Centrifugal vs. PD Pumps

BSI ENGINEERING
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CONTENT

ABSTRACT

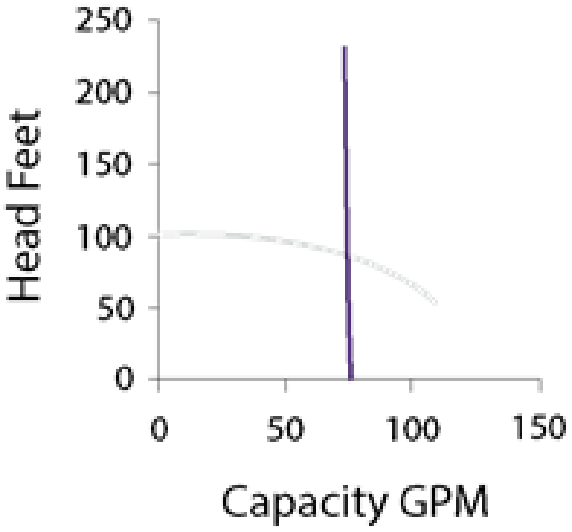
There are two principal groups of pumps: positive displacement and centrifugal (rotodynamic). Both have their uses and best areas of application. It is important to be able to identify where each pump type is best suited for the application and be selected, which ultimately comes down to their working principle and the intended application.

Positive displacement pumps are characterized by an operation that moves fluid by trapping a fixed volume and then forces that trapped fluid into the discharge pipe. A centrifugal pump transfers the kinetic energy of the motor to the liquid by a spinning impeller; as the impeller rotates it draws in fluid causing increased velocity that moves the fluid to the discharge point.

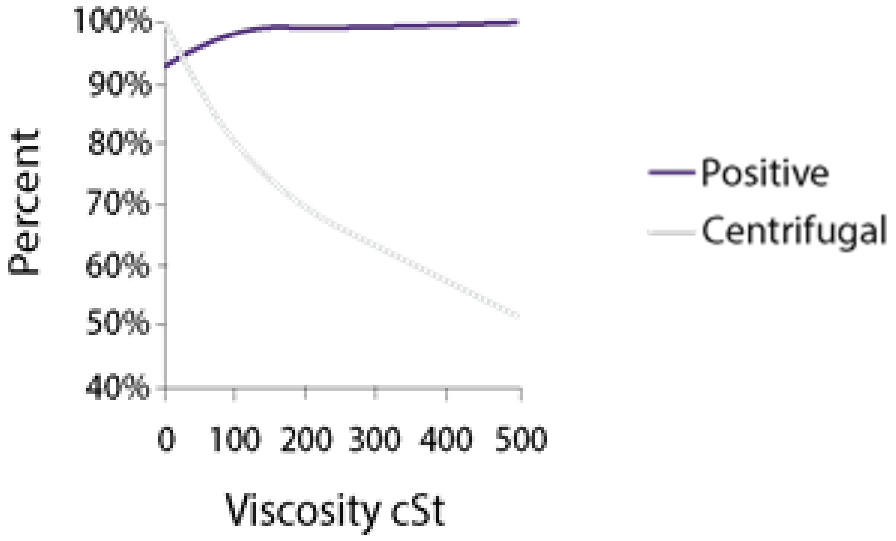
The intent of this White Paper is to allow a user a quick evaluation and decision to be able to focus on other aspects of the pump selection.

