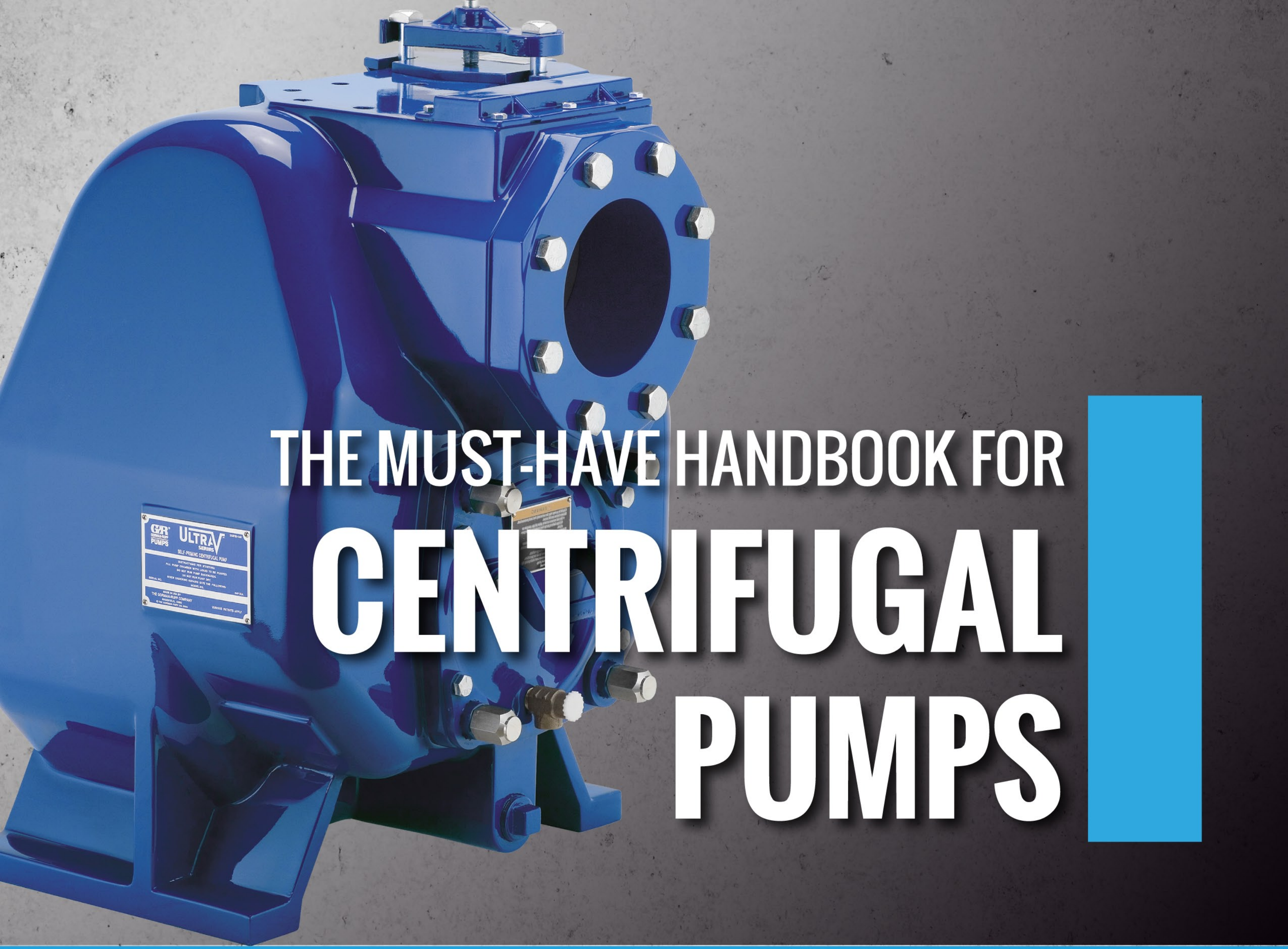


THE MUST-HAVE HANDBOOK FOR CENTRIFUGAL PUMPS

BEST APPLICATIONS / ADVANTAGES / DISADVANTAGES

9 Centrifugal Pumps You Ought To Know

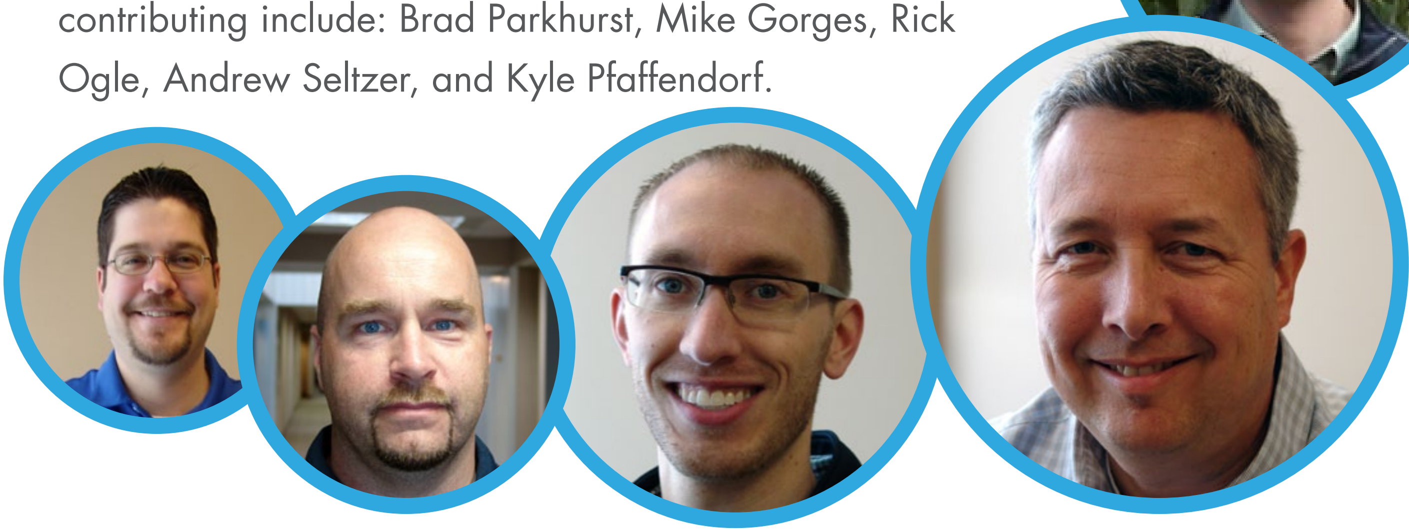
Wondering which centrifugal pump will work best for your application? With a myriad of centrifugal pump types available, it's important to know what each type is designed for. In this eBook you'll get a basic understanding of 9 different kinds of centrifugal pumps.

CRANE ENGINEERING

Content Inside

About the Authors

This comprehensive guide was a collecitve effort among many engineers and account managers at Crane Engineering. Those contributing include: Brad Parkhurst, Mike Gorges, Rick Ogle, Andrew Seltzer, and Kyle Pfaffendorf.



An overview of centrifugal pumps.

Centrifugal pumps are a very broad category of pumps. They vary so much in size, capacity, and abilities that it can be difficult to understand which is right for your application. This guide is designed to help you get a very basic understanding of the best applications, advantages, and disadvantages of different centrifugal pumps we help our customers with every day.

Before we dive into the different types available to you, let's get back to basics and understand what characterizes a centrifugal pump, and how it really works.

How It Works

Centrifugal pumps move fluid by using centrifugal force to generate velocity of the liquid. Fluid enters the pump through the suction nozzle, into the eye of the impeller. The impeller vanes catch the fluid and rotate it both tangentially and radially until it exits the pump on the discharge side. The fluid leaves under a greater pressure than when it entered.

Best Applications

Centrifugal pumps work best with water and other low viscosity fluids. Efficiency is reduced when pumping viscous fluids.

They have a greater tolerance for solids than positive displacement pumps, some are built specially to handle large solids, up to 3″ in diameter.

Advantages

Centrifugal pumps are great for moving a lot of low viscosity fluid at fast speeds. With such a wide variety of options, it is not hard to find a centrifugal pump for just about any application.

