A Guide To Blasting: Nozzle Selection

Choosing the right blast nozzle for each application is simply a matter of understanding the variables that affect cleaning performance and job costs. There are four basic questions to answer for optimum cost/performance.

WHAT BLAST PATTERN DO YOU WANT?

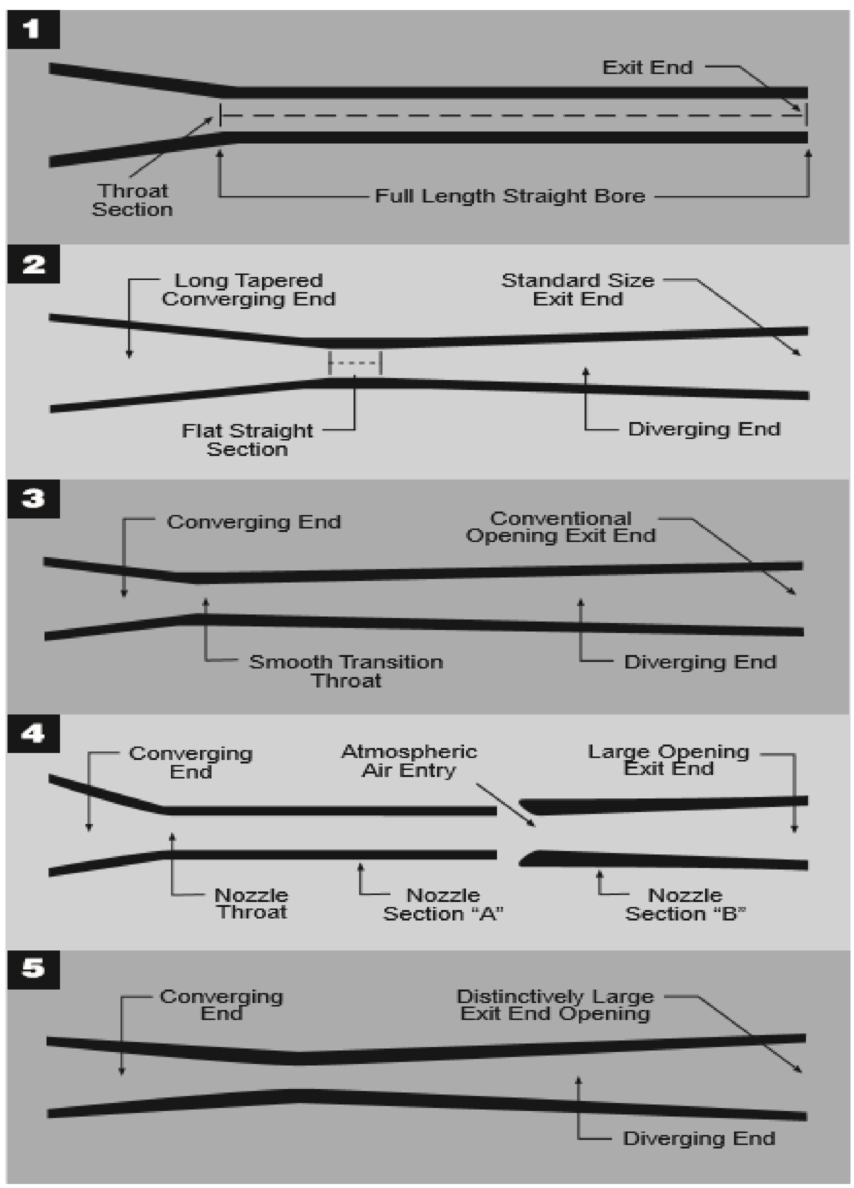
A nozzle's bore shape determines its blast pattern. Nozzles generally have either a straight bore or a restricted, venturi bore. **Straight Bore** nozzles (Figure 1, Number 1) create a tight blast pattern for spot blasting or blast cabinet work. These are best for smaller jobs such as parts cleaning, weld seam shaping, cleaning handrails, steps, grillwork, or carving stone and other materials. **Venturi bore** nozzles (Figure 1, Numbers 2 and 3) create a wide blast pattern and increase abrasive velocity as much as 100% for a given pressure. Venturi nozzles are the best choice for greater productivity when blasting larger surfaces. Long venturi style nozzles like the BRUISER® blasting nozzles, for example, yield about a 40% increase in productivity compared to straight bore nozzles, while abrasive consumption can be cut approximately 40%.

