Metering Pump Design Comparison
Gear Pump vs. Hydra-Cell Pump

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Our February article described advantages Hydra-Cell style pumps have compared to other types of positive displacement pumps (Pumping Difficult to Handle Liquids with Hydra-Cell Pumps). The unique features of a Hydra-Cell pump results in competing with many different types of positive displacement pumps, so this month we are providing an in-depth comparison of a Hydra-Cell Pump and Zenith external style gear pump for metering applications. Future articles will provide comparisons to vane, lobe, progressing cavity, piston/plunger and air operated diaphragm pumps. This will assist customers comparing specific pump types rather than rely on generalizations.

Positive displacement pumps displace a fixed volume of liquid per pump shaft revolution and can operate at pressures >1000 PSIG. What makes the Hydra-Cell design relatively unique is that it has no dynamic seals in contact with the pumped liquid.

There are different types of gear pumps and they are available for a range of flow rates and pressures. To make this article relevant for our customers I've chosen to compare the Hydra-Cell P400 metering pump with a Zenith C-9000 Series gear pump (for corrosive and poor lubricating fluids) as they are both similar in their flow rate and operating pressure range, thus conceivably being considered for similar applications.

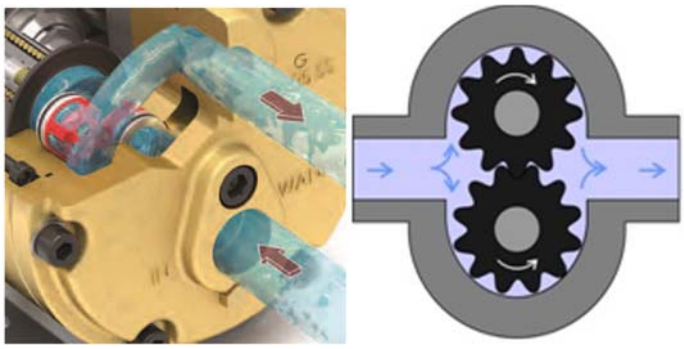
	P400	C-9000
Maximum flow rate (GPH)	224	144
Maximum outlet pressure (PSI)	1000	1000
Maximum inlet pressure (PSI)	250	300
Temperature range (F)	15 to 250	-40 to 350
Shaft rotation	doesn't matter	clockwise
Seals	non-dynamic seal	dynamic seal (mechanical, double-lip or magnetic)
Pump head construction	316SS, brass, cast iron, PVDF, Polypropylene, Hastelloy	316SS

While each pump outputs similar flow rates and pressures, the Hydra-Cell pump design provides more flexibility in materials of construction, however that is not the main advantage, rather it is the non-dynamic sealing design which provides increased reliability and minimizes fugitive emissions compared to a gear pump.

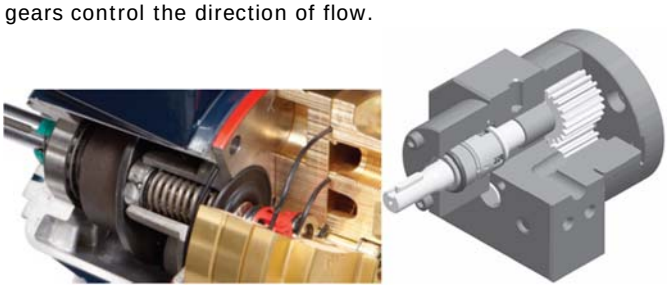
Comparison of Hydra-Cell and Gear Pump Designs

A Hydra-Cell pump head consists of two sections, a manifold and a valve plate. The manifold has a single inlet and outlet connection on one side and on the other it is machined to route the flow to the individual pump chambers in the pump; Hydra-Cell pumps have 1, 3 or 5 pump chambers depending upon the specific model; the model P400 we are comparing in this article has three pump chambers. Thus liquid enters the inlet port, is distributed to each of the three pump chambers and the exit path from each chamber is combined to a common outlet port.

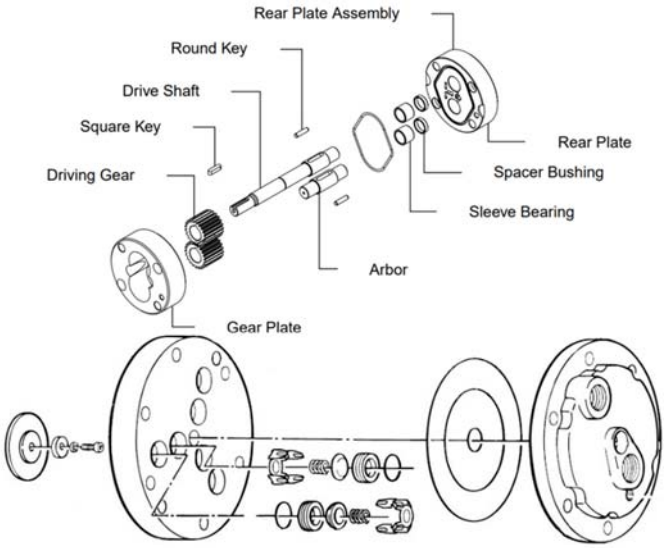
The valve plate also has two sides; the side facing the manifold holds the check valves at the entrance and exit to each pump chamber and the other side forms the non-dynamic seal with the pump body as well as the pump chamber. The rotation of the pump shaft results in increasing/decreasing the volume of liquid within the pump chamber and direction of flow is controlled by the aforementioned check valves.



