Hydra-Cell®
Seal-less Pumps

What Are the Performance Advantages of Seal-less Pumps?

Technological overview and field examples of the seal-less design compared to other pumping technologies in various manufacturing and processing applications.

Wanner Engineering, Inc.

Performance Advantages of Seal-less Pumps

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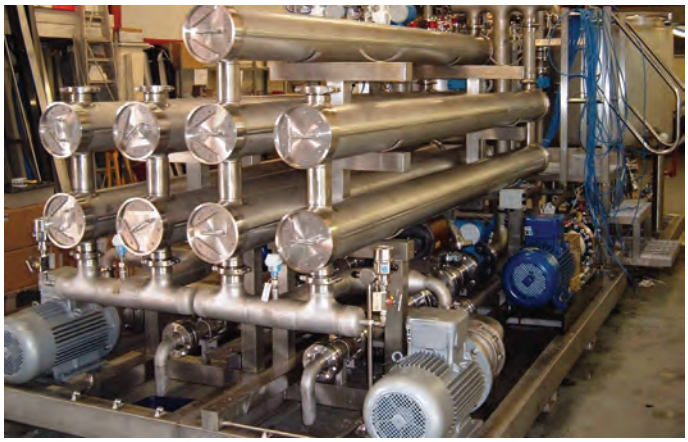
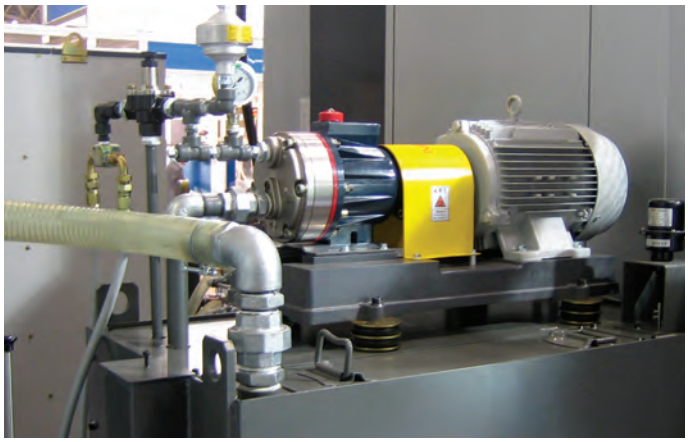
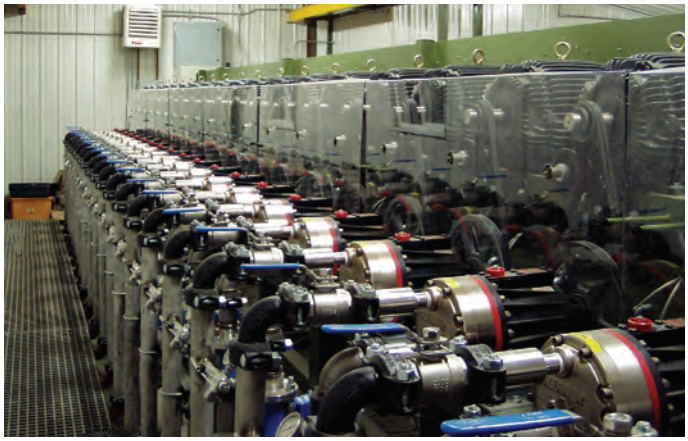