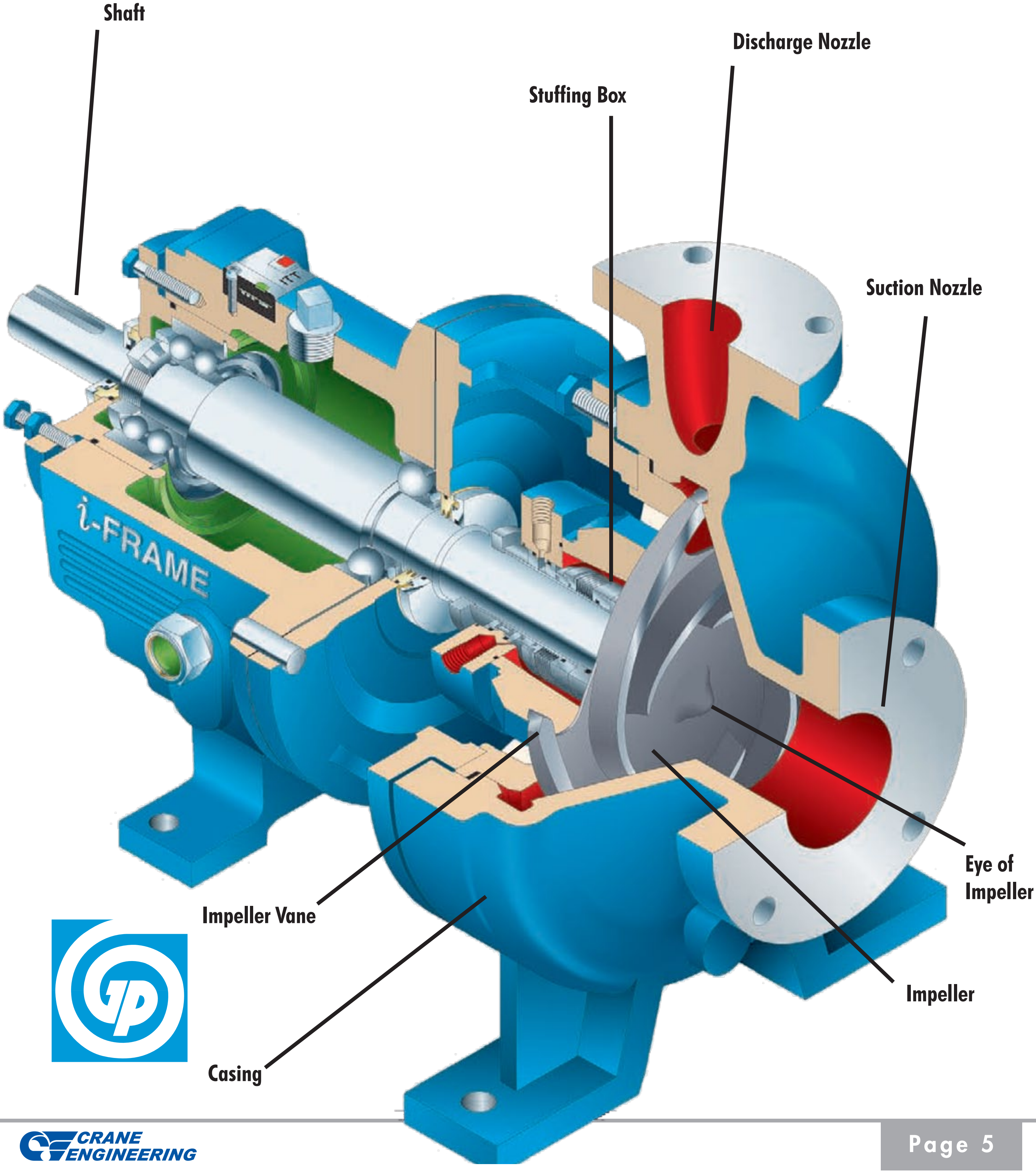
Disadvantages

Centrifugal pumps can be sensitive to operating conditions. Vibrations, unbalance, and cavitation are just some of the factors that can cause a pump to literally self destruct. We wrote an eBook that covers this (36 Ways To Kill Your Pump).

Pump Anatomy

Centrifugal pumps come with their own terminology. Review the section at the end of this book for some common terms associated with this type of pump, then take a look at the diagram on the next page for the basic anatomy of a centrifugal pump.

THE ANATOMY OF A CENTRIFUGAL PUMP



Single Stage, End Suction

The single stage, end suction centrifugal pump is the most common type of centrifugal pump. It has a single impeller stage which adds energy to fluid as it rotates inside the volute casing.

