OPTIMA

TECHNICAL BULLETIN

Volume VI • Number 3

OVERVIEW

- Screen plate characteristics – patterns, open areas, and types of holes – affect both the quality and efficiency of the screening system.
- The 60-degree and 45-degree staggered centers are the most common hole patterns.
- Open areas can be determined for various patterns by using formulas.
- Generally speaking, drilled holes, rather than punched holes, provide the greatest stability and flexibility for screen plates.

A Basic Guide to Open Area for Screen Plate/Cylinder Selection

Developed by the Technical Group, J&L Fiber Services

Many mills operate their screening systems at less than optimal quality or efficiency. Typically the remedy involves trade-offs: operate at reduced capacity or endure lower quality. The preferred solution, of course, is to change the system to operate efficiently at maximum capacity and quality. Most mills cannot change the stock characteristics – such as fiber length, consistency or freeness – so the logical step is to change the screen plates.

Since screen- cylinders come already installed in a new screen, it can be difficult to designate specifics other than the hole size. The replacement cylinders are often handled by Maintenance or Purchasing, so screening room personnel may have little or no input. Occasionally, changes are made at the suggestion of a mill superintendent or even a screen vendor. For the most part, however, the details of open area, hole pattern, hole design, and metal thickness and type are seldom discussed.

This guide is intended to shed some light on screen plate characteristics. It will show the standard patterns available, as well as simple ways to determine your pattern and open area. It will also describe the different methods for making holes in metal, and how this relates to screen plates which are made into cylinders.

Hole patterns

Round holes are punched or drilled in two basic patterns: 45-degree and 60-degree staggered centers. These patterns get their designations by the angle between adjacent-hole center lines (*Fig. 1*).

The 60-degree staggered-centers pattern is the most commonly used. It is visually determined by locating a

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hexagon with a hole in the middle. The 45-degree staggered-centers pattern is the second preference. It is best described as a square with a hole in the middle. There are also variations to these patterns that are available. These variations expand or compress the hexagon to create higher or lower open area.

Open area

Open area is a perforating trade term used to describe the number of holes per square inch. The more holes per square inch, the larger the open area. Open area is expressed as the percentage of open space in relation to the total area. Open area is shown graphically in *Figure 2*. If a four-square-inch area has a one-inch square punched out of it, then $^1/_4$ or 25% of the total area is open. The same holds true for a round hole.

There are formulas that can be used to determine the open area for 60-degree and 45-degree staggered-centers patterns. The formula for the 60-degree pattern is as shown in *Figure 3*.

The formula for determining the open area for the 45-degree pattern is as shown in *Figure 4*.

Fig. 1: Two basic hole patterns

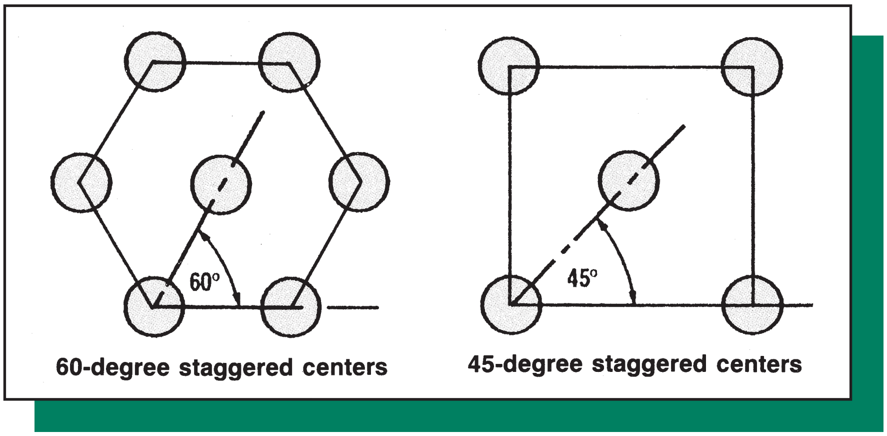


Fig. 2: Open area

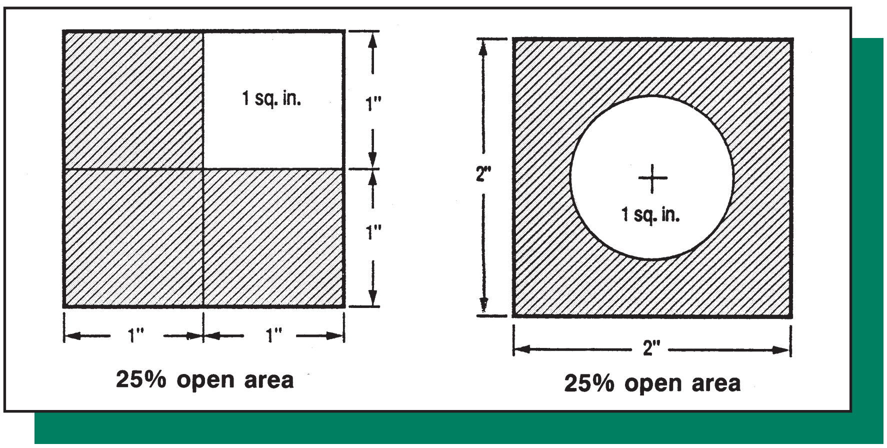
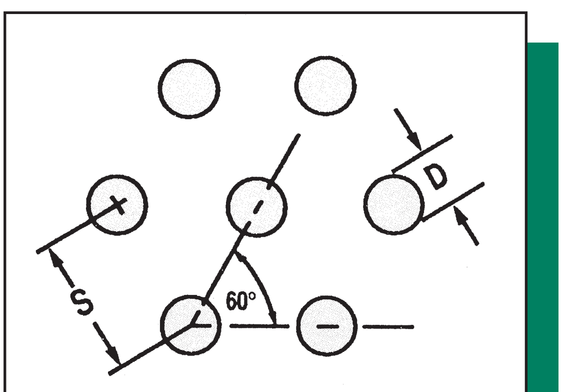