PERFORMANCE CURVES COMPARISON

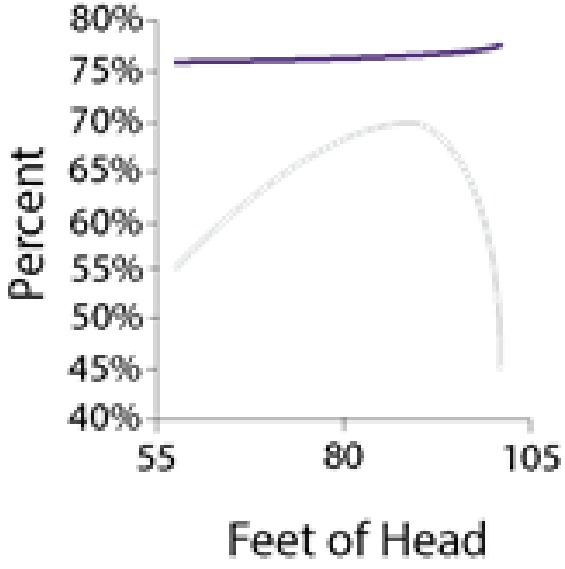
Flow Rate vs Pressure



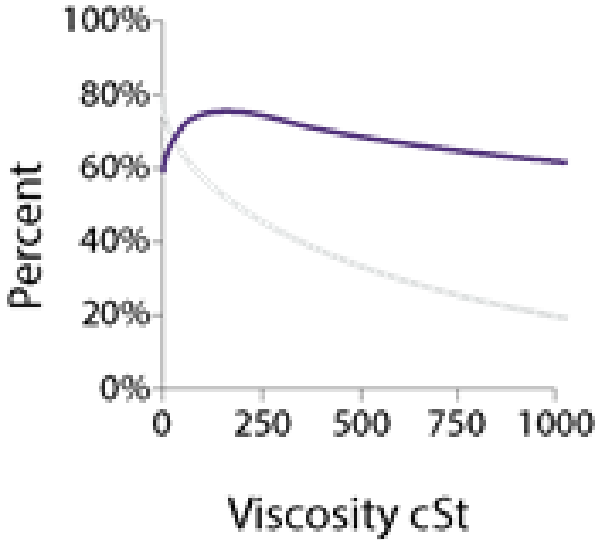
Flow Rate vs Viscosity



Efficiency vs Pressure



Efficiency vs Viscosity



GENERAL APPLICATIONS SELECTIONS

Centrifugal Pumps are the most common pump type for the transfer of low viscosity fluids in high flow rate, low pressure installations, which makes them ideal for applications that require the pump to deal with large volumes. The centrifugal pump design is often associated with the transfer of water but is also a popular solution for handling thin fuels and chemicals. Generally, centrifugal pumps are used with clean liquids, but if a correct impeller is selected, they can handle some solids slurries.

Centrifugal pumps are suited to applications where the pump is used often or is even continuously run. The simplicity of the construction also makes centrifugal pumps easy to produce in many different materials including plastics and cast iron for lighter duties, and bronze and stainless steels for more corrosive or hygienic application. Hence the multiple fluids that centrifugal pumps are suitable for use with.

The centrifugal pump design is also very compact in comparison to other pump types that produce the same output levels, making them a good option when space saving is an issue. Basic centrifugal pumps, unless specially designed to maintain a flooded impeller at all times, are not capable of self-priming.

Centrifugal pumps – operate via rotation of the impeller
- Open impeller
- Closed and semi-closed impeller
- Multi-stage

Positive Displacement Pumps are usually selected for their ability to handle high viscosity fluids at high pressures and relatively low flows as their efficiency isn't affected by pressure. Unlike centrifugal pumps, which are commonly installed due to their simplicity, positive displacement pumps provide capability of handling more difficult conditions where centrifugal pumps may fail, thanks to their ability to be run at any point on their curve. Most of the positive displacement pumps are capable of self-priming.

There are two classifications of positive displacement pump; rotary and reciprocating.

Rotary positive displacement pumps – operate via rotation of the pumping element
- Progressive cavity pumps
- Vane pumps
- Screw pumps
- Peristaltic pumps
- Gear pumps
- Lobe pumps

Reciprocating positive displacement pumps – operate via a constant back and forth motion
- Diaphragm pumps
- Piston pumps

MAIN DIFFERENCES

5 differences between centrifugal pumps and positive displacement pumps

1. Fluid Type

Centrifugal pumps are known for their versatility – they can handle both clean fluids and also those with a high solid content. However, they may have limitations when it comes to fluids with high viscosity, whereas positive displacement pumps may be better equipped to deal with such liquids, along with those containing entrained gases.

Fig 1: Centrifugal Pump

2. Efficiency

Centrifugal pumps generally have a narrow window for performing at best efficiency – this is due to frictional losses which occur when viscosity increases. Meanwhile, changes in viscosity and pressure tend not to affect positive displacement pumps.

3. Pressure head

Centrifugal pumps usually need to operate at high speeds in order to deliver high discharge pressure, but it's possible to achieve great differential pressures via positive displacement.

Fig 2: Positive Displacement Pump

4. Flow rate

Centrifugal pumps tend to be used for handling high flowrates, whereas positive displacement pumps are better suited to applications with low flow rates.

5. Flow type

Centrifugal pumps are known for producing a smooth flow, while certain positive displacement pumps (namely reciprocating pumps) deliver a pulsating flow which requires a damper at the pump discharge.

