WARRENDER, LTD.

Disc-Rotor Pumps

Series VSS Disc-Rotor Sealed Pumps

DESIGNED FOR :
The most abrasive, and erosive particulates, slurries and sludge. fragile crystals, sensitive chemicals and polymer emulsions.

Minimize spare parts, maintenance and operational costs.

Warrender, Ltd.
Series VSS Pumps
Viscosity - Slurry - Solids

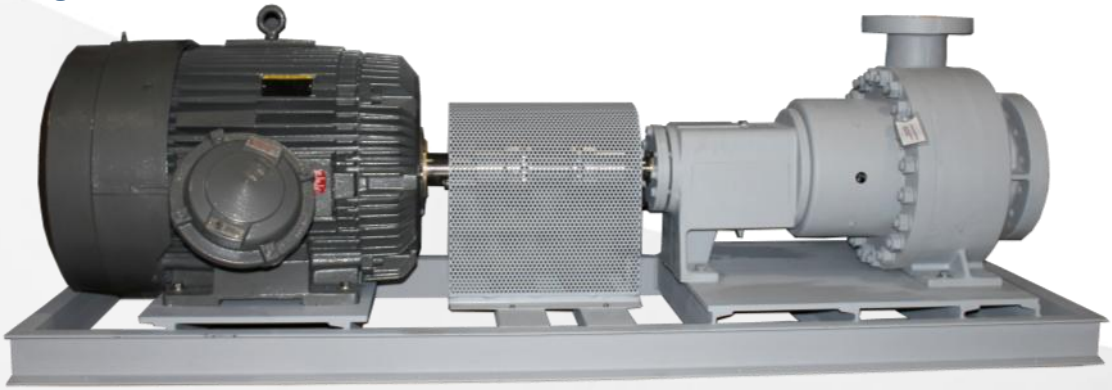
Warrender VSS pumps provide reliable solutions for pumping varying viscosities, abrasive slurries, and damaging solids.

This innovative approach contrasts other pumping designs by achieving unsurpassed levels of reliability and with it greater productivity along with the minimum overall Life Cycle Costs in the most difficult pump applications. This allows for wide use within a wide range of all processing industries.

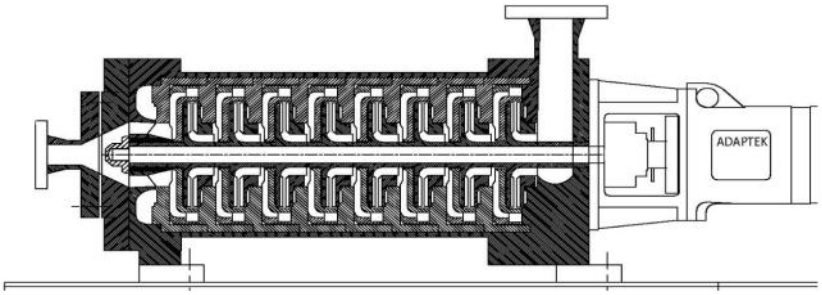
The disc-rotor design has solved the toughest problems. It is able to pump a broad range of services including: viscous, solids and abrasives The ability to resist pump damage translates to minimal damage to process fluids as well. The capacity for pumping ultra shear sensitive products without damage has led to this design being chosen for seemingly unrelated services from crude oil with entrained contaminants (e.g. sand, waxes, water, etc.), polymers to crystalline products, to latexes and oil/water separator feed. The disc-rotor pump is also uniquely capable of pumping fluids with exceeding high volumes of entrained gas / air, such as foams, and . This design has become the pump of choice within petroleum, chemical, municipal, food, beverage and pharmaceutical processing industries. What all have in common is the goal of seeking relief from the high costs of conventional pump technologies being pressed into services in which they suffer from rapid wear, lost performance, excessive wear, constant maintenance, costly spare pumps & parts replacement, repeated down-time, unnecessary product damage, all collectively leading to massive lost profits. The Goal of minimizing these cost factors has been routinely realized through trying something very different - the Warrender, Ltd. disc-rotor pump technology and consequently seeking more new ways to apply it and realize the advantages.

While the disc-rotor pump technology was actually developed decades ago, recent (Patent Pending) design improvements have resulted in substantial efficiency increases. This has now brought the disc-rotor pump into consideration within a dramatically expanded range of applications.

The Warrender VSS Disc-Rotor pump greatly extends MTBF / MTBPM in arduous services over conventional centrifugal or positive displacement designs.

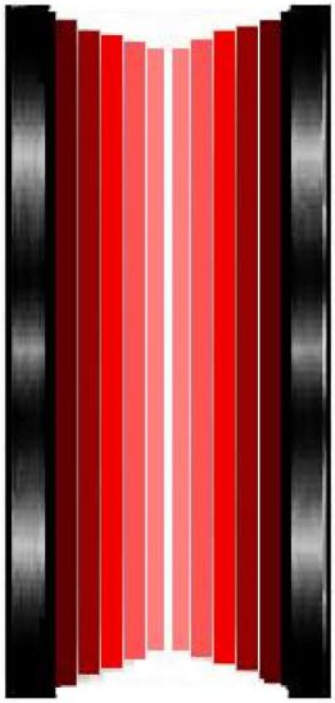


The appearance is similar to centrifugal pumps, minus the internal friction and wear associated with conventional impeller vane technology. VSS disc-rotor pumps function like centrifugals, and are more versatile than progressive cavity (PC), rotary lobe and gear configurations. VSS pumps deliver flows from 2 to 6,000 GPM and heads to over 4,000 ft.