Double venturi and wide throat nozzles are enhanced versions of the long venturi style nozzle.

The **double venturi** style (Figure 1, Number 4) can be thought of as two nozzles in series with a gap and holes in between to allow the insertion of atmospheric air into the downstream segment of the nozzle. The exit end is also wider than a conventional nozzle. Both modifications are made to increase the size of the blast pattern and minimize the loss of abrasive velocity.

FIGURE 1. NOZZLE TYPES

1. Straight bore
2. Conventional design long venturi
3. Laminar flow design long venturi
4. Double venturi
5. High pressure



Wide throat nozzles (Figure 1, Number 5) feature a large entry throat and a large, diverging exit bore. When matched with the same sized hose they can provide a 15% increase in productivity over nozzles with a smaller throat. When wide throat nozzles also feature a larger diverging exit bore (e.g., BAZOOKA® nozzle), they can be used at higher pressures to yield up to a 60% larger pattern with lower abrasive use.

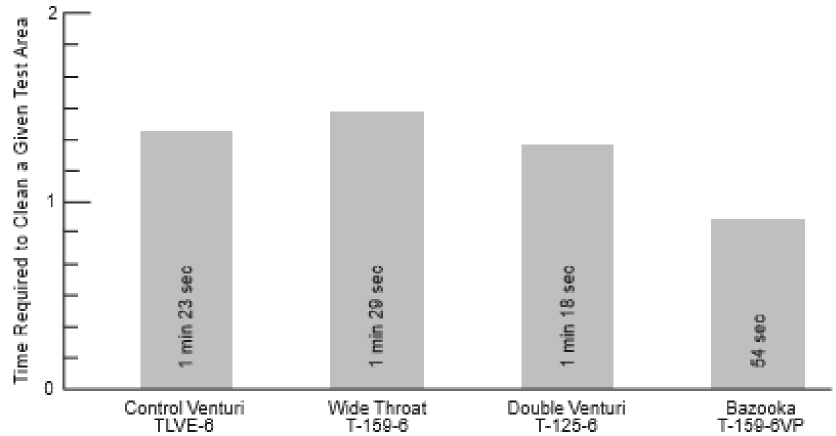
It's also a good idea to have **angle nozzles** available for tight spots like bridge lattice, behind flanges, or inside pipes. Many operators waste abrasive and time waiting for ricochet to get the job done. The little time it takes to switch to an angle nozzle is always quickly recovered and total time on the job is reduced.

CAN YOUR COMPRESSED AIR SUPPLY SUPPORT THE NOZZLE?

As a general rule, the air supply system should be able to provide at least 50% more air volume (cfm) than a new nozzle would need to develop the required working blasting pressure, whether that is 100 psi or 140 psi. This ensures a nozzle can continue to provide good service even after it is slightly worn. Remember, though, excessive wear should not be allowed or productivity decreases dramatically.

Keep in mind, too, the nozzle entry throat must match the inside diameter of your air supply hose. The wrong size combination can lead to wear points, pressure drop, and excessive internal turbulence.

FIGURE 2. NOZZLE PERFORMANCE COMPARISON



	Control Venturi TLVE-6	Wide Throat T-159-6	Double Venturi T-125-6	Bazooka T-159-6VP
Size of Blast Pattern (Nozzle-to-Surface Distance, 18 in.)	3 in.	3 in.	3 in.	4 in.
Av. Back Pressure (lbs.)	15	13	14	11

Data compares the time required of different nozzles to clean a given test area based on the nozzle's blast pattern. Also shown is the average back pressure exerted by each nozzle, an indicator of the effect of nozzle selection on operator fatigue.

