Select the Best Nozzle for Cost-Effective Shot Peening

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To be of any value, the shot peening process must be consistent and repeatable. To achieve those goals, your shot peening nozzle must deliver a uniform quantity of shot traveling at a consistent velocity as it strikes a given surface area. These two forces combine to produce the peening intensity, and peening intensity is what you measure when you read the arc of an Almen strip.

Because most companies employ air-powered pressure blast shot peening systems, this article will concentrate on nozzles for pressure blasting.

For shot peening, you need a blast nozzle that generates the required peening intensity while providing a cost-effective production rate.

Pressure blast nozzles come in straight bore and venturi shapes. Both are sharply tapered from the point where the air and media enter the orifice—the section with the smallest inside diameter (ID). This rapid reduction in ID and controlled expansion of the air moving through the tapered outlet, work together to accelerate the shot. For maximum acceleration, the nozzle orifice should be about one-third the ID of the blast hose. (In fact, the nozzle orifice must be the narrowest point in the entire system.)

In a straight-bore nozzle, the ID remains constant from this point to the end. When the air and shot reach the end of the nozzle, the less-dense air quickly expands (without the controlling influence of the tapered outlet), while the momentum of the shot tends to carry it along the center of the blast pattern.

The result—a straight bore nozzle has a smaller blast pattern with a center area of very high intensity tapering out to lower intensity at the perimeter. It takes longer to cover a large surface area with this small hot spot of higher-intensity peening, compared to a venturi nozzle. This hot spot means a straight bore nozzle works well peening in recessed or restricted areas.

Inside a venturi nozzle, the ID tapers outward past the orifice, allowing the mixture of air and shot to expand more uniformly before it exits the end of the nozzle. A venturi nozzle gives excellent peening intensity, but, more important, it delivers that intensity more uniformly across the blast pattern.

The precise ratio of a venturi nozzle's length to its entry and exit tapers determines its efficiency at creating a large blast pattern with uniform intensity.

As a venturi nozzle begins to wear, it allows more air and shot to pass. Unless the compressed air supply can keep up with the increased flow, pressure at the nozzle begins to drop. Even though more air and media flow through the orifice, media velocity and peening intensity begin to fall.

Nozzle orifice sizes are measured in sixteenths of an inch. Once the nozzle wears one size, or to one-sixteenth inch greater ID than it started, it should be replaced. Beyond that point, the pattern may deviate, peening intensity drops, and the liner may become so thin it can crack and fail catastrophically.

All nozzles wear out. The relative life expectancy for a nozzle hinges on the composition of the liner material and of the blast media. The harder the peening media, the more durable the nozzle liner needed. Table 1 shows the relative life expectancy for the three most popular nozzle liner materials used with two commonly-used peening media.

Table 1

Nozzle Liner Composition	Nozzle Life (Hours) Steel Shot
Tungsten Carbide	400 to 700
Silicon Carbide	500 to 800
Boron Carbide	1,000 to 1,500

All carbide nozzles work well with steel shot, but for glass bead or ceramic shot, boron carbide nozzles deliver consistently longer life.

Much like a magnifying lens, a nozzle has an optimum operating distance, the distance from the end of the nozzle where the blast pattern is well-defined and the shot is moving at near-maximum velocity. Move the nozzle too close, and the smaller pattern requires more overlaps to achieve complete coverage; too far, and shot velocity decreases and the production rate slows to a crawl.

To calculate the blast pattern size for a venturi nozzle, multiply 0.125 times the distance from its end to the work surface. Then, add the ID of the nozzle orifice.

For example, a number 6 pressure nozzle (6/16 ID) positioned 8 inches from a surface has a 1.375-inch diameter pattern.

8 inches x 0.125 = 1
Plus the nozzle ID of 0.375 inch (that's 6/16 or 6÷16)
= a blast pattern of 1.375 inch

Once you know the pattern size, you still must determine the best way to cover the desired surface area as quickly as possible—move the nozzle, move the part, or add nozzles—but that's a topic for another article. ❍