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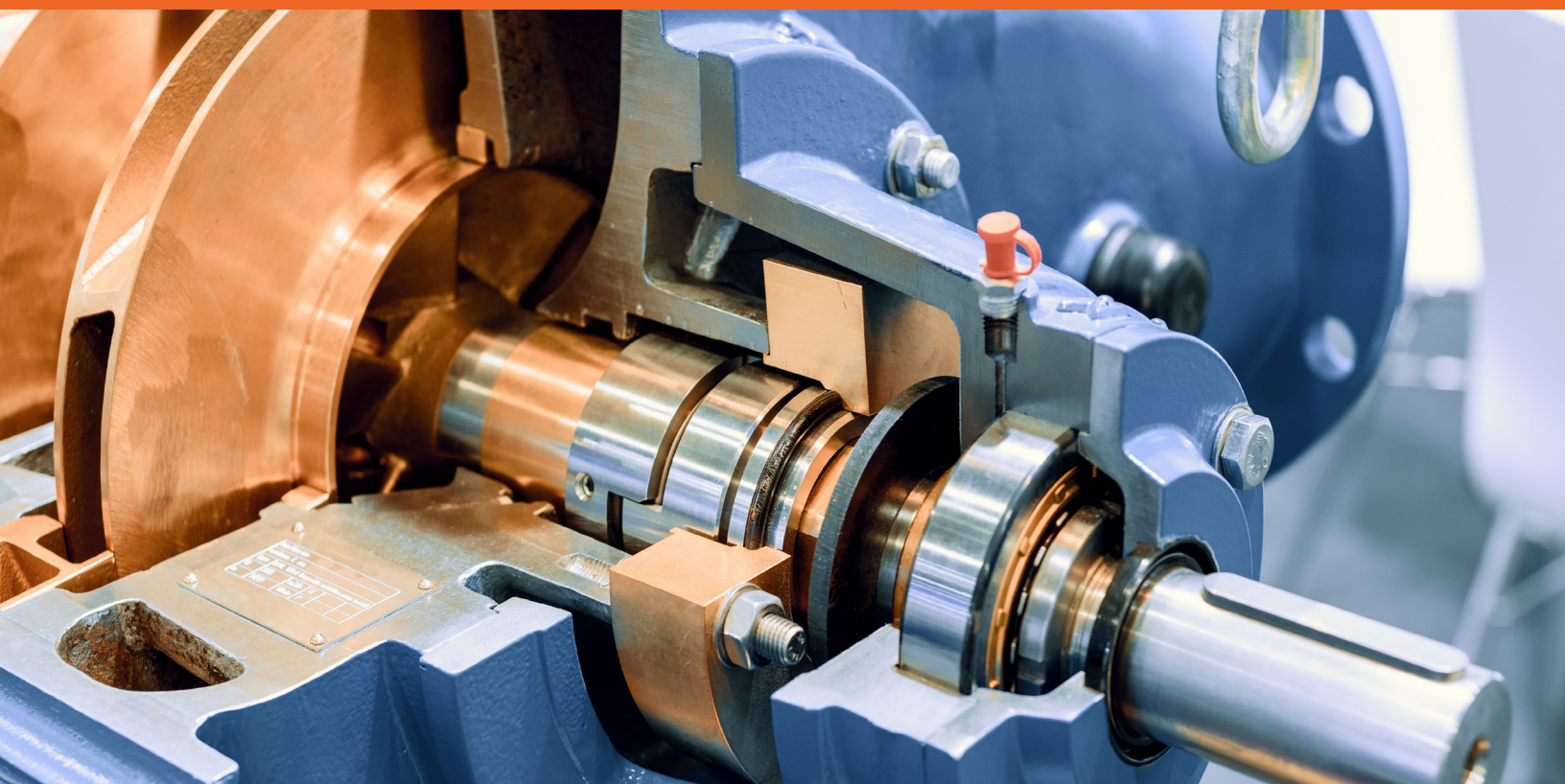
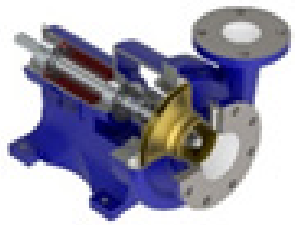


COMPARISON

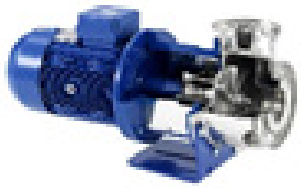
Factor	Centrifugal	Positive Displacement
Mechanics	Impellers pass on velocity from the motor to the liquid which helps move the fluid to the discharge port (produces flow by creating pressure).	Traps confined amounts of liquid and forces it from the suction to the discharge port (produces pressure by creating flow).
Performance	Flow rate varies with a change in pressure.	Flow rate remains constant with a change in pressure.
Viscocity	Flow rate rapidly decreases with increasing viscosity, even any moderate thickness, due to frictional losses inside the pump.	Due to the internal clearances high viscosities are handled easily and flow rate increases with increasing viscosity.
Efficiency	Efficiency peaks at a specific pressure and flow; any variations decrease efficiency, sometimes significantly. Does not operate well when run off the middle of the curve; can cause damage and cavitation.	Efficiency is less affected by pressure, but if anything tends to increase as pressure increases. Can be run at any point on their curve without damage or efficiency loss.
Suction Lift	Standard models cannot create suction lift, although self-priming designs are available and manometric suction lift is possible through a non-return valve on the suction line.	Create a vacuum on the inlet side, making them capable of creating suction lift.
Shearing	High speed motor leads to shearing of liquids. Not good for shear sensitive mediums.	Low internal velocity means little shear is applied to the pumped medium. Ideal for shear sensitive fluids.