MATCHING NOZZLE SIZE AND COMPRESSOR SIZE FOR REQUIRED PRODUCTION RATE

Production rate required (sq. ft./hr)	Blast nozzle orifice	Production rate at 100 psi nozzle pressure	Production rate at 90 psi nozzle pressure	Production rate at 80 psi nozzle pressure	Compressor size CFM at 100 psi nozzle pressure
Up to 100	1/4"	100	85	70	185 cfm 40-50 h.p.
101-160	5/16"	160	136	112	250 cfm 60-75 h.p.
161-230	3/8"	230	195	161	375 cfm 75-100 h.p.
231-317	7/16"	317	270	222	450 cfm 125 h.p.
318-400	1/2"	400	340	280	600 cfm 150 h.p.

This chart is estimated and based upon use of a long venturi nozzle, SSPC-6 commercial blast specification.

NOZZLE PRESSURE, ABRASIVE VELOCITY AND EFFICIENCY

Blast Nozzle Pressure	Estimated Abrasive Velocity	Estimated Efficiency Factor
140 psi	588 mph	160%
125 psi	525 mph	138%
110 psi	462 mph	115%
100 psi	420 mph	100%
95 psi	400 mph	93%
90 psi	365 mph	85%
85 psi	330 mph	78%
80 psi	270 mph	70%
75 psi	210 mph	63%
70 psi	190 mph	55%