Introduction

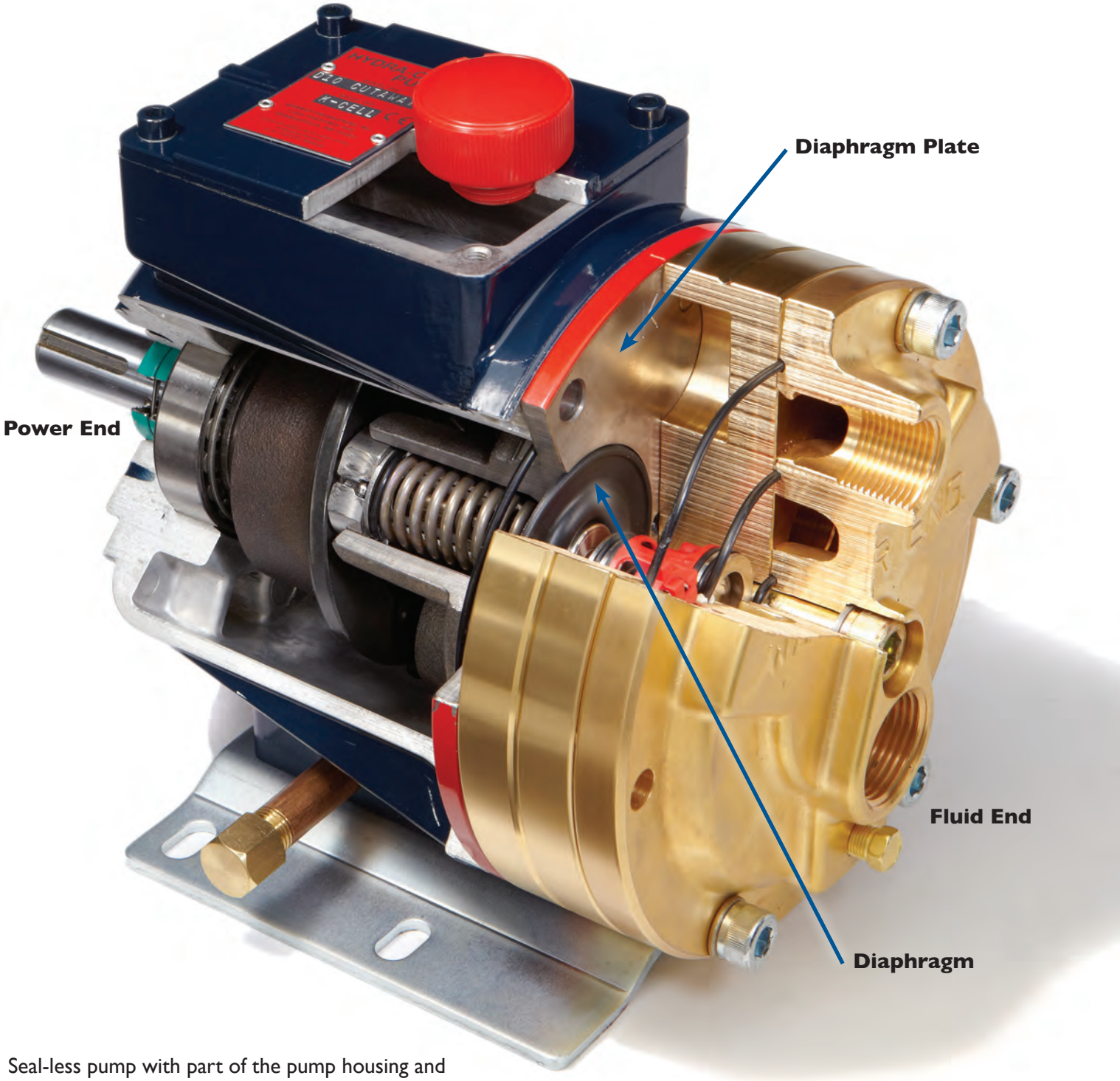
Whether processing pharmaceuticals, treating drinking water, or feeding a boiler in a power plant, pumps are among the most extensively used industrial products.

Not only do pumps come "in all shapes and sizes," there are different pumping technologies available to meet widespread applications.

This paper examines a specific technology, the seal-less design of a positive displacement, diaphragm pump. It cites examples where this type of seal-less pump replaced other types of pumps to overcome problems in the field.