An external style gear pump has inlet and outlet ports 180° apart ("in-line") and a pair of rotation cogs or "gears". The space between the pump casing and rotating gears traps liquid, propelling it towards the pump outlet. Intermeshing of the gears control the direction of flow.



While the overall mechanical design of a gear pump has fewer components, Hydra-Cell pumps have fewer components in contact with the liquid pumped.



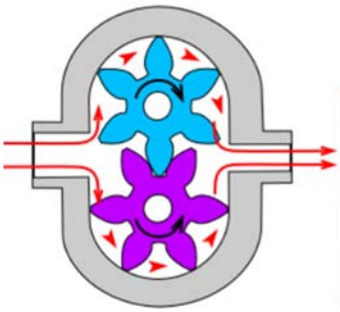
Gear pumps have the intermeshing gears, drive/arbor shafts, sleeve bearings and spacer bushings in contact with the liquid pumped. Hydra-Cell pumps only have their check valves and elastomers in contact with the process liquid.

A significant advantage to the Hydra-Cell design is that its check valves and elastomers are available in a variety of alloy and non-alloy materials whereas a gear pump is inherently more limited due to its design.

Intermeshing Gears vs. Check Valves

To be an efficient and reliable metering pump, each shaft rotation needs to displace a fixed volume of liquid. The Hydra-Cell style exceeds API 675 metering pump performance standards. The only wear item are the check valves and their wear is gradual depending upon the aggressiveness of the liquid and it is usually the interface of the valve and seat. This can be somewhat compensated for by using exotic alloys and non alloys to increase chemical and abrasive resistance.

	API 675	Hydra-Cell
Accuracy	±1%	±½%
Linearity	±3%	±3%
Repeatability	±3%	±3%



To obtain such accuracy with a gear pump requires the gears to come very close together, thus wear of the gears, casing and sleeve bushings contribute to performance. Furthermore, to seal the liquid from the external shaft of the pump, a mechanical seal is used. Since all of these components are subject to abrasive wear, **Zenith recommends filtering the liquid to 5 microns absolute**. As described in our article Understanding Retention Efficiencies for Filter Cartridges, this level of filtration requires a relatively expensive filter housing and cartridge design to achieve a Beta 5000 performance ratio.

The P400 Hydra-Cell pump will pass solids as large at 500 microns and thus inexpensive nominally rated filter media can be used.

Those intermeshing gears are dependent upon the liquid pumped for lubrication and cooling; the manufacturer advises against operating the pump dry (without fluid). Even for self-priming it is recommended that the pump head is filled with liquid prior to operating the pump.

Hydra-Cell pumps can operate dry because they lack dynamic seals and therefore truly self-prime. Therefore, inlet cavitation, often caused by clogged inlet filters, doesn't damage a Hydra-Cell pump but will damage a gear pump because they need lubrication to reduce wear of the gear teeth.

Viscosity and Efficiency

Gear pumps experience reduced efficiency with thinner viscosity liquids due to the small gaps between the gears and housing as well as the intermeshed gears. When using gear pumps for less viscous liquids it is advised to oversize the pump such that it operates at lower RPMs.

Viscosity has little effect on Hydra-Cell pump efficiency due to the low mass, high-speed spring-loaded design of its check valves.

Characteristics of the Application Matter

While the flow rate and discharge pressure capabilities might be similar, the designs of external gear pumps and Hydra-Cell pumps are completely different. If you have a gear pump requiring expensive filtration or annual maintenance costs are high due to component wear, it would be worth taking a look at a Hydra-Cell pump.

Hydra-Cell pumps are capable of pumping viscous, water-like, abrasive and shear sensitive liquids. Their filtration requirements are less than other styles of positive displacement pumps, a cost not often considered even though it is directly attributable to the type of pump used for an application.

Cost

I compared pricing from 2016 that I found online for a Zenith C-9000 series pump to the cost for a P400 Hydra-Cell in 2016 and it was exactly 50% less!

I am unsure what it costs to replace the wear components in the Zenith pump; the P400 would require (2) quarts of synthetic oil and up to (2) valve replacement kits which only cost about $600 in 2022. The check valves are easily replaced without the need for special tools or training.

In contrast, Zeniths IOM manual instructs using only plastic tools and not using force during maintenance as the tolerance is very high for their parts. The silicon carbide sleeve bearings are "interference fit" at the factory and thus it is recommended that they are not removed by the customer:

> *"These sleeve bearings are extremely brittle and fragile, and can be easily broken resulting in multiple part damage and high replacement cost."*

So, there is some application overlap between Hydra-Cell sealless pumps and industrial gear pumps. If you currently experience gear pump reliability issues or you have a new pump application but not sure what type of pump provides the best value, take advantage of our 31+ years of pump application experience - it's just a phone call or email away! Our web-based inquiry forms are pump specific to streamline the selection process but we are just as happy to have a discussion with you about your specific application. If it is not a good fit for one of the pump designs we offer, we can usually recommend a pump design that would be better suited for your application.