NOZZLE AIR AND PRESSURE REQUIREMENTS

		NOZZLE PRESSURE PSI (BAR)						
NOZZLE ORIFICE	**AIR, POWER, AND ABRASIVE REQUIREMENTS**	**50 (3.45)**	**60 (4.14)**	**70 (4.83)**	**80 (5.52)**	**90 (6.21)**	**100 (6.89)**	**125 (8.62)**
1/8 inch (3.2 mm)	AIR (cu ft/min) (cu m/min)	12 (0.34)	13 (0.37)	15 (0.42)	18 (0.51)	19 (0.54)	21 (0.59)	26 (0.74)
	HORSEPOWER (hp) (kW)	1.75 (1.30)	2 (1.49)	2.5 (1.86)	3 (2.24)	3.5 (2.61)	4 (2.98)	6 (4.47)
	ABRASIVE (lb/hr) (kg/hr)	70 (32)	80 (36)	90 (41)	100 (45)	110 (50)	120 (54)	135 (61)
3/16 inch (4.8 mm)	AIR (cu ft/min) (cu m/min)	25 (0.71)	30 (0.85)	35 (0.99)	40 (1.13)	43 (1.22)	45 (1.27)	60 (1.70)
	HORSEPOWER (hp) (kW)	5 (3.73)	8 (5.97)	9 (6.71)	9.5 (7.08)	10 (7.46)	10.5 (7.83)	16 (11.93)
	ABRASIVE (lb/hr) (kg/hr)	150 (68)	170 (77)	200 (91)	215 (98)	240 (109)	260 (118)	320 (145)
1/4 inch (6.35 mm)	AIR (cu ft/min) (cu m/min)	50 (1.42)	55 (1.56)	60 (1.70)	70 (1.98)	75 (2.12)	80 (2.27)	95 (2.69)
	HORSEPOWER (hp) (kW)	10 (7.46)	12 (8.95)	13 (9.69)	16 (11.93)	17 (12.68)	18 (13.42)	25 (18.64)
	ABRASIVE (lb/hr) (kg/hr)	270 (122)	300 (136)	350 (159)	400 (181)	450 (204)	500 (227)	675 (306)
5/16 inch (8 mm)	AIR (cu ft/min) (cu m/min)	80 (2.27)	90 (2.55)	100 (2.83)	115 (3.26)	125 (3.54)	140 (3.96)	190 (5.38)
	HORSEPOWER (hp) (kW)	17 (12.68)	20 (14.91)	25 (18.64)	27 (20.13)	28 (20.88)	30 (22.37)	36 (26.85)
	ABRASIVE (lb/hr) (kg/hr)	470 (213)	530 (240)	600 (272)	675 (306)	750 (340)	825 (374)	1000 (454)
3/8 inch (9.5 mm)	AIR (cu ft/min) (cu m/min)	110 (3.12)	125 (3.54)	145 (4.11)	160 (4.53)	175 (4.96)	200 (5.66)	275 (7.79)
	HORSEPOWER (hp) (kW)	25 (18.64)	29 (21.63)	32 (23.86)	35 (26.10)	40 (29.83)	45 (33.56)	57 (42.50)
	ABRASIVE (lb/hr) (kg/hr)	675 (306)	775 (352)	875 (397)	975 (442)	1060 (481)	1100 (499)	1350 (612)
7/16 inch (11 mm)	AIR (cu ft/min) (cu m/min)	150 (4.25)	170 (4.81)	200 (5.66)	215 (6.09)	240 (6.80)	255 (7.22)	315 (8.92)
	HORSEPOWER (hp) (kW)	35 (26.10)	40 (29.83)	45 (33.56)	50 (37.28)	55 (41.01)	60 (44.74)	70 (52.20)
	ABRASIVE (lb/hr) (kg/hr)	900 (408)	1000 (454)	1200 (544)	1300 (590)	1400 (635)	1550 (703)	1800 (816)
1/2 inch (12.7 mm)	AIR (cu ft/min) (cu m/min)	200 (5.66)	225 (6.37)	250 (7.08)	275 (7.79)	300 (8.50)	340 (9.63)	430 (12.18)
	HORSEPOWER (hp) (kW)	45 (33.56)	50 (37.28)	55 (41.01)	63 (46.98)	70 (52.20)	75 (55.93)	95 (70.84)
	ABRASIVE (lb/hr) (kg/hr)	1200 (544)	1350 (612)	1500 (680)	1700 (771)	1850 (839)	2025 (919)	2525 (1145)
5/8 inch (16 mm)	AIR (cu ft/min) (cu m/min)	300 (8.500)	350 (9.91)	400 (11.33)	450 (12.74)	500 (14.16)	550 (15.58)	700 (19.82)
	HORSEPOWER (hp) (kW)	70 (52.20)	80 (59.66)	90 (67.11)	100 (74.57)	110 (82.03)	120 (89.48)	150 (111.85)
	ABRASIVE (lb/hr) (kg/hr)	1900 (862)	2200 (998)	2400 (1089)	2700 (1225)	3000 (1361)	3300 (1497)	4000 (1814)
3/4 inch (19 mm)	AIR (cu ft/min) (cu m/min)	430 (12.18)	500 (14.16)	575 (16.28)	650 (18.41)	700 (19.82)	800 (22.66)	1100 (31.15)
	HORSEPOWER (hp) (kW)	100 (74.57)	115 (85.76)	130 (96.94)	145 (108.13)	160 (119.31)	175 (130.50)	215 (160.33)
	ABRASIVE (lb/hr) (kg/hr)	2700 (1225)	3100 (1406)	3500 (1588)	3900 (1769)	4300 (1950)	4700 (2132)	5700 (2586)

This table is to be used as reference only. Actual results may vary depending on specific abrasive medium used. This table is based on sand with a bulk density of 100 pounds per cubic foot.

WHAT BORE SIZE DO YOU NEED?