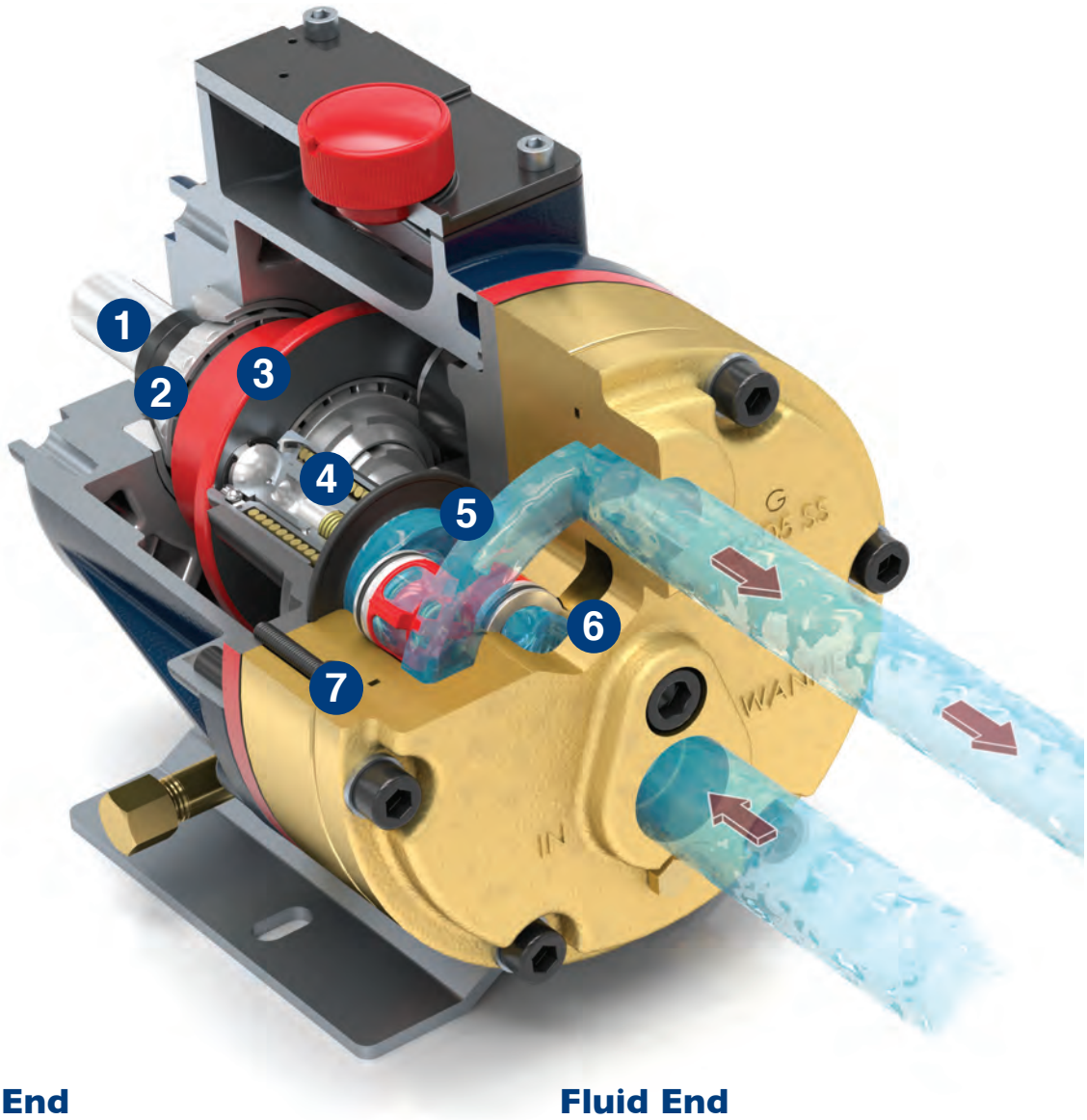
What Does “Seal-less” Mean?

A pump that has no packing or seals (mechanical or dynamic) used to isolate the process fluid from the power end.



Seal-less pump with part of the pump housing and pump head “cut away” to show the internal design and components. The fluid is processed strictly within the pump head, separated from the power end by a diaphragm plate and the diaphragms.

Seal-less Pump Technology Abstract



Power End

The power (or hydraulic) end of a "Hydra-Cell" seal-less pump includes:

(1) Drive Shaft

(2) Tapered Roller Bearings

(3) Fixed-angle Cam

(4) Hydraulic Cells

As the drive shaft turns, the cam (a wobble plate) oscillates forward and back, converting axial motion into linear motion.

The hydraulic cells move sequentially and replenish themselves with lubricating oil on the rearward strokes so that the cells remain filled with oil on the forward strokes.

Fluid End

The fluid (or liquid) end of a "Hydra-Cell" seal-less pump includes:

(5) Hydraulically-balanced Diaphragms

(6) Horizontal Disk Check Valve Assembly

(7) Discharge Valve Assembly

The diaphragms flex forward and backward when the wobble plate moves to provide the pumping action.

Fluid enters the pump head (manifold) on the backward stroke and flows though the horizontal disk check valve assembly.

The fluid is then forced back out the pump by the forward stroke through the discharge valve assembly.

Unlike pump technologies that use packing or seals, the hydraulics of a seal-less pump do not come into contact with the fluid being processed.

