Hydra-Cell Pump Check Valves
Diagnosing Wear, Maximizing Wear Life

By: Chris Pasquali, CEO Factory Direct Pipeline Products, Inc.

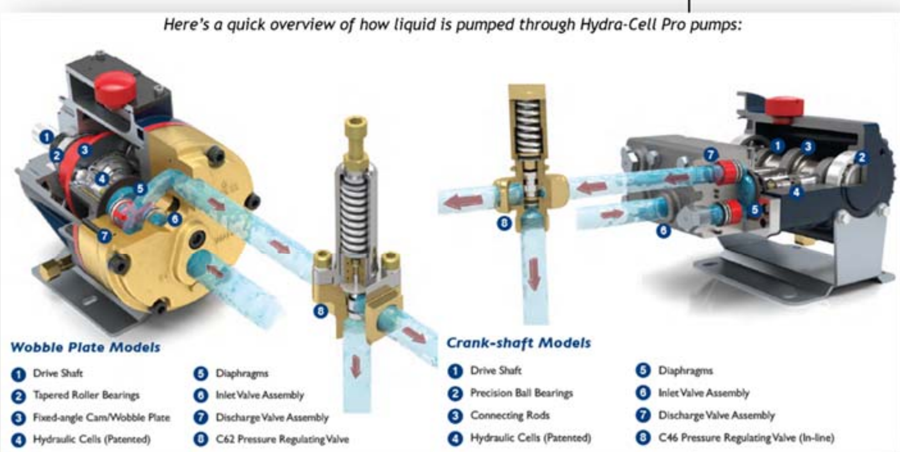
Wanner™ Hydra-Cell® Pro sealless positive displacement pumps are quite unique industrial pumps; their non-dynamic seal design enables them to pump "challenging liquids" more reliably than piston, plunger, gear and progressing cavity style pumps. The primary wear component for Hydra-Cell® Pro pumps are their check valve assemblies, and more specifically the valve disc and seats.

Previous articles have compared pump designs and addressed important aspects such as repair, troubleshooting and lubrication:

Past Articles

- Comparison of a Hydra-Cell metering pump to an External gear pump
- Comparison of a Hydra-Cell pump to AODD (Air Operated Double Diaphragm pump)
- Comparison of a Hydra-Cell pump to Piston and Plunger pumps
- Hydra-Cell pump internal components
- Hydra-Oil: role and importance of oil used in Hydra-Cell pumps
- Troubleshooting Hydra-Cell Pumps

This article will focus solely on the check valves used in the liquid end of the pump.



The only components exposed to the pumped liquid are the check valve assemblies, the diaphragms and o-rings. Check valve assemblies are comprised of a valve seat, valve disc, spring, gasket and retainer.

The retainer seals the flow path though the check valve assembly by compressing the gasket and likewise compresses the spring to push the valve against the valve seat; it also acts as a guide for the spring, which in conjunction with the machined valve disc, helps position the spring and valve against the valve seat. Thus, with proper material compatibility and without upset conditions, the main component wear point is the interface between the valve disc and seat.

Each pump chamber has a pair of check valves installed in the valve plate to control the flow path from a common inlet channel to a common outlet channel within the pump manifold. Each shaft rotation causes an increase and then decrease of the pump chamber volume, drawing in and pushing out liquid. Hydra-Cell Pro pump shafts are operated as high as 1750 RPM, equating to 1750 check valve openings and closings per minute.

Normal Valve/Seat Wear

Impact of the valve disc against its valve seat physically wears away material from both components. When pumping liquids containing few particulates and using heat-treated stainless-steel valve/seat material, one can expect to receive about 6000 hours of use before the valve/seat wear sufficiently to result in a rough running pump.

As the valve/seat wear, their ability to efficiently seal against each other diminishes. The loss of material eventually leads to gaps between the valve/seat. Simultaneously the spring tension is reduced so the reaction time is not as quick.

This manifests itself as a rough running pump because the flow rate is less smooth, with some of the discharge pushed into the inlet manifold with each stroke. You will hear a louder pump, like a "clanking noise" and you will notice the discharge pressure can vary considerably, a reflection of the varying volume of liquid displaced due to the poor seating between valve and seat.

Wear tends to be exponential; perhaps smooth operation for the initial 6000 hours, to minor rough running for a few hundred hours and then extremely rough operation follows.