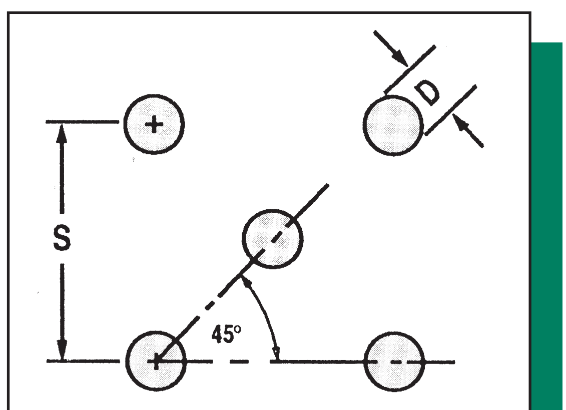
Fig. 3: Determining the open area in a 60-degree pattern



$$\frac{90.69 \times (D)^2}{(S)^2}$$

D = hole diameter
S = center spacing

Fig. 4: Determining the open area in a 45-degree pattern



$$\frac{157.08 \times (D)^2}{(S)^2}$$

D = hole diameter
S = center spacing

If it is unclear whether a pattern is a perfect hexagon (60-degree centers), the formula in *Figure 5* is used.

Types of holes

There are three basic types of holes: the slot, the punched hole, and the drilled hole (usually conically drilled). This *Optima* will deal only with the round punched hole and the drilled hole.

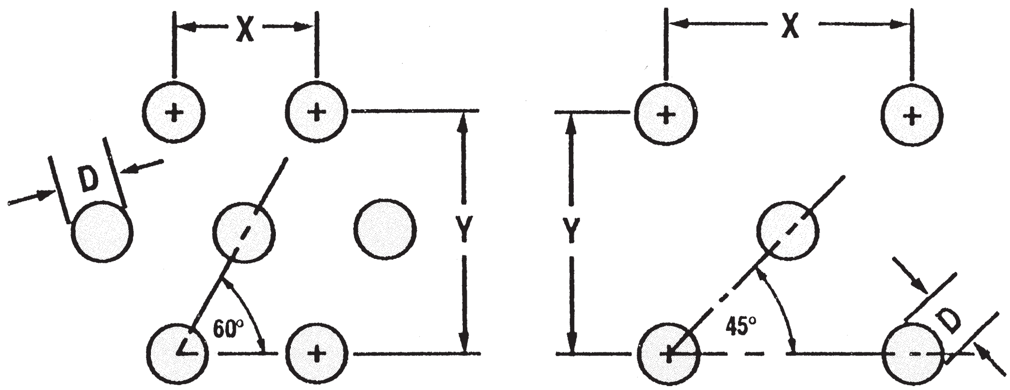
The punched hole was developed for use in the centrifugal screen. These screen plates are produced by forcing a punch through a metal plate and into a die, similar to punching holes in leather, or pressing cookies with a cookie cutter. A separate die set must be produced for every hole diameter and different pattern. The parts fit together to form the die set as shown in *Figure 6*.

The metal passes between the stripper and the die section. A blow is delivered by the press to the backup plate and punches. The punches cut through the upper 1/3 of the metal until the yield point is met, and the remaining 2/3 of the metal thickness is torn away. The stripper cleans metal away from the punches on the upstroke. Die sets are costly because they have to be produced to exacting tolerances by skilled craftsmen.

Fig. 5: Determining the open area of any pattern

$$\frac{157.08 \times (D)^2}{(X \times Y)}$$

D = hole diameter
X = center spacing in horizontal direction
Y = center spacing in vertical direction



