May 26, 2015

Proper Compressor Sizing for Down Hole Hammer Drilling

Client: Living Water International

Request:

Field staff continues to ask for bigger compressors to operate Down Hole Hammers (DHH) and not get the bits buried from incomplete hole clearing. How do we know what size compressor is necessary to properly drill with a DHH? Is there a simple formula?

Recommendations:

After consulting with DHH manufactures, Drill Rig Manufactures, and Water Well equipment suppliers, the following conclusions were reached.

The general industry standard is that a **minimum** annular velocity (commonly know as an up hole flushing velocity) of **3000 FPM** (feet per minute) is needed to maintain sufficient volume to properly clear cuttings. The optimum range is **4000 FPM to 7000 FPM.** If the annual velocity is less than 3000 FPM, the use of drilling foams is recommended to increase the air viscosity and sufficiently lift and clear cuttings.

Three variables determine the annular velocity:

1. Diameter of the borehole being drilled (bit diameter)
2. Outside Diameter (OD) of the drill rod being used
3. Size of the compressor-air output

The formula for calculating the up hole flushing velocity (in standard measurements) is as follows:

$$\frac{\text{(Air Output in CFM x 183.4)}}{\text{((Bit Dia. in inches)}^2 - \text{(Drill Rod Dia. in inches)}^2)} = \text{Up hole Flushing Velocity (Ft. / min.)}$$

Note: The constant of 183.4 is for standard measurements of inches, cubic feet per minute, and feet per minute. For metric units the constant is 76,404.7, with volume measured in L/sec, length in mm and velocity in M/min.

Cotton Gin LLC 907 Bains St. PO Box 1241 Brookshire, TX 77423
Tel 281.375.5535 Fax 281.934.1616

Examples:

1. A 850CFM compressor drilling with a 7 inch bit and 3 ½ OD drill rod would give you a up hole flushing velocity of 4,242 Ft/ Min. This setup is with the optimum recommended range.

$$\frac{(850 \text{ CFM} \times 183.4)}{((7 \text{ in.})^2 - (3.5 \text{ in.})^2)} = 4242 \text{ (Ft. / Min)}$$

2. A 750CFM compressor drilling with a 6 ¾ inch bit and 3 ½ OD drill rod would give you a up hole flushing velocity of 4,129 Ft/ Min. This setup is with the optimum recommended range.

$$\frac{(750 \text{ CFM} \times 183.4)}{((6.75 \text{ in.})^2 - (3.5 \text{ in.})^2)} = 4129 \text{ (Ft. / Min)}$$

3. A 600CFM compressor drilling with a 6 ¾ inch bit and 3 ½ OD drill rod would give you a up hole flushing velocity of 3303 Ft/ Min. This setup meets the minimum requirements but is outside the recommended range. Any deviation from optimum drilling conditions would lead to insufficient air volume.

$$\frac{(600 \text{ CFM} \times 183.4)}{((6.75 \text{ in.})^2 - (3.5 \text{ in.})^2)} = 3303 \text{ (Ft. / Min)}$$

4. A 400CFM compressor drilling with a 7 inch bit and 3 ½ OD drill rod would give you a up hole flushing velocity of 1996 Ft/ Min. This setup does not meets the minimum requirements.

$$\frac{(400 \text{ CFM} \times 183.4)}{((7 \text{ in.})^2 - (3.5 \text{ in.})^2)} = 1996 \text{ (Ft. / Min)}$$

5. A 375CFM compressor drilling with a 6 ¾ inch bit and 3 ½ OD drill rod would give you a up hole flushing velocity of 2293 Ft/ Min. This setup does not meets the minimum requirements.

$$\frac{(375 \text{ CFM} \times 183.4)}{((6.5 \text{ in.})^2 - (3.5 \text{ in.})^2)} = 2293 \text{ (Ft. / Min)}$$

A point worth noting:

- The formula is exponential, not linear, as seen in the squaring of the diameter if the bit an drill rod. Thus, reducing the size of the bit or increasing the size of the drill rod will have a greater effect on the up hole flushing Velocity than increasing the capacity of the compressor.

Pressure vs. Volume:

The second parameter that has less to do with hole clearing and more to do with proper functionality of the DHH and penetration rate is pressure. Each hammer bit is rated to a specific minimum and maximum pressure for the piston to fire properly, the bit to function correctly and for the bit to penetrate the rock. Too much pressure will prematurely wear the bit, and insufficient pressure will inhibit the bit from working correctly.

Other points worth noting:

- Sizing Bits to near the same weight as the hammer piston will increase drilling performance
- Install a properly sized jet sub over the hammer when there is excess air volume will direct the excess volume to hole clearing
- Drilling in water reduces the effective psi at the bit. Groundwater will exert and reduce the effective pressure of the hammer by14.5psi for ever 33 feet (1bar).