QUALITY WATERBLASTING

Basic knowledge of water mechanics can help you achieve better results for your customers in multiple applications

When waterblasting, it's important to use a tool designed for the job — but that by itself is not enough. Factors outside the realm of tool design are also important. In the simplest terms, the goal of a waterblasting system is to deliver as much of the pump's power as possible to the surface being cleaned. Use of the wrong tools or mismatched equipment can forfeit as much as 80 percent of the pump's power.

Four factors are critical to productive waterblasting:

1. Preserve jet quality

The first prerequisite for a successful job is high quality jetting. The jet is nothing more than a shaped restriction in the flow channel that forces the water to accelerate, converting potential energy (pressure) into kinetic energy (velocity).

The jet shape, materials, and upstream flow turbulence are all important to delivering maximum energy to the work. A powerful, cohesive, high-velocity jet is established in the first 8 to 25 orifice diameters downstream from the orifice. Farther away, the outside surface of the jet is slowed by drag through the air. Droplets of water appear in the air surrounding the jet and bubbles of air are entrained into the jet's outer surface. This turbulent zone grows at the expense of the powerful, cohesive core of the jet until there is no power left at all. Only the cohesive core of the water stream cleans effectively, not the turbulent zone.

Even the best jet deteriorates with air drag. It is possible, though, to lose as much as half the jet's power at the start due to excessively turbulent flow upstream of the jet. Turbulence can be increased by abrupt diameter changes in the flow channel, or by direction changes.

Of course, turbulence can't be avoided completely, so we need ways to repair its effects. Fortunately, that can be done with a straight section of pipe or with a flow straightener inlet to the orifice.

Eventually every jet wears out from erosion caused by microscopic cavitation from the high-velocity water. Seen through a microscope, the eroded surface looks like a rough canyon. That rough flow channel causes rapid growth in the turbulent zone, which can be seen as a fanned-out shape to the water jet.

In severe cases, the orifice diameter grows to the point that pump discharge pressure falls. Even before it's worn so badly that pressure falls, the jet's impact power is severely reduced. When cleaning performance deteriorates, with no obvious reason, then it's time to replace jets.

Erosion-resistant materials are important in jet design. Ceramics are probably the most erosion-resistant materials. Tungsten carbide nozzles are also popular, and hardened, plated, polished stainless steel jets can last even longer. Whatever the material, the important point is to select nozzles that start with a visible tight, cohesive jet shape, and retain it for a long time.

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2. Manage the numbers

The second important principle is to use the fewest and most powerful jets possible. If one good jet doesn't cut through the deposits, then more jets will not do better.

Consider the conventional assortment of jetting nozzles used — non-rotating sleds, bullets, torpedoes — needing 6 to 12 jets to clean without leaving dirty streaks. These are good options because they have no moving parts and are inexpensive. The drawback is that they divide the pump horsepower into 6 to 12 relatively low-powered jets. Greater power is delivered to the surface with fewer, more powerful jets, rotated to cover the entire surface in a helical jet path. In a nozzle using three or five jets, each jet is 2 to 2.5 times as powerful as the non-rotating alternative.

3. Control rotation speed

The third important factor is to control rotation rate to avoid jet quality deterioration and to provide enough dwell time so that the jet can do its work.

A good rule of thumb is to provide about 15 mph transverse jet velocity along the surface being cleaned. This rule works whether the tool is cleaning a one-inch-diameter exchanger tube, a 12-inch pipe, or a 40-foot-diameter crude oil storage facility.

The bigger the diameter, the slower the rotation required. Large pipes or vessels may require air-motor powered gearboxes to keep rotation slow enough to maintain the necessary transverse velocity at the wall.

Unfortunately, rotation speed control adds complexity and expense to a waterblast tool. Some nozzles rely on a viscous fluid governor to brake the rotation speed, but other technologies work too. For example, centrifugal and magnetic mechanisms are also effective. Users need to recognize when the rotation control system needs repair. The best tool is the human ear. If the rotating nozzle sounds like a jet aircraft engine, it's too fast, and repairs must be done before the seals and bearings burn out.

4. Manage hose pressure drop

The fourth important factor is to balance hose pressure drop for the pump. Hose pressure drop — a direct, proportional loss in power — is caused by friction as water molecules slide across the wall of the hose and against other water molecules in the hose. The only ways to reduce pressure drop are to use shorter length or larger diameter hose.

Most contractors replace worn-out hose with a long section, cutting it off as the end wears or is damaged. If you notice more powerful jetting with old hose, it's because it is a shorter hose with less pressure drop. It can make sense to buy shorter lengths as replacements. Higher-pressure, lower-flow pump combinations lose proportionately less power to hose pressure loss. That is because less flow has to go through the hose, and pressure loss is a smaller fraction of the initial pressure.

Pump optimization is an important way to manage hose pressure loss. Since the jets control the flow, it's easy to accomplish. The pump will operate throttled back a bit from maximum power, but more power will be delivered to the tool.