Seal-less Pump Design Strengths

No Leak Path

Since the fluid and power ends are separate, there is no leak path and no harmful emissions. Operators are protected from the release of harmful substances, such as Volatile Organic Compounds, and enjoy a greater peace of mind.

Reduced Maintenance and Downtime

With no seals or packing that leak or wear out, there is no downtime or extra cost for seal replacement. There are no clean-up and disposal costs associated with packing that has to leak for lubrication and cooling.

Runs Dry

Running dry can cause catastrophic failure in pumps with mechanical seals. A seal-less pump will operate indefinitely without damage if the suction line becomes blocked or is closed. A seal-less pump will also run without damage if other conditions prevail, such as insufficient liquid supply, excessive vacuum at the inlet of the pump, or inadequate discharge pressure.

Handles Abrasives and Particulates

Integrated within the seal-less design, spring-loaded, horizontal disk check valves can process abrasive, un-dissolved particles (up to 800 microns in size, depending on the model) that would damage or destroy other types of pumps. This also eliminates the need for fine filtration in many applications.

Pumps Low-to-High Viscosity Fluids

Due to the seal-less design and availability of a wide range of metallic and non-metallic materials of construction, thin and non-lubricating liquids as well as highly viscous fluids can be pumped reliably.

Field Examples of Seal-less Pumps

Eliminates Seal Failure

Application:

Transfer raw ingredients (acids) for food and beverage production.

Problem:

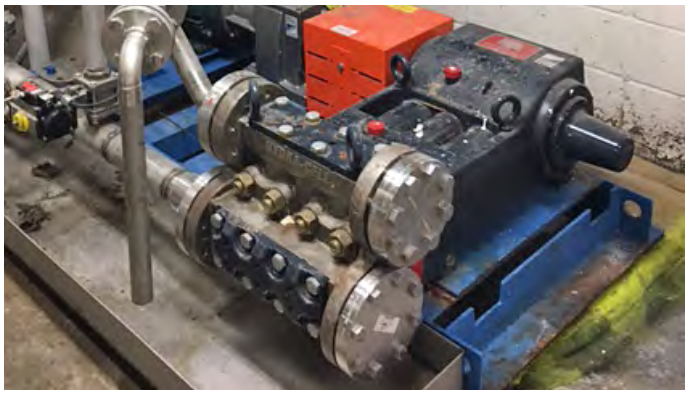
Mechanical seal failure and high energy costs (150-hp motor).

Previous Pump Technology:

Horizontal multi-stage centrifugal pump.

Seal-less Pump Design Advantages:

- ✔ Reduces maintenance because there are no mechanical seals to fail.
- ✔ Solids handling capability improves reliability.
- ✔ Lowers energy costs (20-hp motor).



Overcomes Seal Weepage

Application:

Inject hazardous industrial and municipal wastes into disposal well.

Problem:

Downtime with annual maintenance and repair costs up to $140,000 due to seal weepage.

Previous Pump Technology:

Single-stage centrifugal pump.

Seal-less Pump Design Advantages:

- ✔ Reduces maintenance because there are no dynamic seals to fail and cause weepage.
- ✔ Slashes downtime and virtually eliminates repair costs.

Field Examples of Seal-less Pumps

Controls VOC Emissions

Application:

Metering acetate and methane for a natural-gas based chemical plant.

Problem:

Pump with dynamic seals leaked Volatile Organic Compounds (VOC).

Previous Pump Technology:

Triplex plunger pump.

Seal-less Pump Design Advantages:

- ✔ No leak path and no dynamic seals, so VOC are 100% contained.
- ✔ Smaller footprint and less maintenance required.
- ✔ Meets API 675 performance standards.

Reduces Maintenance

Application:

Transferring crude oil from an oilfield to a midstream pipeline.

Problem:

Packing and mechanical seals required frequent maintenance and replacement.

Previous Pump Technology:

External gear pump.

Seal-less Pump Design Advantages:

- ✔ No packing or mechanical seals to leak, wear, or replace.
- ✔ Easier to service.

Field Examples of Seal-less Pumps

Handles Solids

Application:

Reverse Osmosis (RO) to produce household drinking water from seawater.

Problem:

Seals ruptured (and the piston also broke) because the pump could not handle solids (up to 40,000 ppm).

Previous Pump Technology:

Plunger piston pump.

