INTRODUCTION

Efficient air drilling (as opposed to mud drilling) relies on the proper selection of air compressors to supply the required air volume and pressure for bit operation and cuttings removal. Despite its critical role, compressor sizing in many drilling operations is often based on equipment availability or general experience rather than technical evaluation. This practice leads to frequent mismatches between compressor capacity and operational demand; resulting in either underperformance or inefficiency.

A compressor must be adequately sized to meet all operational, technical, and safety requirements of the drilling task without being under- or over-specified.

A fit-for-purpose compressor provides sufficient air volume (CFM) and pressure (PSI/bar) to:

1. Power the drilling tool (e.g., DTH hammer or rotary bit) efficiently,
2. Lift and clean cuttings from the borehole at the correct up-hole velocity.

The size of an air compressor is linked to the possible borehole diameter; it is essential to the drilling process that the air travels up the hole fast enough to carry debris with it.

Air is low in density. It is also low in viscosity, having a viscosity approximately 2% that of water. A chip which will settle through water at about 0.2 m/sec (40 fpm) would settle in air at about 4 m/sec (790 fpm). Therefore, the up-hole or bailing velocity, using air for circulation, must be at least 20 times as high as the velocity required when using water.

Quick reference chart

(assumes drill pipe OD= 4.5 in)
Shown for two common target annular velocities: 3000 ft/min (typical minimum) and 4000 ft/min (more conservative

Hole dia (in)	Annular area (in²)	CFM @ 3000 ft/min	CFM @ 4000 ft/min
6”	12.37	≈ 258 CFM	≈ 344 CFM
8”	34.36	≈ 716 CFM	≈ 954 CFM
10”	62.64	≈ 1,305 CFM	≈ 1,740 CFM
12”	97.19	≈ 2,025 CFM	≈ 2,700 CFM

(Values rounded to sensible engineering precision.) Calculation method and worked examples follow standard drilling references.

DETERMINING THE COMPRESSOR CAPACITY REQUIRED

By analyzing the relationships between air volume (CFM), pressure (PSI/bar), and borehole cleaning efficiency, the framework defines the operational envelope within which compressors can perform optimally. Drillers or clients engaging drilling contractors Should be able to specify compressors that deliver the required air power for a particular borehole without excessive energy losses.

Air volume (cfm or m³/min):

- Measures total air volume delivery.
- The absolute most important variable for removing cuttings and clearing the annular space.
- Increases scaling with larger borehole diameters and larger down-hole tools.
- Specified by manufacturers as Free Air Delivered (FAD).

Air Pressure (PSI / bar):

- Indicates the physical force of the air.
- Crucial for deep drilling and driving heavy tools (like DTH hammers), but **must not be** confused with volume when calculating up-hole velocity.
- Think of pressure as the power supplied to lift the cuttings weight, while up-hole velocity is the speed they travel out of the hole.

Up-hole (air bailing) velocity

A compressor should provide adequate up-hole velocity ensure effective removal of cuttings:

Minimum: 15 metres per sec (900 m/min; 3000 fpm)
Recommended: 25 metres per sec (1500 m/min; 5,000 fpm)
Maximum: 35 metres per sec (2100 m/min; 7,000 fpm)

Determine the Free Air Delivery (FAD)

$$\mathrm{CFM} = \frac{\mathrm{Air\ \ Velocity\ \ } \times \langle \mathrm{D^2h - D^2p} \rangle}{183.4}$$

Example: Using a bit diameter of 8 inches and 4½-inch drill pipe, air velocity of 3000 feet/minute for dry air drilling, solving the equation:

$$\mathrm{CFM} = \frac{3000\ \ \times \langle 8^2 - 4.5^2 \rangle}{183.4} = \ \ 716$$

The compressor should have a minimum FAD of 716 CFM.

Determine Exerted Pressure

$$\mathrm{Pressure(kPa)} = \mathrm{Specific\ \ gravity(S.G)} \times \mathrm{Depth(m)} \times 9.8$$

Determine the pressure exerted by the drilling fluid at the bottom of the hole, given; Hole depth = 60m, S.G. of air = 1.2

$$\mathrm{Pressure(kPa)} = 60 \times 9.8 \times 1.2 = 705.6\mathrm{kPa} \approx 102\mathrm{PSI}$$

The compressor should have a working pressure of at least 102 PSI.

WHERE TO FIND COMPRESSOR INFORMATION

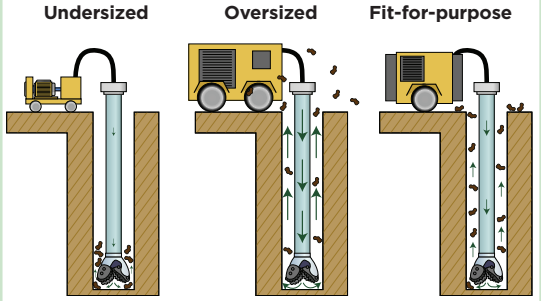
Before purchasing a compressor as a driller, or engaging a contractor as a client, it is essential to know the capacity of the compressor. This can be found on:

1. the manual of the compressor,
2. data plate of the compressor,
3. supplied by the manufacturer or
4. available online.

	Units	XR1000	XRH 1100 Excel	XRV 1200 Excel
Free air delivery	cfm	1035	1100	1200
Operating pressure	psig	275	300	330
Length	mm	3942	3942	3942
Width	mm	1600	1600	1600
Height	mm	1865	1865	1865
Dry weight	kg	4100	4100	4100

Figure 1: An example of compressor information that can be provided by the manufacturer of searched online.

Effects of undersized vs. oversized vs. fit-for-purpose compressors



Low air volume and pressure
Poor hole cleaning, slow penetration rate hammer stalling

High air volume and pressure
High fuel consumption, excessive energy use

Adequate air volume and pressure
Efficient drilling, good hole cleaning

CONCLUSIONS

Adopting a fit-for-purpose approach to compressor sizing ensures improved drilling efficiency, reduced fuel consumption, and enhanced borehole quality, contributing to both economic and environmental sustainability in water well drilling operations.