X = .577″
Y = 1″
D = ¼″

X = 1″
Y = 1″
D = ¼″

Therefore, the pattern on the left has an open area of:

$$\frac{157.08 \times (1/4)^2}{(.577 \times 1)} = 17\%$$

The pattern on the right has an open area of:

$$\frac{157.08 \times (1/4)^2}{(1 \times 1)} = 9.8\%$$

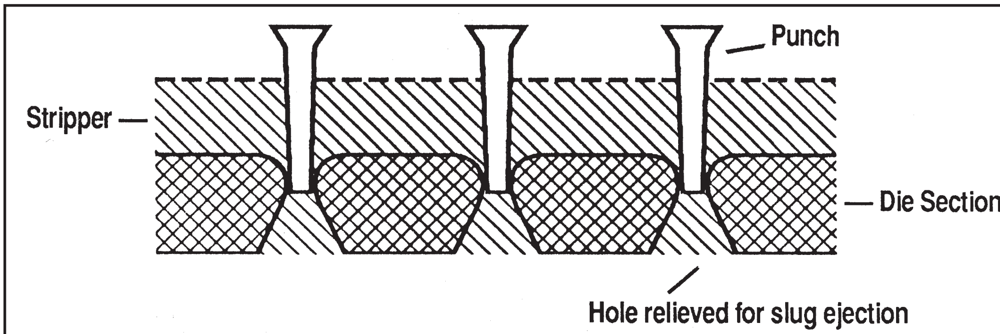
Since these patterns are exact 60-degree and 45-degree staggered-centers patterns, the open area can be double-checked by using the original formulas measuring the dimensions of "S", "X" and "Y":

$$\frac{90.69 \times (1/4)^2}{(.577)^2} = 17\%$$

$$\frac{157.08 \times (1/4)^2}{(1)^2} = 9.8\%$$

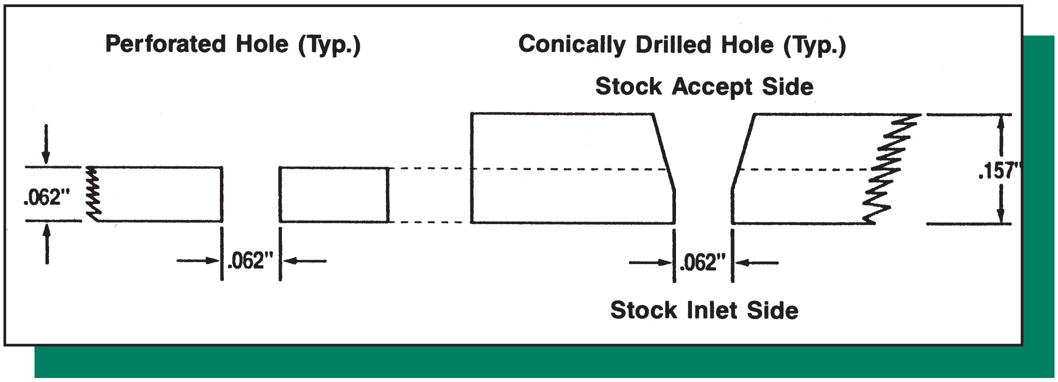
Rather than work directly on the screen plate, it is easier to get the needed center spacings from a pencil rubbing. Simply put a piece of paper on the screen plate and rub it with a No. 2 pencil. Measure the distances between ten holes in each direction and divide the total by ten. This will result in higher accuracy.

Fig. 6: Die set for punched hole pattern



Their expense limits the number of hole diameters and patterns available to the screen-cylinder user.

Fig. 7: Comparison of pass-through characteristics of perforated and conically drilled holes



Another limitation of punched plates is the thickness of the metal. It is a general rule of thumb that the thickness of the metal cannot exceed the diameter of the hole. This is particularly true with stainless steel. Since mechanical pulp is usually screened with a small hole (.050–.065"), punched screen plates are limited to a thickness around #16 ga. (.062"). These thin plates require extensive backing support which restricts the available screening area.

Punching can also work-harden a material, making it brittle. Because of the energy added to the punched plate, the plate becomes deformed and must be roller-leveled after perforating. The leveling helps remove the irregularities, but does not remove all of the stresses in the plate. One way to overcome this problem is to drill the hole rather than punch it.

The conically drilled hole solves many of the problems of the perforated hole.The hole is smoothly machined so there are few stresses created. Thickness is not limited, and the material is not work-hardened. Due to the increased thickness and added strength, much of the backing support can be removed. This allows more available screening area. Since the hole is conical in form, fibers pass through in a similar fashion to the perforated hole (*Fig. 7*).

One of the benefits of using a conically drilled hole comes from the machine used to make the holes. Unlike the perforating press with the rigid die set, the drilling machine is very flexible. The patterns can be easily changed because the drilling heads and the work piece holder can “float” in almost any increment. A given hole size can have over forty different center spacings instead of the four or five for the punched hole. This is very important in solving a variety of screening problems. You can shorten the center spacing in the X direction to get more open area, but leave the Y spacing the same to prevent stapling (*Fig. 5*). Or, conversely, you can increase the Y dimension to reduce stapling, but reduce the X dimension to keep the open area at a desired level. This variance in X and Y is also helpful if you want to keep the same hole diameter, but increase or decrease the open area.

It would be an oversimplification to say that changing the open area of conically drilled holes can solve all screening problems. However, it is easier to fine tune a screening system when the hole diameters, open areas, and center spacings are so flexible.

Conclusion

This guide should make some of the terminology of the screen plate/cylinder producer more understandable. Armed with a working knowledge of screen plate characteristics, the user can choose the optimum patterns, open areas, and hole types for any screening application.

Look for an explanation of slotted screen cylinders in an upcoming *Optima*.

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