Seal-less Pump Design Advantages:

- ✔ Solids handling capability eliminated costly maintenance.
- ✔ Lower energy consumption.
- ✔ Proven to run dry without damage.

Runs Dry

Application:

Injecting an emulsion with the precise amount of explosives for quarrying.

Problem:

Pumps were incapable of running dry without damage, and the packing required frequent adjustment and replacement from wear.

Previous Pump Technology:

Packed plunger pump.

Seal-less Pump Design Advantages:

- ✔ Ability to run dry without damage to the pump.
- ✔ Less maintenance because of no packing to wear or replace.
- ✔ More accurate injection for the detonations.

Field Examples of Seal-less Pumps

Protects Sensitive Fluids

Application:

Feed sensitive oils into a filter press for pharmaceutical processing.

Problem:

Air entrapment and overheating within the pump clouded and damaged the oils.

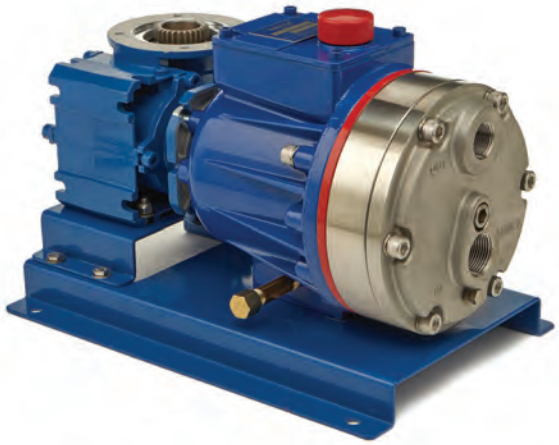
Previous Pump Technology:

Centrifugal pump.

Seal-less Pump Design Advantages:

- ✔ Protects sensitive fluids from air entrapment.
- ✔ Prevents overheating because the power and process ends are isolated.

Eliminates Leak Path



Application:

Injecting a toxic solvent, Dimethylformamide, (DMF) for urethane production.

Problem:

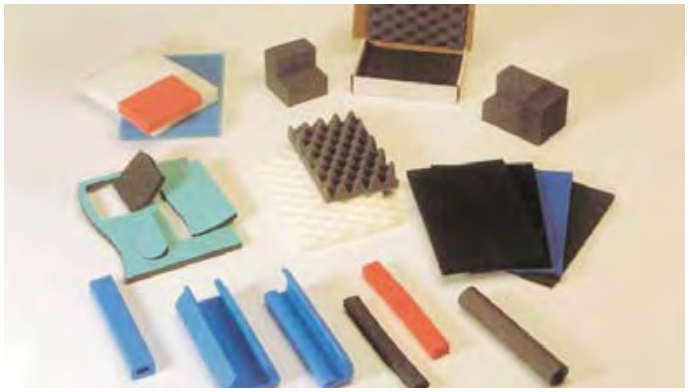
Maintain a safe working environment in which DMF is fully contained, and provide accurate, repeatable, virtually pulse-free flow.

Previous Pump Technology:

Conventional metering pump.

Seal-less Pump Design Advantages:

- ✔ No seals or leak paths, so DMF is fully contained.
- ✔ Meets API 675 performance standards for accuracy and repeatability while providing virtually pulse-free flow.



Field Examples of Seal-less Pumps

Manages Entrapped Air

Application:

Pump a viscous, sheer-sensitive bonding resin to produce bonded abrasives.

Problem:

Entrapped air and run-dry conditions damaged the screw pumps, which required frequent maintenance and annual replacement.

Previous Pump Technology:

Screw pump.

Seal-less Pump Design Advantages:

- ✔ Runs dry without damage to the pump.
- ✔ Minimal maintenance with year-after-year reliable operation.
- ✔ Handles high-viscosity fluids.

Prevents Pump Damage

Application:

Spray Ethylene Glycol on a coal handling belt for dust suppression and proper processing.

Problem:

Pump was susceptible to damage when running dry, and its seals, cups, and packing wore out frequently.