Disc-rotor pumps utilize the molecular principles of the initial boundary layer and viscous attraction. While relying primarily upon these two principle as a pumping process is relatively new in the design of pumps, it is routinely recognized elsewhere in process hydraulic engineering, such as in the influence on flow characteristics and friction related loss through a piping system. Under laminar flow conditions, streams of liquid travel at varying velocities through the piping system. Fluid forms a stationary layer adjacent to the pipe wall that separates the pipe surface from the balance of the fluid flow. The relative layer thickness increases with viscosity. Each successive layer will move more quickly with highest velocity in the center of the piping.

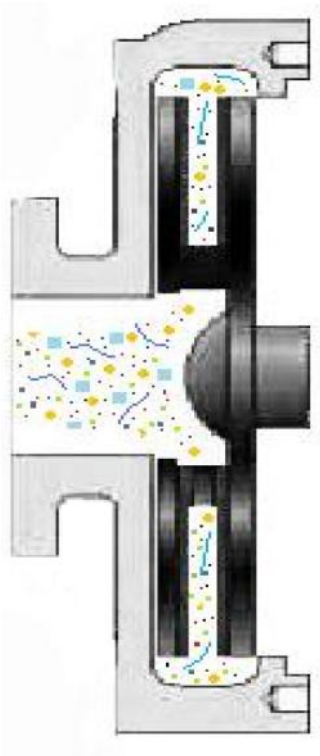
As with piping, when fluid enters the disc-rotor pump, process fluid molecules adhere to the surfaces of the rotor - one or a series of parallel disc - that comprises what is known as the rotor. This creates the initial fluid layer. As the rotor turns, energy is transferred from the initial to successive fluid layers within the space around and / or between the discs through the principle of viscous attraction to generate velocity / pressure within the Rotor. This combination of the initial layer and viscous attraction causes a fluid 'force field' that accelerates the fluid within and through the pump creating a smooth, turbulence-free laminar flow.



Disc-rotor pumps incorporate the principles of initial-layer adhesion and viscous attraction to achieve a smooth, pulse-free laminar process fluid flow.

The pumped fluid path is in parallel to the rotor disc, the initial fluid layer achieves a fluid barrier essentially protecting the rotor and the other internal pump surfaces from the effects of the fluid. The result in minimal impact upon the fluid and damage to internal pump components. This is the primarily difference in how the disc pump functions compared to other designs, each of which depends on impingement device such as an impeller vane, or other method of forcing through the pump such as of screw, lobe, gear, hose diaphragm or others to essentially force the fluid out the pump.

By minimizing contact between the pump and the process fluid, pump wear is greatly reduced and service interruptions virtually unknown. In applications handling delicate and shear sensitive fluids, product damage is almost completely eliminated. The ability to solve the most ardent and chronic problems has elevated the disc-rotor pump to near legendary status within the pump world. If you are currently struggling with such a problem killing your bottom line, why not explore a totally different approach and find a cure for the problem.



Disc-rotor pumps employ pumping action, with a minimal contact between the fluid and internal pump surfaces.

Primary Applications

Crude Oil
Centrifuge, Belt & Filter press feed
Heavy oils, waste oil, and hot oil
Filter & Belt Press Feed
Waste Oil
Latex
Polymers
Sand, Gravel & Grit
Reactor Column Bottoms
Corn Mash
Gypsum
Hot Tar
Underflow Thickener Sludge

Abrasive Slurries

Titanium Dioxide
Calcium Carbonate
Synthetic Fuels (40+% abrasives)
Clay
Crude Oil w/ Sand, Gas & Water
Heavy Salt Brine
DE Pre-coat
Bottom & Fly Ash
Concrete & Grout
Refractories
Municipal Primary Sludge
Digested Sludge
Ceramic Slip
Lime (50+%)

Self Priming

Tanker & Rail Car Unloading
High Solids Bilge Water
Mine Dewatering
Coal Fines & Sediment
Lift Stations
Sludge Sumps

Sheer Sensitive & Delicate Materials

Polymers
Latex
Sugar Crystals
Polystyrene
Crystalline Suspensions
Oil / Water Separator Feed

Unusual Service

Fumed Silica (slurry & dry powder)
Fumed Silica (dry) Rail and tanker loading

Pulsation-Free Smooth Laminar Flow

Pulsation-free flow enhances gentle processing of fragile products and eliminating costly damage along with greatly reducing wear in pump and related piping and instrumentation.

No Tight Internal Tolerances

This allows the disc-rotor pump to pass large and irregular hard solids, as well as variable solids stream without plugging.