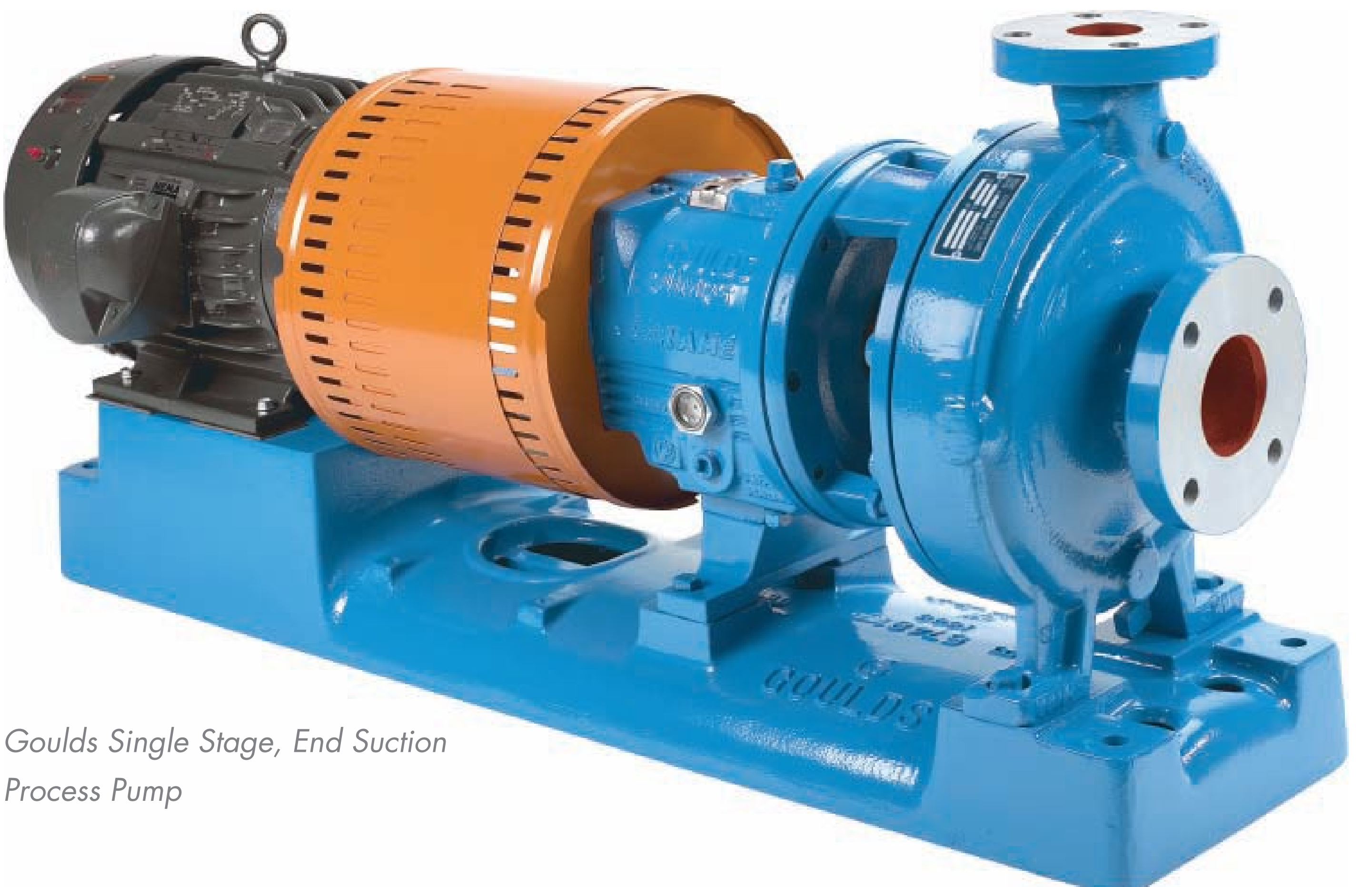
Fluid enters the pump through a suction nozzle at the end opposite of the drive (motor & bearing frame) and is redirected (at a right angle) to the discharge nozzle where it leaves the pump at an elevated pressure.

The amount of flow and pressure discharged depends upon a number of factors:

- Size of suction and discharge nozzles
- Diameter of the impeller
- Speed (RPM) of the pump

Impeller Designs

There are a couple of impeller options. Open vane designs have a close clearance between the vanes and the pump volute or wear plate, preventing most of



Goulds Single Stage, End Suction Process Pump the fluid from recirculating back to the eye of the impeller. Closed vane impellers have the vanes shrouded on both sides. This “closed” design utilizes wear rings to restrict the amount of fluid that recirculates back to the suction side of the impeller.

Sealing

Fluid must be restricted between the impeller and drive utilizing some type of shaft sealing device such as packing, mechanical seal, or magnetic drive.

Best Applications

The single stage, end suction pump is used in a wide range of services in all industries requiring the transfer of fluids. These pumps should be the first consideration when pumping relatively low viscosity (approximately 500 cps or less) fluids.

Advantages

A multitude of sizes materials, sealing arrangements and drive configurations are available to customize design for the most reliable and efficient transfer of liquid.

Disadvantages

These types of pumps must be properly sized, applied, and installed or reliability and efficiency are compromised.