Previous Pump Technology:

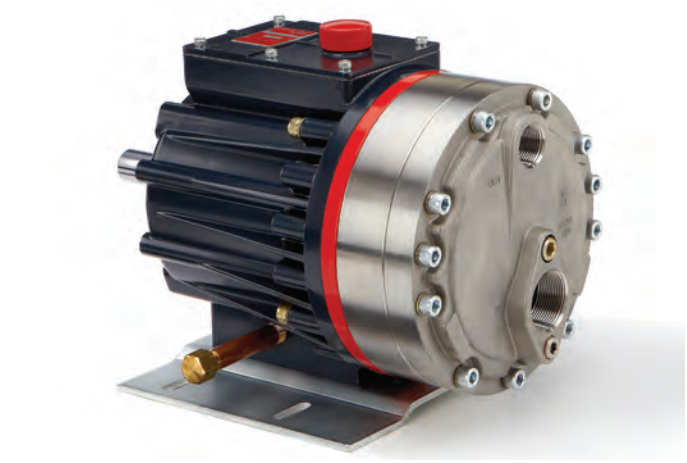
Piston pump.

Seal-less Pump Design Advantages:

- ✔ Ability to run dry without damage.
- ✔ No seals, cups, or packing to wear or replace.

Field Examples of Seal-less Pumps

Reduces Downtime



Application:

High-pressure spraying for in-plant cleaning of trays, pallets, and totes.

Problem:

Frequent downtime and maintenance plus safety and disposal issues because of packing leakage and wear.

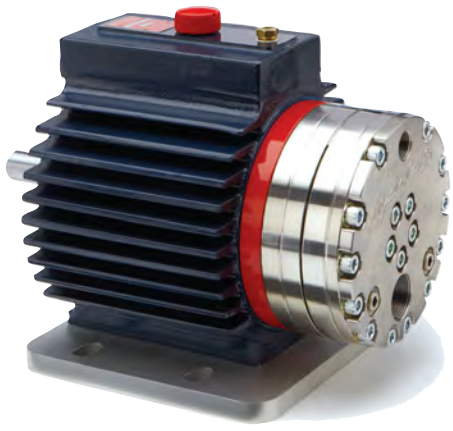
Previous Pump Technology:

Packed plunger-piston pump.

Seal-less Pump Design Advantages:

- ✔ Less downtime and maintenance because there is no packing to wear or replace.
- ✔ Eliminates disposal issues from packing that leaks.

Handles Abrasive Particulates



Application:

Pumping low- and high-viscosity machine tool coolant at high pressure.

Problem:

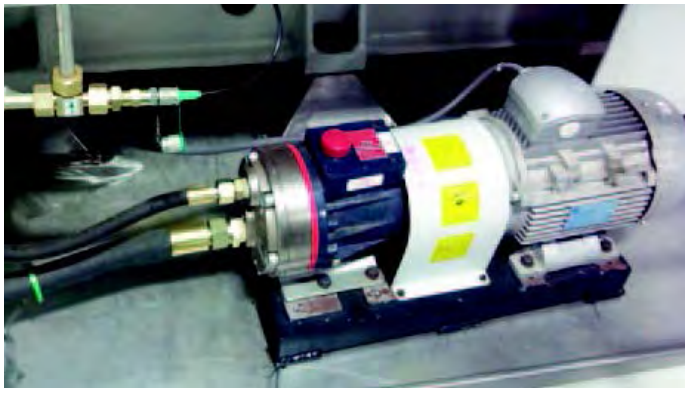
Pumps suffered from seal leakage and wear and could not handle abrasive particulates without fine filtration.

Previous Pump Technology:

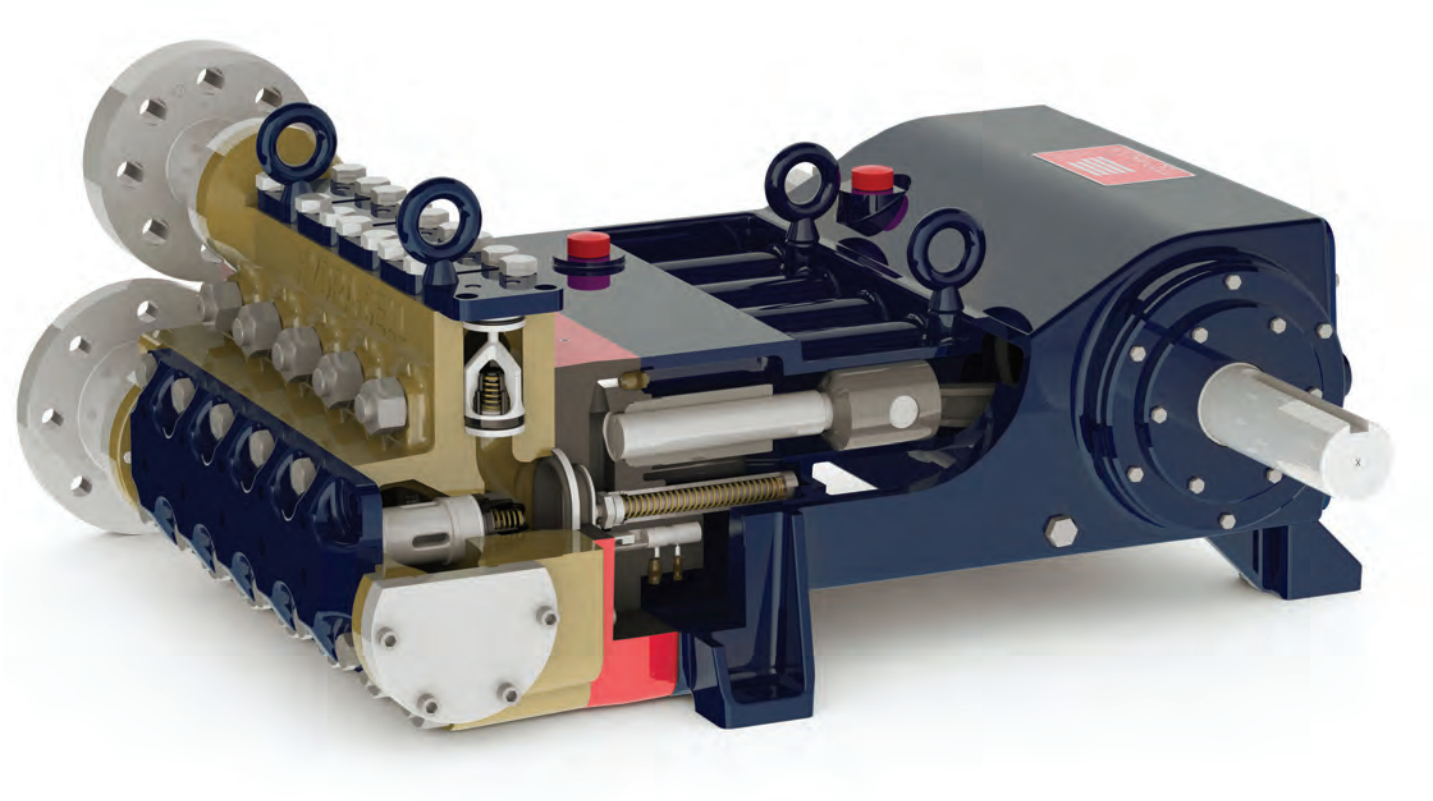
Packed plunger-piston pump.

Seal-less Pump Design Advantages:

- ✔ Pumps low-to-high-viscosity fluids.
- ✔ Handles abrasive particulates without the need for fine filtration.
- ✔ No mechanical or dynamic seals to leak, wear, or replace.



Performance Advantages of Seal-less Pumps



Summary

Although pumps with packing and mechanical or dynamic seals have proved themselves in processing applications and for plant operations, there are many times when such pumping technologies are at a disadvantage to seal-less pumps.

In this report, the seal-less design of the Hydra-Cell positive displacement, multiple-diaphragm pump is presented. Several field examples are cited where Hydra-Cell Seal-less Pumps have:

- Reduced maintenance and downtime because there is no packing or seals to leak, wear, or replace.
- Prevented pump damage because of its ability to handle abrasive solids (up to 800 microns in size, depending on the pump model) and to run dry.
- Improved safety because there is no leak path to emit VOC or other harmful substances.
- Lowered energy costs and other operating expenditures.
- Demonstrated versatility in a wide range of applications that required pumping low- or high-viscosity fluids as well as protecting sensitive fluids.

USA Patents

Patent Number	Title
5,707,219	Diaphragm pump
6,019,124	Valve assembly for use with high-pressure pumps
6,899,530	Diaphragm pump with a transfer chamber vent with a longitudinal notch on the piston cylinder
6,941,853	Pump diaphragm rupture detection
7,467,582	Pump diaphragm rupture detection
7,090,474	Diaphragm pump with overfill limiter
7,425,120	Diaphragm position control for hydraulically driven pumps
7,665,974	Diaphragm pump position control with offset valve axis

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