Mills Must Analyze Several Variables To Maximize Knockoff Effectiveness

Shower pressure, impact of water, and placement and number of nozzles are important factors in improving sheet release from the wire

By: Roy Jones

Although they may be losing favor to the more effective flooded nip and wash roll doctor knockoff (KO) techniques, conventional knockoff showers vary widely in performances. For those machines continuing to use knockoff showers, it is important to know how to maximize their effectiveness.

A number of variables affect knockoff showers:

- Gpm of nozzle
- Pressure
- Fan angle
- Single or up to double overlap
- Distance of the nozzle from the fabric
- Diameter of shower pipe (feed one or both sides)
- One or two shower pipes (pre-wetting plus KO)
- Fabric cfm is also very important[i]

IMPACT. The actual impact or force imparted in the vertical direction is the most important factor in determining whether the sheet will knock off. This is calculated as follows:

Theoretical total impact of a single nozzle

$$= 0.0526 \text{ (gpm of nozzle at spray pressure} \times \sqrt{\text{spray pressure (psi)}}$$

Note, if the gpm is known at some pressure, P1, but another pressure, P2, is desired,

$$\text{Then } gpm_2 = gpm_1 \frac{\sqrt{P2}}{\sqrt{P1}}$$

where gpm 1 / 2 is the nozzle gpm at pressure P1 / P2, respectively. Actual impact is reduced by increasing the fan angle since the same volume is spread over a wider area (Figure 1):

Using the fan angle and this figure,
Actual impact (psi) = theoretical X % impact.

However, since a fan operates in a fairly narrow band in the machine direction (MD), the force/linear CMD in., rather than the force/sq.in., is more important in defining its effectiveness. Therefore,

$$\text{Actual impact/in. (lb/in.)} = \frac{\text{number of nozzles x actual impact}}{\text{wire width (in.)}}$$

For example, a 364-in. machine at 2,000 fpm has two knockoff showers. The first shower, Shower A, has 61 nozzles, 6-in. spacing, 80° fan, and 8.74 gpm at 250 psi. The second shower, Shower B, has 122 nozzles, 3-in. spacing, 40° fan, and 4.79 gpm at 250 psi. Using the previous formulas:

Shower A theoretical impact
$= 0.0526 \times 8.74 \times \sqrt{250} = 7.269$ psi
Actual impact (using Figure 1)
$= 0.05 \times 7.269$
$= 0.363$ psi per nozzle.
Actual impact/in.
$= \frac{61 \times 0.363}{364}$
$= 0.0608$ lb/in.
Similarly for Shower B,
Actual impact/in. = 0.160 lb/in.

Obviously, Shower B is much more effective for knockoff, and it is doubtful if Shower A is necessary.

KNOCKOFF EFFICIENCY. Another factor in defining the effectiveness of a knockoff shower is how many gallons of water are used to create one unit of knockoff force or actual impact/in. of wire width. This can be called knockoff efficiency,

Where KO efficiency (lb-knockoff force/gal. of water used) =

$$\frac{\text{actual impact/in.}}{\text{total gpm/wire width}}$$

or more simply,

$$= \frac{\text{actual impact (psi)}}{\text{nozzle gpm}}$$

Now the knockoff efficiency of various showers can be compared from a water utilization viewpoint. Using the previous example:

Shower A

$= \frac{\text{actual impact}}{\text{nozzle gpm}}$

$= \frac{0.363}{8.74} = 0.0415$

Similarly Shower B

= 0.0998

Shower B, although using slightly higher total water consumption (584 gpm vs 533 gpm), is 2.4 times more efficient in producing knockoff.

Relatively low water pressure can be effective in producing good knockoff, provided the fan angle is low and the volume high, as shown in the following example. A machine 265 in. wide has a shower (Shower C) with 89 nozzles, each rated at 5.81 gpm at 125 psi, using 30° angle fans, and 3-in. spacing positioned 5½" from the fabric.

Theoretical impact

$= 0.0526 \times 5.81 \sqrt{125} = 3.417$ psi

Actual impact

$= 0.155 \times 3.417 = 0.53$ psi

Actual impact (lb/in.)

