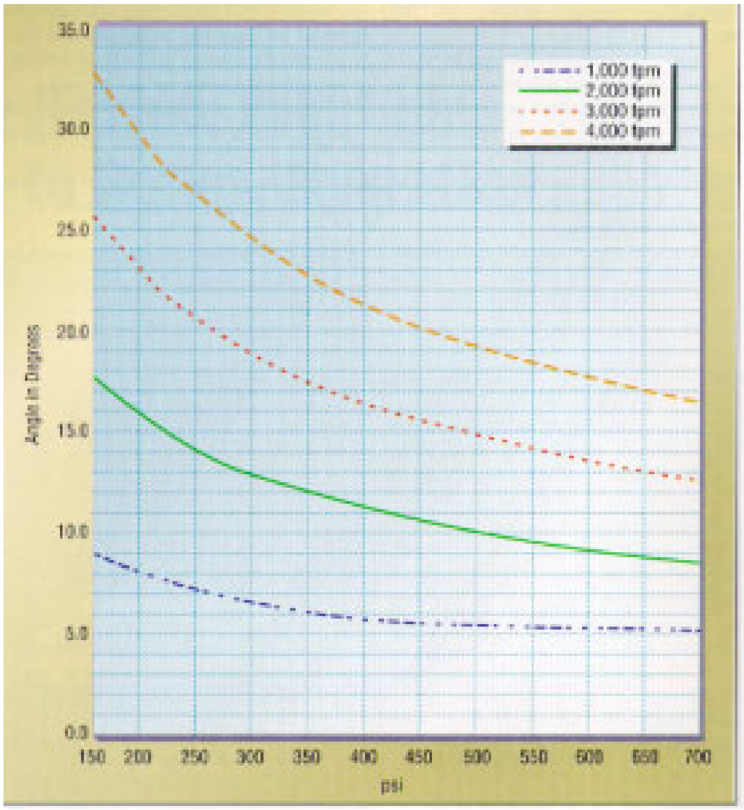


FIGURE 10: *Sometimes used to remove surface contaminates, shoveling results from sharply angling the shower.*

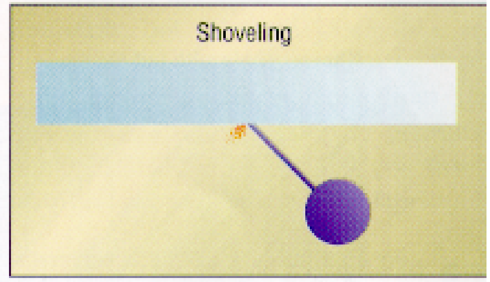


FIGURE 11: *Collision velocity is the sum of the fabric vector velocity and jet velocity of the shower.*

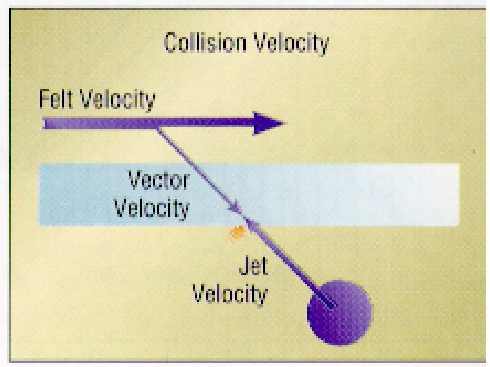


Figure 13 is similar to Figure 12 except that it is for a shower angled with the run. These graphs suggest that, at high machine speeds, fabric damage will occur at lower needle shower pressure when the needle is turned into the fabric than when it is turned with the fabric run.

WATER CONDITIONS. Water should be clean to prevent plugging of the nozzles and the temperature should be close to that of the fabric to prevent temperature shock. Water pH should be close to the headbox pH to prevent pH shock.

Temperature and/or pH shock will cause precipitation of contaminants. Once precipitation occurs, contaminants are much more difficult to remove.

RECOMMENDATIONS. Based on observations of various needle shower setups and operations, the following recommendations can be made.