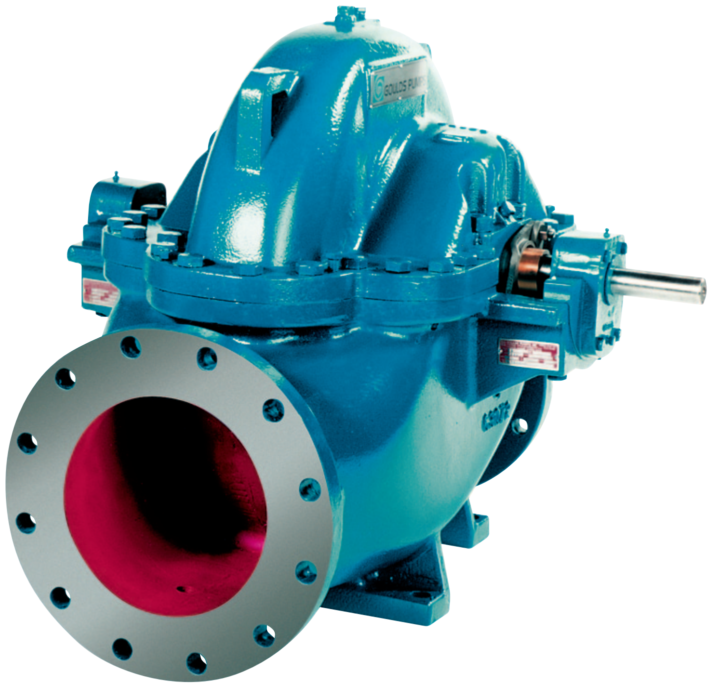
Examples of open vane impellers.

Horizontal Split Case

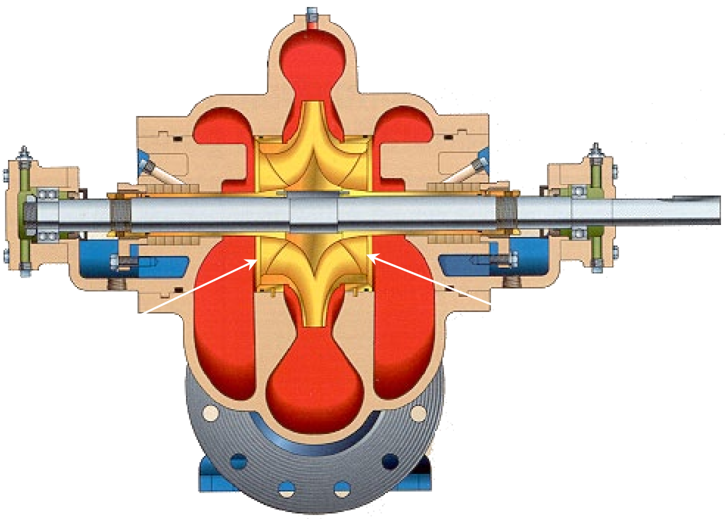
Horizontally split case pumps are characterized by the ability to remove the upper casing for easier inspection, maintenance, or removal of the rotating element, without disturbing piping or alignment.

They sometimes include multiple impellers, or stages, to generate higher head. The shaft supporting the impellers is supported on both ends to provide balance.

The impellers on the horizontal split case are closed impellers. The double suction variety will have two opposing impeller eyes, each receiving half the flow. These two impellers balance axial thrust.



Goulds Split Case Pump



Inside of a double suction split case pump. Arrows point to inlet eyes on the impellers.

Best Applications

The horizontal split case pump is great for a wide range of applications that require high capacities and high head. Applications include:

- Practically any relatively clear process liquid
- Abrasive applications (with harder wear parts)
- Cooling tower service
- Boiler service

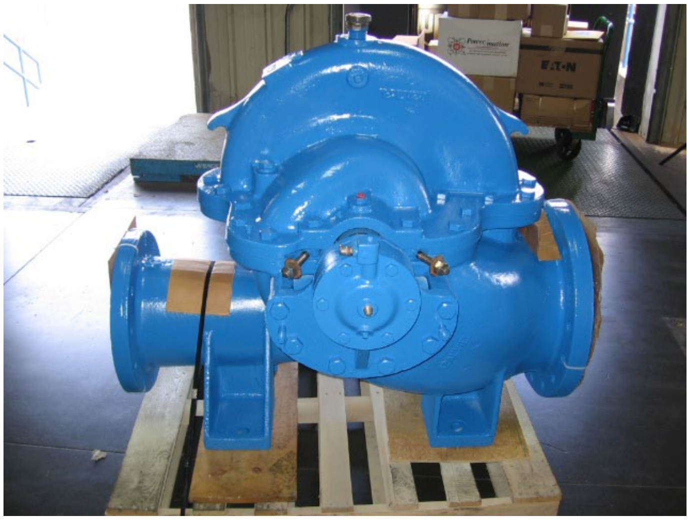
Advantages

One of the best advantages of the horizontal split case pump is that they can be maintained and serviced without disturbing piping and alignment. Simply removing the upper half casing gives access to the rotating element.

