What Should You Consider When Choosing a Wet-Mix Shotcrete Pump?

by Paul Sulman

When it comes to pumping a typical concrete mixture, let's face it—most pumps out there will work. When it comes to pumping a shotcrete mixture, however, your choice of pumps is critical.

Shotcreting can be the most demanding job for a concrete pump. Basically, you are asking your pump to push a low-slump mixture, usually through a 2 in. (50 mm) diameter hose, as fast and as far as possible. Before you go and buy the largest, toughest pump you can find, you should ask yourself some questions.

How far (feet or meters) and how fast (yd^3/h or m^3/h) do I need to pump? How fast can I really apply shotcrete? Will you be shooting a high volume through a 2-1/2 or 3 in. (64 or 75 mm) hose with a robotic shotcrete arm, as is typical in an underground application—or will someone be holding the hose to spray a swimming pool or rock feature? What type of tow vehicle do you already have or will you need to buy? Will you be using the pump for applications other than shotcrete such as placing concrete or pressure grouting?

Some shotcreters buy too large a pump. This can be a waste of money in the long run due to wasted fuel, costly maintenance, and extra wear and tear on your tow vehicle. You may find the only benefit of buying a monster pump is to be able to shoot an occasional long-distance job perhaps 1 or 2 yd^3 (m^3) per hour faster—hardly worth the extra expense.

Basically, a shotcrete pump performs two functions—it overcomes pressure and moves concrete (performs work). The pressure can be measured in psi (MPa) or bars. It is assumed that the work being done is related to and performed using horsepower.

Pressure—Pumps don't produce pressure. Pressure is created by resistance to flow of the concrete in the conveying system (pipe or shotcrete

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hose). The longer the conveying system, the greater the resistance to flow and, therefore, the more pressure required to force the concrete through the system. Other factors affecting this pressure are pumping uphill or vertically. The slump also matters. The lower the slump, the higher the backpressure created. The higher the required output, the more pressure required due to an increase in the coefficient of friction in the pipe or hose. In general, the higher the pressure rating of the shotcrete pump, the farther it will pump or the better it will overcome the concrete's resistance to flow.

Horsepower (HP)—HP is required to do the work, carry the load, and create the supply volume. If you had a pump that could overcome 1000 psi (7 MPa) pressure, but only had 10 HP, you might get the concrete to the end of a long hose, but the output would be so slow that the job would take forever to complete. HP is required to provide the volume or output at a given required pressure.

So far, we've shown that a pump with a high pressure rating and lots of horsepower will shotcrete faster and farther than a pump with lower pressure and horsepower ratings.

Volume—Volume, or shotcrete output, is usually measured in cubic yards or cubic meters per hour. Shotcrete requirements typically range from 1 to 30 yd/h (0.8 to 23 m^3/h). Lower outputs are usually associated with patch repair or rock-scape type work. Shotcreting pools typically requires volumes from 12 to 22 yd^3/h (9 to 17 m^3/h). Higher outputs such as 22 to 30 yd^3/h (17 to 23 m^3/h) are normally applied using a robotic spray arm with a large 2-1/2 to 3 in. (64 to 75 mm) diameter hose. This is too heavy for a man to handle and is more common in mining and tunneling applications or other forms of shotcreting for ground support.

Structural integrity—How much work do you plan on doing? If you plan to shotcrete only on the weekends, or if you are a pool contractor who shoots only 30 pools per year, then a lighter-duty pump may work for you. If you plan to earn your income with one pump, then a heavily-built pump is the way to go. Towing a pump from job site to job site can be very tough on the frame. Pushing the pump to the limits on a very long pumping distance or low-slump job can put a lot of strain on mounts and the pumping cell. The best way to tell how well a pump is constructed is to inspect it first-hand to look at the gauge of steel, quality of the welds, and the sizes of the bolts and tie-rods. A heavier pump uses more steel and costs the manufacturer more money to build than a lighter one, so you'll typically pay more for a heavier-duty pump. However, it is wise to think of this extra initial investment as an insurance policy against future problems.

Efficiency verses wear—Another issue to consider when selecting a pump for shotcreting is that a pump with smaller-diameter concrete cylinders (say, 4 in. [100 mm]), will have to do less work reforming a 4 in. (100 mm) cylinder of concrete into a 2 in. (50 mm) shape as it is forced through the reducer into the hose. In other words, less energy will be wasted compared with a 7 in.-diameter (178 mm) concrete cylinder having to reform the concrete into a 2 in. (50 mm) hose. The tradeoff is that with the 4 in. (100 mm) cylinders, more strokes will be required to move the same volume of shotcrete, which in turn decreases wear life on your wear parts in your hopper and concrete cylinders.

Tow vehicle—Always consider the truck you are towing with before committing to buy a trailer pump. Some of these trailers can weigh over 8000 lb (3625 kg). Even if you are using a truck-mounted pump, it is almost always better to use a bigger truck than is required. This will result in less wear and tear on your truck and will generally be safer to operate. Remember that you'll most likely be carrying hose and probably an air compressor. Laws in each state can differ; but, in general, never tow anything heavier than the towing vehicle.

Ball-valve verses S-tube or Rock-Valve™—Both types can be used as shotcrete pumps. Generally, ball-valve types are less expensive than S-tube or Rock-Valve pumps. Mechanical ball-valve pumps are less complicated and generally smaller than S-tube or Rock-Valve pumps (usually 0 to 30 yd^3/h [0 to 23 m^3/h] and under 50 HP). Hydraulic ball-valve pumps are also generally less expensive than

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their equivalent S-tube/Rock-Valve counterparts. They cost less because they require less hydraulic circuitry, because they don't have to swing a tube from cylinder to cylinder or reverse the cylinders. Because the S-tube and Rock-Valve types can have a "reverse" feature, they can be safer for unplugging hoses. When a S-Tube pump is reversed, the pressure in the concrete system can be reduced prior to releasing hose clamps to clean out the system. S-tube and Rock-Valve pumps are usually capable of pumping larger aggregate than the ball valve types, which means they are more forgiving with contaminated mixes that may have the odd large piece of aggregate. One advantage of ball-valve type pumps is that they generally have fewer clean-up issues on site, as the hoppers can have less concrete in them to dispose of at the end of the job.

Shotcrete pump

After understanding these basic concepts of shotcrete pumps, we need to go back to the most important questions to get started:

How much shotcrete do we need to pump? How quickly? What size hose? How far from the pump do we need to go in a worst-case situation? A pump manufacturer or dealer will use this information to help you decide which model is best suited to your particular application. The variables are just too numerous to formulate a graph or formula to precisely select a specific pump model. You should look at the other companies in your industry to see what equipment they are buying. Ask them if it is adequate for the application. What do they like best and what do they dislike about it? Of the wet-mix shotcrete pump inquires we get, I would say over 75% of them initially want a pump that is oversized for their requirements. Be careful not to get caught in the "bigger is better" philosophy, as it can cost you more, both up front and in the long run.

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