What size nozzle should I use?

As shown on the right, nozzles are available that use from 15 to 225 scfm of compressed air. The amount of soil that can be dislodged in a given amount of time is roughly proportional to the amount of air used. The 150-scfm nozzle is the most commonly used size for arboricultural and industrial applications. This nozzle has great productivity and is designed to run on the most common size of portable air compressor, a 175 to 185 scfm unit.

What size air compressor do I need to use the AIR-SPADE® properly?

Air compressors are sized by pressure and flow. In the US, pressure is measured in pounds per square inch above atmosphere; psig. Flow is measured in cubic feet of air per minute; cfm. Generally all air compressors will produce at least 100 psig; while flows will vary from a few cfm for small electric piston units to hundreds of cfm for gas or diesel driven portable screw compressors. All AIR-SPADE® nozzles are designed to operate best at a pressure of 90 psig, but vary in flow to match the standard available compressors according to the table below. Note, a smaller nozzle may always be used on a larger compressor, but not the reverse. Trying to run a larger nozzle on a smaller compressor will result in significantly less than 90 psig being delivered and will noticeably diminish performance.

Recommended Compressor Size

Nozzle (cfm)	*Flow Rating (cfm) at 100 psig*
15	15
25	25 to 30
60	60 to 70
105	125
150	175 to 185
225	250

Excavation Rates (cu ft / min)

Nozzle air flow (scfm)	*OSHA Type C*	*OSHA Type A*
15	0.5	0.2
25	0.9	0.4
60	1.1	0.7
105	1.5	0.9
150	1.8	1.2
225	2.3	1.7

What size of air hose do I need to use the AIR-SPADE® properly?

Compressed air flowing through a hose experiences a drop in pressure from friction and constrictions. Friction loss is proportional to the length of the hose. The amount of air, its pressure, the hose inner diameter and its smoothness also determine the loss. The table below shows the pressure loss for 50 feet of common air hose with couplings as a function of size and nozzle flow, cfm, for air at a pressure of 90 psig. Generally, a 1-inch air hose is recommended for use with the AIR-SPADE®.

Pressure Loss (psig) for 50 feet of common air hose

		Flow	*(cfm)*		
Hose ID	25	60	105	150	225
¾”	0.3	1.6	5.6	12.3	25.0
1”	0.1	0.4	1.3	2.8	5.5
1 ¼”	0.0	0.1	0.4	0.8	2.0

The AIR-VAC makes a perfect companion to the AIR-SPADE® for a complete air-vacuum excavation system.

AIR-SPADE®

Frequently Asked Technical Questions

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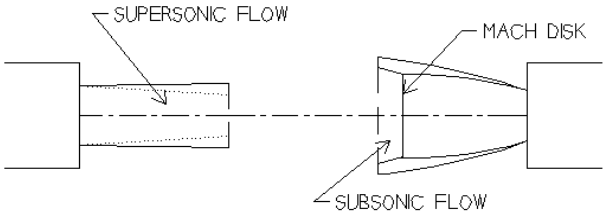
How does the AIR-SPADE® work?

The patented supersonic nozzle in the AIR-SPADE® turns compressed air into a high speed, laser-like jet moving at twice the speed of sound; Mach 2. All of the energy and momentum of this air moving at approximately 1200 mph is focused onto the soil, dislodging it in a fraction of a second.

Soil is an unconsolidated assemblage of solid particles that may or may not contain organic matter. The voids between the particles are occupied by air and/or water. The aggregate nature of soil aids the ability of the air to fracture it; while stronger materials and ones that are not porous like metal or plastic pipes, cables, or even wooden tree roots are unaffected.



COMPARISON OF FLOWS AT 1 INCH FROM EXIT

Why does the AIR-SPADE® outperform other air tools?

In head to head tests, the AIR-SPADE® dislodged harder clay soil and dug faster than other air digging tools. Soil fractures from compressive stress, tons per square foot (tsf), exerted on its surface. As shown above for the same pressure and flow, compressed air exiting from an improperly designed nozzle expands outward rapidly to 3 to 4 times the area versus the jet from the patented supersonic nozzle in the AIR-SPADE®.

Will higher pressure make the AIR-SPADE® work better?

Increasing the air pressure above 90 psig on a properly designed supersonic nozzle does not lead to a proportional gain in excavation capability. For example, doubling the nozzle pressure to 180 psig increases the air jet force by only 10% and the exit momentum flux (stress seen by the soil) by only 45%. Supplying higher pressure to a nozzle designed to work at 90 psig actually un-focuses the air jet degrading performance while consuming more air.

In what types of soil will an AIR-SPADE® work?

Because of its unique, focused air-jet, the AIR-SPADE® works in most soils, even hard clays. Cohesive soils can be classified and described by unconfined compressive strength as shown below. Tests have shown the AIR-SPADE® to be effective in compacted soils with unconfined compressive strengths, well above the values listed for hard clay.

Watering the work area ahead of time can sometimes be helpful. Water reduces most airborne dust if the soil is extremely dry. It also reduces the soil's strength making it easier to dig. Combining the use of the AIR-SPADE® with a low pressure water jet is effective even with extreme cases of highly compacted or sun-baked soils.

The AIR-SPADE® in general will not cut through rock. Shales, however, may be broken apart by the AIR-SPADE® if the jet is directed between the laminations of the rock. Similarly, the AIR-SPADE® will not dislodge hard frozen soil which may behave like pavement or concrete.

Strength of Clays

Consistency	*Unconfined Compression Strength (tsf)*
Very soft	0 to 0.25
Soft	0.25 to 0.5
Medium	0.5 to 1
Stiff	1 to 2
Very Stiff	2 to 4
Hard	> 4

How should I dig with the AIR-SPADE®?

The AIR-SPADE® will dislodge up to several inches deep in a medium to stiff soil. Unless the soil is highly compacted, dwelling on the same spot is unnecessary and tends to increase spray. The AIR-SPADE® can be moved over the soil surface at a rate of about 1 to 2 feet per second. When several inches of soil have been loosened, the soil should be removed to expose a fresh working face for the air jet. Vacuum suction, as provided by our AIR-VAC unit, is an excellent companion to the AIR-SPADE® since it is likewise non-damaging.

OSHA Cohesive Soil Classifications

OSHA Type	*Unconfined Compressive Strength*	*Description Cohesive soils including:*
A	>= 1.5 tsf	Clay, silty clay, sandy clay, clay loam, caliche, hardpan, and sometimes silty clay loam and sandy clay loam.
B	<1.5 and >0.5 tsf	Granular cohesive soils like angular gravel, silt, silt loam, sandy loam, and sometimes silty clay loam and sandy clay loam.
C	<= 0.5 tsf	Granular soils such as gravel, sand, loamy sand, submerged soil, or soil from which water is freely seeping.