Some applications are sensitive to flow and pressure fluctuations and monitoring of those characteristics enables a proactive approach to replacing the check valves before performance deteriorates to an unacceptable level.

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Pumping liquids which chemically attack the check valve material accelerates wear of the valve disc and seat and could also damage the valve spring or retainer.

Hydra-Cell Pro pumps are renowned for their reliability of pumping reclaimed liquids and slurries containing hard particulates. Examples of such liquids are lime slurry, spray drying ceramic slip, airless paint spraying, bentonite clay injection and waxy resins – such materials accelerate check valve and seat wear. Replacing the check valve assemblies is usually accomplished within 1-2 hours, it doesn't necessitate removing the entire pump from the system and the cost of the check valve kit is much less expensive when compared to wear components of other types of positive displacement pumps.

Wear Forces Against the Valve Discs and Seats

The low mass, high-speed check valve design, using a valve disc instead of a solid ball, is needed for efficient operation at full pump capacity.

The main wear forces contributing to valve and seat wear are:

1. Impact: the physical interaction of the valve pushed against its seat, which can be as high as 29 times/second (@1750 RPM) and includes wear of hard particles caught between the two sealing surfaces.
2. Erosion: a combination of the velocity through the check valve throughout its opening and closing cycle, along with the hardness of particulate impacting across the valve and valve seat surfaces.
3. Stress: uniform pitting of valve and seat surfaces, caused by a cavitation-like effect as the valve disc physically approaches impact with the valve seat. This is usually not observable as strictly "stress wear", because it is a contributing factor to impact wear. It is also possible to stress the valve and seat materials chemically and through exposure to extreme temperatures.

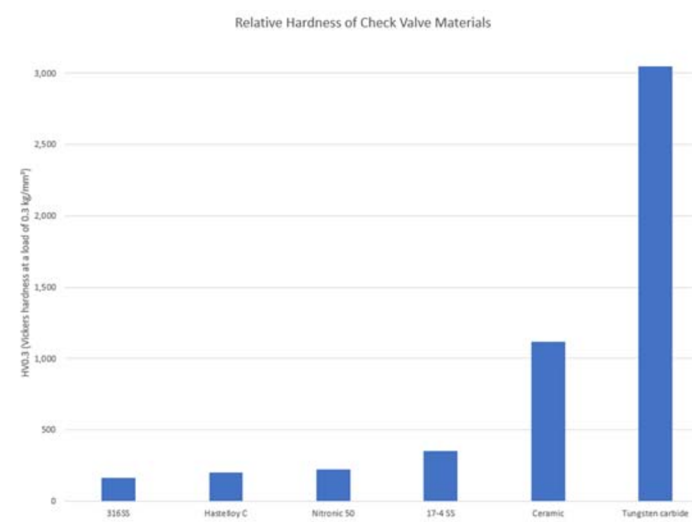
Ways to Extend Check Valve Wear Life

If you have an existing pump system and want to increase wear life of your check valves, the easiest way to do this is to upgrade to a harder or more chemically compatible material. The standard check valve material is 17-4 (heat treated) stainless steel. If the liquid pumped is suspected of being chemically aggressive to 17-4 SS, you may try 316L SS Nitronic 50 or Hastelloy C materials. If the pumped liquid is a slurry or contains hard particles, ceramic and tungsten carbide materials are harder and more resistant to erosive wear.

The "best time" to maximize your valve wear life is when initially sizing your system. For example, comparing the model D10 (8.8 GPM @ 1750 RPM) and the model H25 (20 GPM @ 1200 RPM), the model H25 pump will resist erosive wear better when operated at 506 RPM (8.8 GPM) than the model D10 which needs to operate 3½ times faster for the same flow rate. The is due to the H25 pump having physically larger check valves, thus at the low flow rate of 8.8 GPM the velocity through these valves is significantly reduced.

If pumping water and water-like liquids with few particulates, you can choose a smaller size pump, operate at a higher RPM and address check valve wear life with different materials.

When pumping slurries and abrasive liquids, it is best to "oversize" the pump, operate at a lower RPM and through larger check valves – in addition to using harder check valve materials.



Hardness is not the only factor, for example the ceramic material has a fragility aspect which the alloy materials do not; they can shatter if dropped or subject to extreme thermal shock, so that is a consideration as well.

Let us put our years of knowledge and experience to work for you the next time you have a challenging pump application!