For maximum productivity, select the nozzle bore size based on the desired blast pressure and the available air pressure and flow. For example, assume you are running a 375 cfm compressor at 80% capacity. In addition to the blast cleaning nozzle, the compressor is supplying air to an air helmet and other components such as air motors and pneumatic controls, leaving 250 cfm available for the nozzle. Referring to the chart on the previous page, you can see that 250 cfm is sufficient for a 7/16" nozzle operating at 100 psi. A larger nozzle, or a worn 7/16" nozzle, will require more air flow to maintain 100 psi. This extra flow requirement will either overwork your compressor or decrease productivity. On the other hand, choosing a nozzle with a bore smaller than your compressor can supply will result in less than maximum productivity from the system.

WHAT ARE THE BEST NOZZLE MATERIAL CHOICES?

Nozzle material selection depends on the abrasive you choose, how often you blast, the size of the job, and the rigors of the job site. Here are general application guidelines for various materials.

Aluminum oxide "alumina" nozzles offer good service life at a lower price than other materials discussed here. They are a good choice in low usage applications where price is a primary factor and nozzle life is less important.

Tungsten carbide nozzles offer long life and economy when rough handling can't be avoided and mineral and coal slag abrasives are used. All tungsten carbide nozzles are not equal. Note that all Boride tungsten carbide nozzles feature top wear grade material and thick-wall construction.

Silicon carbide composite nozzles offer service life and durability very near tungsten carbide, but these nozzles are only about one-third the weight of tungsten carbide nozzles. Silicon carbide composite nozzles are an excellent choice when operators are on the job for long periods and prefer a lightweight nozzle.

Boron carbide nozzles provide longest life with optimum air and abrasive use. Boron carbide is ideal for aggressive abrasives such as aluminum oxide and selected mineral aggregates when rough handling can be avoided. Boron carbide will typically outwear tungsten carbide by five to ten times and silicon carbide by two to three times when aggressive abrasives are used.

SERVICE LIFE COMPARISONS

Approximate Service Life in Hours			
Nozzle Material	**Steel Shot/Grit**	**Sand**	**Aluminum Oxide**
Aluminum oxide	20-40	10-30	1-4
Tungsten carbide	500-800	300-400	20-40
Silicon carbide composite	500-800	300-400	50-100
Boron carbide	1500-2500	750-1500	200-1000

Estimated values for comparison. Actual service life will vary depending on blast pressure, media size, and particle shape.

WHEN WET BLASTING IS A REQUIREMENT

There are three options when wet blasting is required or desired.

First is a "water ring" attachment for standard blast nozzles that forces water on the blast stream as it exits the nozzle. While inexpensive, this option uses a lot of water and reduces the size of the blast pattern and the energy of the blast stream, cutting productivity up to 50%.

Second is a water injection system that uses a high-pressure pump to get water into the abrasive and air stream. Not only does this type of system add considerable cost and mechanical complexity, it slows air stream velocity and requires as much as six gallons of water per minute.

The third option is the WIN® water induction system from Boride. The WIN® system uses a unique nozzle configuration that takes advantage of the venturi principle to draw or induct water from a low pressure line into the abrasive and air stream. This method is much simpler than a water injection system, effective, and water consumption is reduced from up to six gallons per minute to not more than several quarts...usually less. By reducing water use you increase abrasive velocity and work speed. You enjoy a larger blasting pattern for greater production rates since WIN® nozzles incorporate a considerably larger orifice than conventional nozzles. You also gain flexibility since the WIN® system can also operate with air-only for blowdown applications or with an air/water mix for rinsing applications.

WANT TO CUT NOZZLE REPLACEMENT COSTS 66%...OR MORE?

Try a boron carbide replacement nozzle from Boride Products. Boron carbide replacements cost more initially, but provide you with much longer service life. Your per-hour cost with boron carbide is about one-third of the cost of cheaper nozzles.