- For penetration to clean the fabric interior (energy maintenance to the fabric interior):
  - Pressure should be high: 200 to 450 psi.
  - Distance from the fabric should be less than 4 in.
  - Shower angle should approximate the shear angle with the fabric run.
- For cleaning the fabric surface (rapid energy dispersion at the surface of the fabric).
  - Pressure should be low: 100 to 200 psi.
  - Distance from the fabric should be 7 to 8 in.
  - Shower angle should be into the run.
- Other:
  - Shower angle should be *with* the fabric run to reduce sheet stealing.
  - Shower angle should be perpendicular or *into* the fabric run to reduce blowing.

- Oscillation rate should be high and the shower should be angled with the fabric run to reduce marking.

FIGURE 12: *For a machine running 3,500 fpm with the shower turned 30° into the fabric run and having a needle shower pressure of 300 psi, the equivalent pressure is 430 psi.*

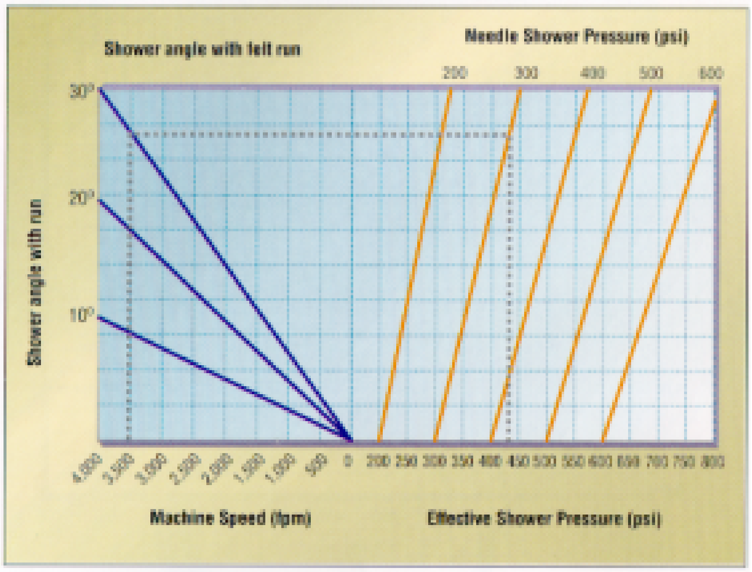
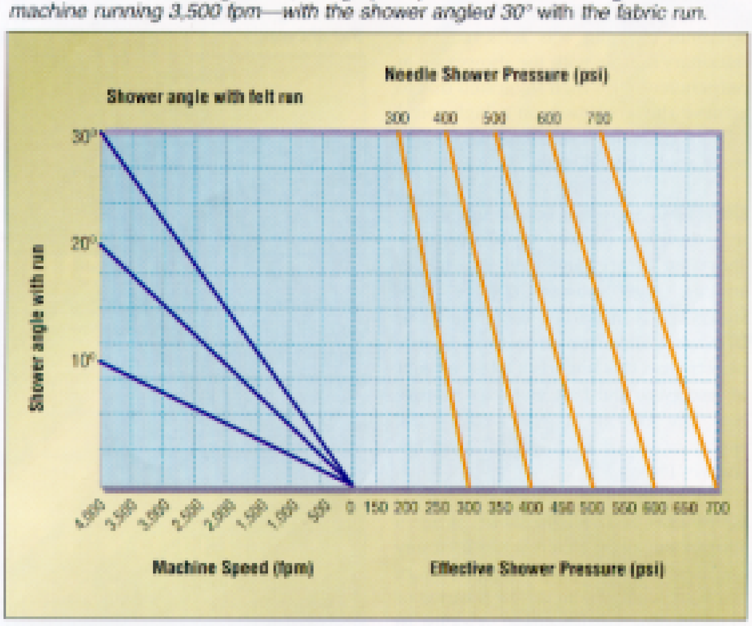


FIGURE 13: *Similar to Figure 12, this graph represents fabric damage for a machine running 3,500 fpm—with the shower angled 30° with the fabric run.*



REFERENCES

1. L. J. Olsson, "Cleaning of Forming Fabrics with High-Pressure Showers," *Pulp and Paper Canada*, Vol. 85, No. 9, 1984.