Low NPSH Requirement

The disc-rotor's low NPSHr ranges from approx. 1/3 to 1/2 that of a conventional centrifugal pump in the same service, also attributed to the smooth laminar flow generated by this design.

Dry-Run Capability

The disc-rotor pump design is capable of being operated indefinitely with zero process fluid. Note: The mechanical seal must be flushed during dry-running.

Dead-Heading Discharge / Starving the Suction

It is possible to deadhead the discharge and / or starve the suction for extended periods of time at normal operating speeds, with minimal damage to the pump. Note: Seal flushing or quenching required under these conditions.

Minimal Radial and Axial Loads

Exceptional low radial and axial loads generated by the disc-rotor result in extended seal, bearing and shaft life.

Exceptionally Versatile Design

Capability of handling a wide range of conditions without requiring internal modifications, even with large variations in process viscosity, temperature, solids type or concentration without process interruption.

Long Life for Pump Components

Few, if any, spare parts are anticipated for the disc-rotor pump over it's life. The oversized shaft along with minimal axial or radial loads, together greatly extend and maximize bearing and seal life.

Low Maintenance / Spare Parts Requirements

Disc-rotor pumps are subject to minimal wear even in the most abrasive services due to minimal fluid to pump service contact and laminar flow characteristic. With this pump you don't need parts.

Maximum Run Time and Reliability

Simply the most reliable pump on the market for hard-to-pump applications, disc-rotor has no close tolerances or wear rings to enhance the minimal fluid contacting action. These factors contribute to maximum run time by preventing clogging.

Higher Production Yields and Improved Product Quality

When pumping delicate, shear sensitive, or otherwise sensitive products, the disc-rotor increases productivity by reducing product losses due to the minimal contact pumping mechanism and laminar flow. Savings can be phenomenal with some pumps actually paying for themselves in matter of weeks.

CAPABILITY OVERVIEW

Highly Viscous Fluids

Because this design utilizes viscous friction, the higher the viscosity the better it pumps. Services include: tank bottoms, clarifier sludge, tar with coke nes and asphalt. Up to 50,000 cPs and higher can be pumped with standard pumps.

Slurries with a High Solids Content

Handles slurries containing up to 80% solids without plugging, wearing excessively or stalling. Examples include pumping oil and sand slurries, titanium dioxide slurries and drilling mud.

Severely Abrasive Fluids

Pumps the most severely abrasive fluids with minimal wear and no maintenance. These include lime slurries, borax, drilling mud with grit and rocks, and ash.

Delicate and/ or Shear Sensitive Products

Virtually eliminates pump related product damage. Exceptionally effective in handling shear damaging, shear thickening (dilatant) and shear thinning (thixotropic) products, such as latexes, polymer emulsions, and crystal slurries.

Fluids with Entrained Air / Gas

Handles fluids containing high levels of air/gas without vapor-locking while resisting cavitational damage, including DAF sludge, crude oil and chemical froths.

Handling Large and / or Irregular Solids

VSS Series pumps can be configured to handle exceptionally large solids. Solids entering the pump move to the area of highest velocity - the midway point between the discs - and pass through without clogging.

Material Options

Pumps are available in a wide range of material to suit a broad range of fluids. Options include: Ductile Iron, 316SS, Carbon Steel. Alloy 20, CD4mCU, Hastelloy, Titanium and others on special request.

High Temperature and High Pressure Processes

Pumps designed to API-610, 8th Edition standards are available to address high temperature and high pressure processes.

Disc-Rotor pumps can be applied within a wide range of industries, including the following:

- Oil Refining and drilling operations
- Pulp and paper manufacturing
- Metal, mining and mine de-watering industries
- Municipal wastewater and utility plants
- Food, beverage and agricultural industries
- Pharmaceutical and bio-medical processing

Pump Configurations

Warrender, Ltd. pumps are precision engineered and designed to meet a customer's exact need. Various rotor designs are available. Pumps are available in direct-coupled, base-mounted, close-coupled, sump, submersible, vertical sump, dry pit and cantilever and self-priming models, with Rotor diameters from 6 to 20-inch.

Pump Sizes

2x1½x8	6x3x17
3x2x10	6x4x17
4x2x12	8x6x17
4x3x12	10x8x17
6x4x12	6x3x20
4x2x14	8x4x20
4x3x14	8x6x20
6x4x14	10x6x20
8x6x14	10x8x20

Materials

Carbon Steel, Ductile Iron, 316SS, Duplex SS, Alloy-20, CD4MU, Hastelloy-C, Titanium

Non-Metallic Materials

Ceramic & Rubber-lined
Other materials available on request.

Operating Range:

Flow capacities: 2-6,000 GPM
Discharge Heads: to 4,000+ft TDH
Suction Pressures: 2 - 1,000 PSIG
Working pressures: to 1400 PSIG.
Temperature: to 1000°F
Viscosities: to 50,000 cPs
Pump speeds: Variable to 3600 rpm
Solids size (max): 0.5 - 3 inches
Drivers: Electric, diesel, hydraulic.

VSS12

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