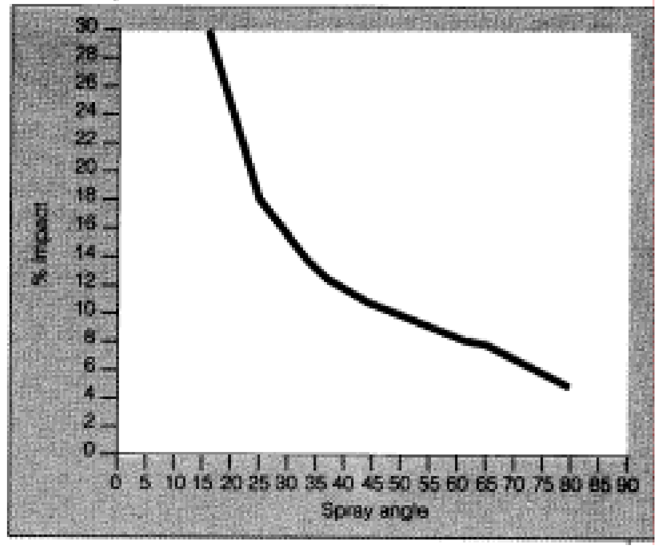
$= \frac{0.155 \times 3.417 \times 89}{265}$

= 0.178 lb/in.

KO efficiency

$= \frac{0.53}{5.81} = 0.91.$

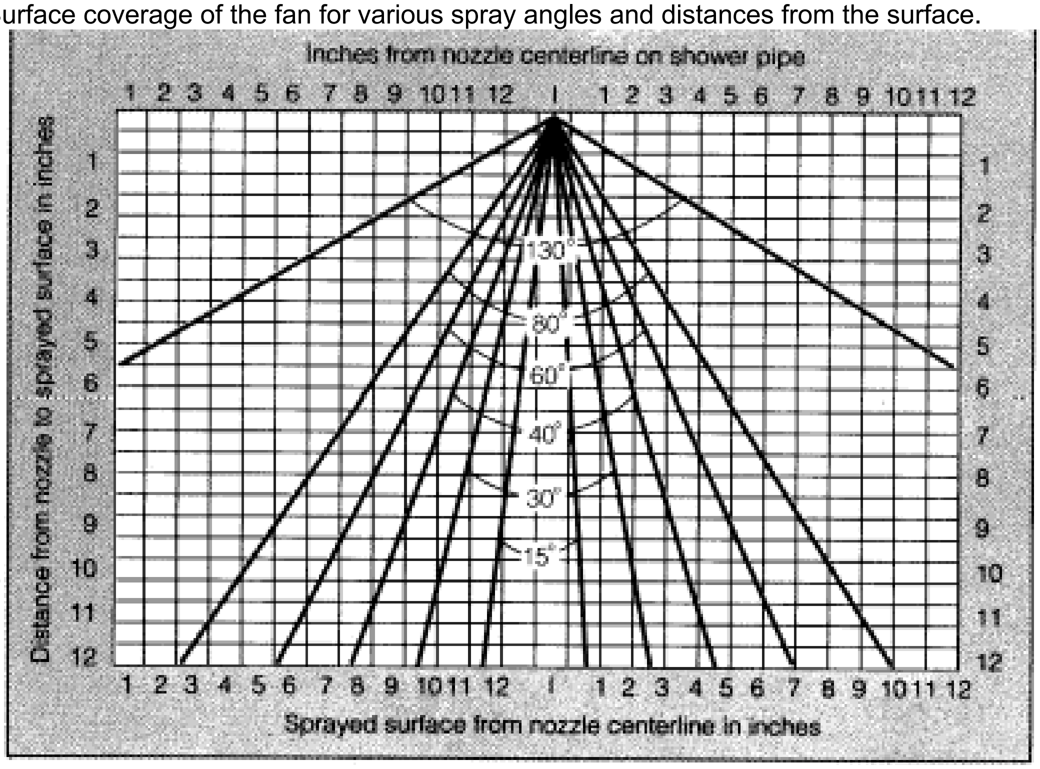
FIGURE 1: **In comparing the percent of impact vs the spray angle, impact is reduced by increasing the fan angle since the same volume is spread over a wider area.**



This shower, using 517 gpm, is more effective than Shower A and almost as efficient as Shower B in the earlier examples. The difference in Shower B and C is the overlap of the adjacent fans.

FAN OVERLAP. Figure 2 shows the surface coverage of the fan for various spray angles and distances from the surface. It has been found that the most effective distance to maximize the impact force is in the 4-in. to 7-in. range (maximum at about 6 in., falling off sharply above 8 in.).

FIGURE 2: Surface coverage of the fan for various spray angles and distances from the surface.



> ***The true test of a shower's effectiveness in assisting knockoff is whether it is doing anything to initiate sheet release from the wire or to change the trajectory of the released sheet.***

Some shower manufacturers have provided up to a double overlap to ensure coverage if any adjacent nozzles block up. Note that overlapping spray patterns must be offset in the machine direction, otherwise the interference pattern can substantially reduce the knockoff force.