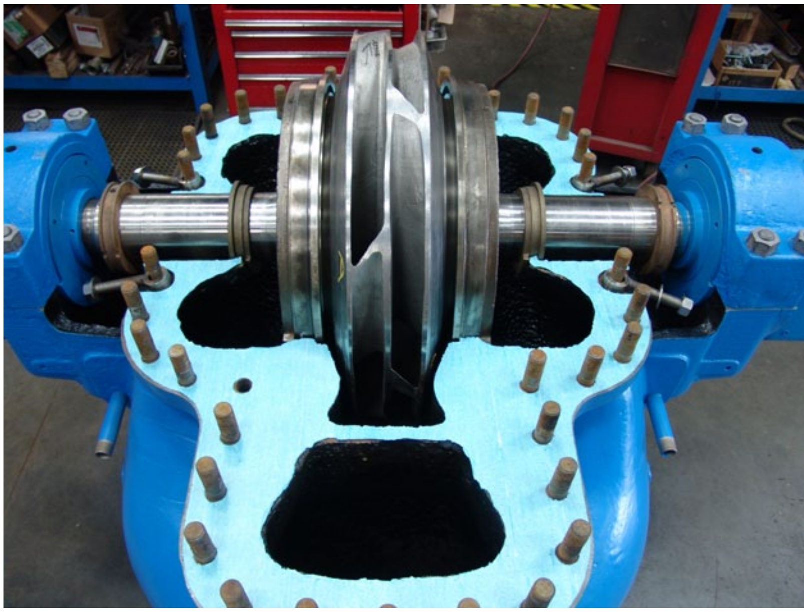
This pump also has little issue with shaft deflection due to its "between the bearing" design.

This type of pump is known to be highly efficient because power is not lost to balance the hydraulic thrust.

The horizontal split case can move large amounts of fluid, generating a great deal of flow and head.



Rebuilt split case pump from a paper mill.



Rotating element with opposing closed impellers.

Disadvantages

Double the seals, means double the chance for seal failures, and double the price for maintenance on those seals. Not only that, but the initial cost of these pumps is higher, especially if stainless steel or special alloys are needed.

Though being able to access the internals through removing the upper casing is convenient, depending upon its size, removing the upper casing may require a crane and overhead space.

Self Priming Pumps

A self priming centrifugal pump is made to lift water from some level below the pump elevation without having to fill the suction piping with liquid. Air is removed from the suction line when the pump creates a partial vacuum at the pump's suction. The pump then releases this entrained air through its discharge or a release valve.

Best Applications

Self priming pumps can handle a variety of fluids. They do well with slurries, corrosive fluids, and solids.

Advantages

There are many advantages to using a self priming pump. One key advantage, when compared to a submersible, is its ability to be out of a pit, high and dry. This allows for easier maintenance and observance of operation, without entering a pit.

Solids handling is another important advantage, as some self priming pumps can handle solids up to 3 inches.

Disadvantages

Inefficiency is a major disadvantage to self-priming pumps, as clearances often need to be larger to allow for better solids handling. Another disadvantage compared to the submersible, is that the pump is out of the pit, taking up floor space. Adding V-Belt motors can take up even more space.

Gorman Rupp Ultra V-Series
Solids Handling, Self Priming Pump

Gorman Rupp Super T-Series
Solids Handling, Self Priming Pump

Additional Resources

For more information on how a self-priming pump works, click on the video below: **Self Priming Pump Basics, Part 1 Introduction**, from Gorman Rupp.

Magnetic Drive Pumps

A magnetic drive pump is a sealless pump coupled to the motor magnetically, rather than by a direct mechanical shaft.

Best Applications

The best applications for mag drive pumps are applications where safely transferring industrial chemicals is critical. They are most commonly used where leakage poses a risk to employees and the environment; applications such as corrosive and combustible fluids.

Mag drive pumps are also good for hard to seal applications. Some fluids are subject to chemical reactions when liquid, air, and heat come together, causing premature wear on shaft seals. These chemical reactions include:

- Crystallization
- Sticking (adhesives, epoxy resins, paints)
- Varnishing

Preventing these three elements from coming together by using a magnetic drive is one solution to sealing such applications.

Facilities with continuous processes also find mag drive pumps beneficial. Shutting down a pump to fix a leaky seal is not always an option, so mag drives are oftentimes a good solution.

Advantages

The most obvious advantage to mag drive pumps is that there are no drive seals, eliminating the risk of leaks. Hazardous fluids can be pumped without the worry of spillages.