HOW TO GET THE MOST SERVICE LIFE OUT OF YOUR BORIDE PRODUCTS NOZZLES

1. Avoid dropping the nozzle or banging it against anything. Nozzle materials can break.
2. Be sure to use a nozzle designed for your application and the abrasive you wish to use.
3. Always use the new gasket or washer supplied with your nozzle or nozzle insert. It can help prevent the nozzle's entry throat from being blasted away. Inspect, and replace if necessary, the gasket or washer after every 10 to 20 hours of use.
4. If you are using a Boride Products nozzle in a flanged holder, turn the nozzle a quarter turn each week. This will help to ensure more uniform wear and prolong nozzle life.

HOW TO INSPECT, WHEN TO REPLACE

How much wear is too much? Here are two simple tests:

1. Insert a drill bit of a size that matches the original bore of the nozzle. If there's any slop, it's time to replace it. Nozzle wear means pressure loss. Pressure loss means lost productivity —there is a 1-1/2% loss of productivity for every pound of air pressure lost.

COMPARING NOZZLE COSTS

(Based on approximate nozzle service life using aluminum oxide abrasive).

	Boron Carbide	Tungsten Carbide
Approximate nozzle cost	$80	$35
Nozzle life in hours*	200	28
Cost per hour*	$0.40	$1.20
Cost per **200 hours**	$80	$240
Number of nozzle changeouts	1	7
Cost per **400 hours**	$160	$480
Number of nozzle changeouts	2	14
Cost per **600 hours**	$240	$720
Number of nozzle changeouts	3	21
Cost per **800 hours**	$320	$960
Number of nozzle changeouts	4	28
Cost per **1000 hours**	$400	$1200
Number of nozzle changeouts	5	35

*Performance may vary based upon pressure, abrasive grit size and quality and other variables. These data are based on comparative testing under controlled conditions.

2. Hold an open nozzle up to the light and look down the bore. Any ripple or orange peel effect inside the carbide liner will create internal turbulence that reduces abrasive velocity. If you notice any uneven wear or pressure drop, it's time to replace.

Check the nozzle's exterior, too. The materials used to build nozzles are tough, but can be brittle. Nozzle jacketing materials are designed to help protect breakable liners from impact damage. If the jacket is cracked, chances are the liner is also cracked. If the liner is fractured, even with hairline cracks, the nozzle should be replaced immediately. It is not safe to use a cracked nozzle.

Remember that all nozzles will eventually break or wear out. Keep a supply of back-up nozzles on hand to minimize down time.

Service Life Comparisons			
Approximate Service Life in Hours			
Nozzle Material	Steel Shot/Grit	Sand	Aluminum Oxide
Ceramic	200-40	10-30	1-4 (over run)
Tungsten carbide	500-800	300-400	20-40
Silicon carbide composite	500-800	300-400	50-100
Boron carbide	1500-2500	750-1500	200-1000

NOZZLE MATERIAL WEAR LIFE COMPARISON

CERAMIC

Ceramic nozzles have been a staple in the blasting industry since the beginning. They perform well with softer abrasives, but wear quickly with today's more advanced abrasives. It takes 100 ceramic nozzles to equal the wear life of 7 tungsten-carbide or a single boron-carbide nozzle*.

TUNGSTEN/SiAlON

Tungsten & lightweight SiAlON nozzles are very popular in today's abrasive blasting market. They are much harder and can outlast ceramic nozzles by more than 14 times*. A great choice for harder cutting and more aggressive abrasives but can still be out-lasted by boron nozzles by a factor of 7:1*.

BORON-CARBIDE

Boron nozzles are the longest wearing of the common materials used in blasting nozzles. They wear 100 times longer than ceramic and 7 times longer than tungsten nozzles*. The best part is they do not cost anywhere near 7 times as much as tungsten nozzles making them the most economical choice for most applications**.

**Based upon approximate service life when using Aluminum Oxide Abrasive. Performance may vary based upon pressure, abrasive grit size, quality of abrasive, and other variables. **Based on current market, prices subject to change without notice.*