In the sample with Shower B, the nozzles with 40° angles on 3-in. centers produce a 4-in. wide pattern at 5½", whereas Shower C nozzles with the 30° angle on 3 in. produce only a 3-in. wide pattern at the same distance. However, knockoff Shower C is desirable since it maximizes the knockoff force for this low-pressure application, and other methods should be employed to keep the nozzles clean and effective.

SHOWER PIPE DIAMETER; MULTIPLE SHOWER PIPES. The diameter of the shower pipe should be such as to keep pressure drop across the pipe to a minimum. A pressure gauge should be located on both the front and back side of the pipe. Above 250 in., consideration should be given to feeding the shower pipe from both sides to assure uniform pressure distribution across the entire machine width.

Multiple showers are used on some machines. Showers A and B in Figure 5 show the idea of an initial "pre-wetting" shower followed by a higher-impact shower. This is not the most efficient use of knockoff water and can actually be detrimental to effective knockoff in some cases.

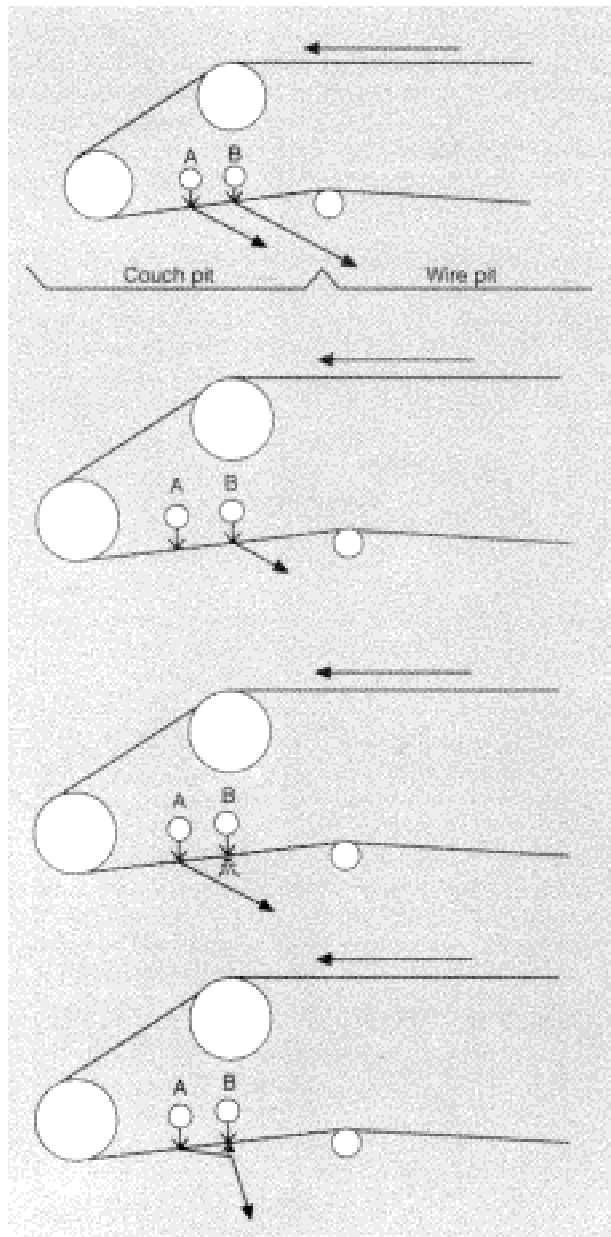
If both showers are fed off one water supply, the pressure to each shower can drop if the two showers are used at once and volume is somewhat limited. Pre-wetting does nothing to improve impact; either it knocks the sheet off or it doesn't.

Since the initial pre-wet shower is located closer to the couch than the knockoff shower, the knocked-off sheet's trajectory would more likely land it in the wire pit than it would have if Shower B replaced Shower A (Figure 3).

This can cause a problem on some machines, but relocating the higher-impact knockoff shower closer to the couch can solve it. The true test of a shower's effectiveness in assisting knockoff is whether it is doing anything to initiate sheet release from the wire or to change the trajectory of the released sheet.

In Figure 4, Shower A is ineffective in assisting knockoff, as is Shower B in Figure 5. In Figure 6, both showers are assisting in producing the desired result of knocking the sheet off and landing it into the couch.

FIGURES 3-6: Some machines use multiple knockoff showers, with an initial "pre-wetting" shower followed by a higher-impact shower. However, depending on the way the showers are set up, this may not be the most efficient use of knockoff showers.



[i] Roy Jones, Sheet Release Problems, *Pulp & Paper*, Vol. 62, No. 8, August 1988, p. 108.