Goulds 3298
Magnetic Drive / Sealless Pump

A variety of mag drive configurations: Standard, self-priming, and vertical in-line.

Other advantages exist because the pump shaft seal has been removed. All costs and maintenance associated with mechanical seals can be avoided. This includes:

- Spare mechanical seals on the shelf
- Internal or external cost of seal replacements
- Lost production
- Potential EPA fines for leaks

Disadvantages

Mag drive pumps only work with clean liquids with no suspended solids. Though they are more expensive than pumps with mechanical seals, a savings can be factored in for reduced maintenance over the life of the pump.

Temperature limits are placed on these pumps to prevent damage to the magnets.

Vertical Multi-Stage Pumps

A vertical multi-stage pump has multiple liquid chambers (stages) that are connected in series. Fluid enters the first chamber at suction line pressure and leaves at some elevated pressure. Upon leaving the first stage, the fluid enters the second stage where the pressure is increased further. The more stages the pump has, the higher the final discharge pressure. These pumps have the unique ability to produce higher and higher pressures with the addition of every stage, but flow range always remains constant for a given rpm.

Goulds Water Technology e-SV Vertical Multi-Stage pump

Best Applications

Because the clearances in these pumps is small, clean water applications are best for this type of pump.

- High pressure shower systems
- Boiler feedwater
- Desuperheater feed

Advantages

The vertical multi-stage is particularly ad-ventageous for areas that don't have much footprint to spare. Its ability to deliver high pressure output with a single pump body and motor combo is also a plus.

Disadvantages

This pump does not tolerate debris or sig-nificant solids, and is also vulnerable to deadhead conditions.

It usually requires a higher rpm motor, therefore not always the highest efficiency pump.

An inside look at the multiple stages inside.

Submersible Pumps

A submersible pump is design to operate with both pump body and motor submerged in the fluid being pumped. The pump can be submerged due to the motor being hermetically sealed and close-coupled to the pump end. A single or double mechanical seal is utilized in submersible pumps to prevent the fluid being pumped from coming in contact with the motor.

Best Applications

Submersible pumps work best in either clean water or waste water applications where the depth of the liquid level prohibits the use of a standard centrifugal pump. They also are great for applications where space is limited for above grade pump installations. In wet well applications, these types of pumps eliminate the need for a dry vault next to the wet well.

ABS Submersible Pumps

A look at the inner workings of a submersible pump.

Advantages

Because the pump is placed below the waterline, the need for priming the pump is eliminated, and noise level is reduced.

These types of pumps are also more efficient than above grade self-priming pump installations due to pump design.

Disadvantages

Troubleshooting a submersible pump can be difficult as the pump is submerged when in operation. Also, mechanical seal or cable failure can lead to moisture in the motor housing.

Dry-Pit Submersible Pumps

Dry-pit submersible pumps are designed for areas that are normally dry, but flood on occasion. A normal submersible pump would not work in this application because without being submersed in water, the motor cannot stay cool. The dry-pit submersible pump, however, will often have the motor housing filled with a cooling oil. In certain applications a cooling jacket will be installed to prevent motor damaged caused by excessive temperature.

Best Applications

These types of pumps are best placed in areas prone to flooding.

Advantages

Resistant to flooding damage. Compact design (due to close coupled motor) is great for applications where space is limited.

Disadvantages

Mechanical seal failure can lead to moisture in the motor housing.

ABS XFP
Submersible Sewage Pumps

Vertical Turbine Pumps

Vertical turbine pumps are mostly used to pump water from deep pits or wells to some sort of water distribution system.

This type of pump is comprised of a motor, discharge head, one or more flanged columns to house the shaft, and one or more bowls (or stages). It's also recommended that a basket strainer is installed on the last bowl to prevent large solids from entering the pump.

Goulds Vertical Turbine Pump

Rebuilt discharge head and flanged columns (left) and bowl assembly (above).

Large headroom is required for installation and maintenance of vertical turbine pumps. The pump pictured is being removed to be rebuilt after 30 years of service in a clean water application.

Best Applications

Vertical turbine pumps can be found in a wide range of agricultural, municipal, and industrial applications. They are generally meant for clean water applications that require high pressure and high head. They are most commonly used to pump out of deep pits or wells.

Advantages

Vertical turbine pumps have a small footprint, and there are no priming issues due to the impellers being submerged in fluid. They are easily customized, and are highly efficient on high head, low flow applications.

Disadvantages

These types of pumps require a large amount of headroom for installation and maintenance. Hydraulic thrust is difficult to balance on vertical turbine pumps due to their overhang design, especially in high suction, high pressure applications.

