

Choosing between a positive displacement pump and a centrifugal pump starts with one simple idea: pumps create flow, not pressure. The pressure you read on a gauge is a measurement of the system's resistance to that flow. Centrifugal and positive displacement pumps respond to that resistance in very different ways, and that difference drives pump selection, system design and troubleshooting.

This article builds on our earlier piece, "Relationship of Flowrate and Pressure for Positive Displacement and Centrifugal Pumps," and uses Wanner Hydra-Cell Pro® seal-less diaphragm pumps as the positive displacement example.

How a Centrifugal Pump Responds to Pressure

A centrifugal pump adds velocity to the liquid with a spinning impeller, and the volute converts that velocity into pressure. For a given pump size and shaft speed, flow and discharge pressure are tied together: higher pressure is only reached at lower flow. That is due to the limits of the velocity the impeller can generate and the losses inherent in the clearance between the impeller and volute.

Our earlier article gives an example from a semi-open impeller performance curve. With a 6-inch impeller at about 34 feet of total head (almost 15 PSI), the pump delivers roughly 50 GPM. Add piping and components so the head rises about 14%, to 40 feet, and flow drops by about 40%, to roughly 30 GPM. A small change in system resistance produces a large change in flow.

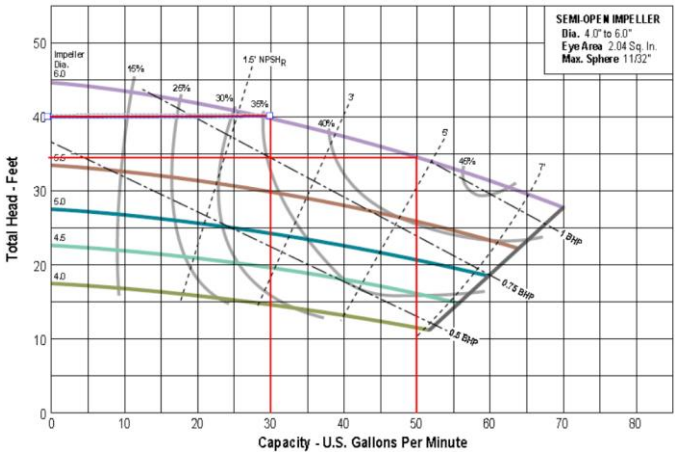
How a Positive Displacement Pump Responds to Pressure

A positive displacement pump moves a fixed volume of liquid with each shaft revolution, and check valves in the pump head control the direction of flow. Because of that, flow is only slightly affected by discharge pressure. In our experience the loss works out to about 1% of flow for each 100% increase in pressure.

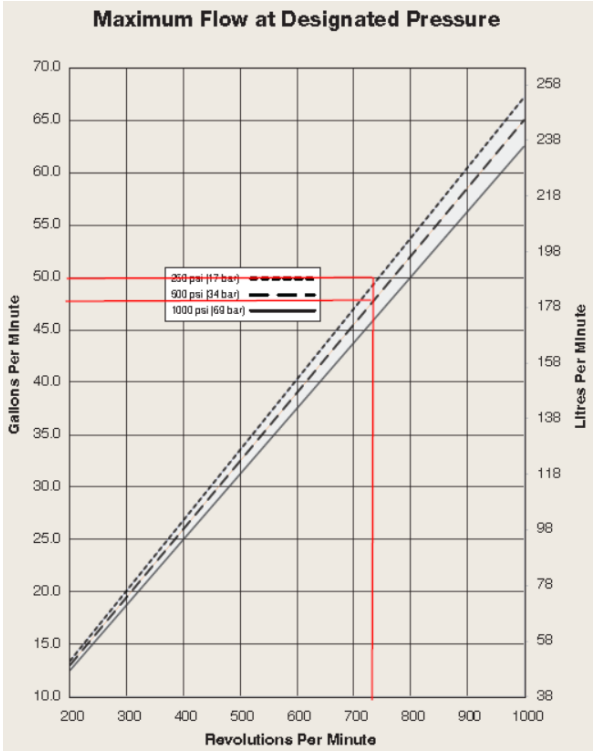
In the Hydra-Cell example from the same article, a pump running at about 740 RPM delivers approximately 50 GPM at 200 PSI and about 48.6 GPM at 700 PSI. That is roughly a 3% drop in flow for a 350% increase in pressure.

The practical summary: a centrifugal pump's flow depends on the pressure it pumps against, while a positive displacement pump's flow depends on its shaft speed. To change the flow of a positive displacement pump, change the speed. To control its pressure, use a properly set pressure-regulating valve.

Centrifugal Pump Performance:
Small pressure increase, large flow decrease



Positive Displacement Pump Performance:
Large pressure increase, small flow decrease



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Where Each Pump Type Fits

Generally, centrifugal pumps are best suited to water-like viscosities and to transferring higher flow rates at lower pressures. Positive displacement pumps are needed for higher pressures and are often used for difficult-to-pump fluids.

Even when two pump styles can both deliver the required flow, one design is often the better choice for reliability and cost of ownership. Fluid viscosity, abrasives, chemical compatibility, required pressure and how the flow must be controlled all matter.

Why Wanner Hydra-Cell Pro® Seal-less Pumps

Wanner Hydra-Cell Pro® pumps are seal-less positive displacement pumps that use a hydraulically balanced diaphragm as the displacement mechanism. Unlike plunger and piston pumps, they have no dynamic seal, so there is no packing or mechanical seal to leak or wear. That makes them reliable on difficult fluids, and the simple design makes troubleshooting easier.

Hydra-Cell elastomers (o-rings and diaphragms) are not typically wear items. If chemical and temperature compatibility are right, they can last for years. The main wear parts are the check valves, which can cycle up to 29 times per second at 1750 RPM. Check valves are easy to replace and are available in several materials for chemical and abrasion resistance. Many users replace the elastomers when they replace check valves, because the head is already open and it adds little to the kit cost. Wanner tests every Hydra-Cell pump at full flow and pressure before it ships, not just a sample. The flow range runs from the F20 (up to 1 GPM, 1500 PSI) to the Q155 (up to 157 GPM, 3500 PSI), with the T100 rated up to 5000 PSI at lower flows. See the individual model pages on the Hydra-Cell Pro® models page for current ratings.

Troubleshooting Low Flow or Low Pressure

Because gauge pressure follows flow, a lack of pressure is really a flow problem. Common causes for both pump types include:

A. Inlet side: not enough net positive suction head available (NPSHa), often from clogged inlet filtration.
B. Pump: worn components or material clogging inside the pump.
C. Outlet side: a worn bypass or pressure-regulating valve, leaks, or worn or oversized spray nozzles.

Hydra-Cell Pro® pumps

For a Hydra-Cell pump, most flow problems start on the inlet side. Starving the pump causes cavitation, rough running and, over time, check valve damage. A quick test is to slow the pump down: if it runs smoother and quieter, inadequate NPSHa is confirmed. Pumps that sat idle for months can have sticky check valves from dried residue, and a pressurized inlet such as city water pressure can often free them. On the discharge side, set the pressure-regulating valve to the maximum pressure you want after the pump has primed, and check whether fluid is being bypassed. See Troubleshooting Hydra-Cell Pro Pumps for more detail.

Centrifugal pumps

Centrifugal pumps share the same NPSHa, aeration and clogging problems, plus a few of their own. Many, like Stan-Cor centrifugal pumps, are not self-priming and must be filled before start-up. Because the impeller-to-volute clearance is critical for generating discharge velocity, a clogged or worn impeller or volute can cut flow significantly.