This type of pump can also experience issues with mechanical seals when pumping fluids with entrained or dissolved gas. The gas tends to accumulate at the top of the stuffing box or seal chamber, where venting is difficult.

Slurry Pumps

Slurry pumps are heavy duty centrifugal pumps meant to pump abrasive and corrosive slurries. These types of pumps are required to work under fluctuating conditions, including ever-changing flow and solids content.

Goulds Pumps
XHD Slurry Pump

The wet end components of these pumps are designed to be thicker and lined with a replaceable rubber molding to extend life in harsh conditions.

Best Applications

Some common slurry pump applications include:

- Dirty water
- Water with solids
- Chemical slurries
- Ash slurry
- Sludge

Advantages

Slurry pumps are constructed specifically for tough pumping applications and continuous operation.

Disadvantages

The purchase price and operating costs of slurry pumps are much higher than standard centrifugal pumps. They tend to pump more slowly than water pumps, depending upon the operating conditions (vibrations, pressure, axial thrust, etc.)

Though these pumps are built to withstand the harshest pumping conditions, they still require far more maintenance than pumps in less demanding applications.

CENTRIFUGAL PUMP TERMINOLOGY

Axial & Radial Thrust - Refers to hydraulic and mechanical forces put on the shaft, causing movement of the shaft and impeller, and vibration throughout the pump.

Cavitation - The formation of vapor bubbles in liquid, developed in areas where the pressure falls below the vapor pressure of the liquid. The imploding or collapsing of these bubbles as they move to higher pressure areas in the pump triggers intense shockwaves inside the pump, causing significant damage to the impeller and/or the pump housing.

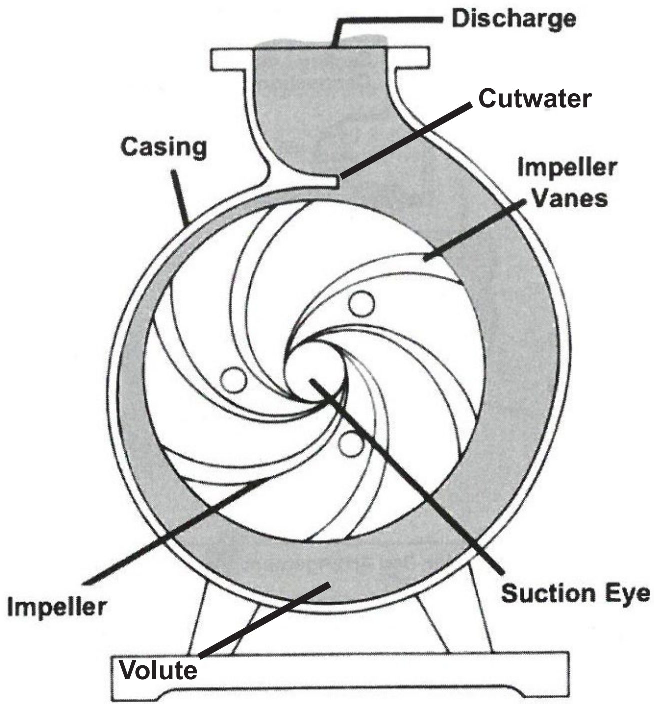


Illustration from Goulds GPM10, pg 889

Cutwater - Located near the discharge nozzle of the centrifugal pump, this part of the casing helps to direct fluid out of the pump.

Head - Simply put, head is the height at which a pump can raise a fluid up.

Impeller - The rotating element on a centrifugal pump that tranfers energy from the motor, to the fluid inside the pump. Accelerates the fluid from the eye of the impeller outward towards the casing, and out the discharge nozzle. Comes in open, closed, and semi-open configurations.

Priming - The act of clearing air from the pump's internals in order to function.

Shaft - The shaft is the part of the pump that carries energy from the motor to the impeller inside the pump casing.

Stuffing Box - The stuffing box houses a seal, or packing to help prevent leakage from where the shaft enters the pump casing.

Vane - Refers to impeller vanes that accelerate the fluid outward from the suction eye, and up to the discharge nozzle of the pump.

Volute - The volute is the shape of the casing that surrounds the impeller. It's volume increases in size towards the discharge nozzle. Its purpose is to keep velocity and pressure constant around the impeller, to stave off radial thrust on the impeller.

CONCLUSION

The centrifugal pumps included in this eBook are just some of the different types we run into day to day. The array of centrifugal pumps in use today are beyond the spectrum of what's been listed here.

When selecting a pump for your application, be sure to involve an engineer who is well versed in all types of centrifugal pumps.

Not sure which to choose? Ask us about it! We gladly provide technical assistance to businesses in Wisconsin and upper Michigan.