ILLUSTRATIONS OF PUMP TYPES

Open Impeller

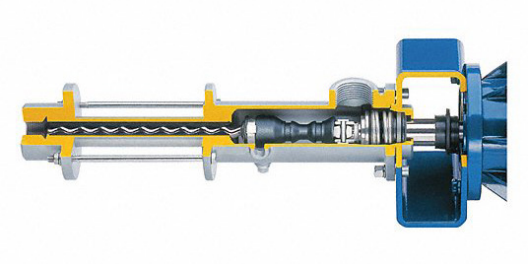


Closed & Semi-Closed Impeller

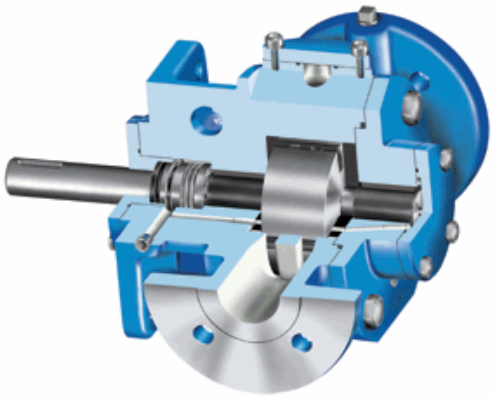


Multi-stage

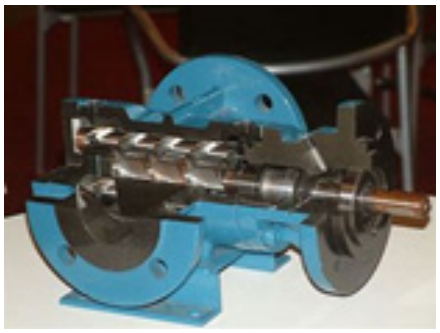
Progressive Cavity Pumps



Vane Pumps

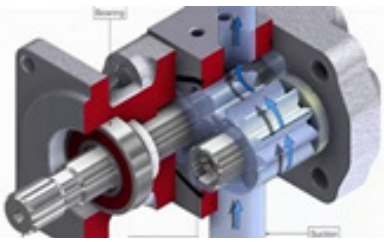


Screw Pumps



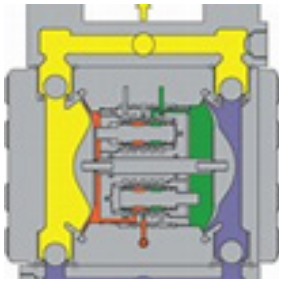
Peristaltic Pumps

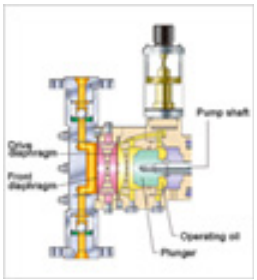
Gear Pumps



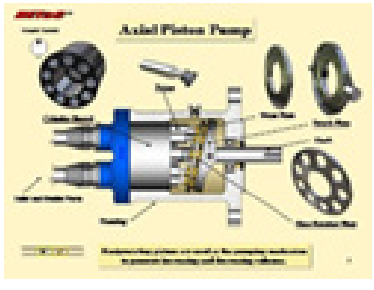
Lobe Pumps

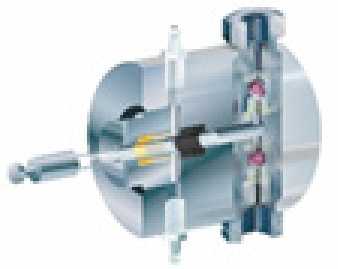
Diaphragm Pumps





Piston Pumps





SUMMARY

Both centrifugal and positive displacement pumps have their place in industrial and commercial applications.

Centrifugal pumps benefit from a simple design with few moving parts, resulting in lower maintenance requirements and costs. Multistage centrifugal pumps are capable of increased pressure delivery, however not as high as the positive displacement pumps.

Positive displacement pumps are designed for the transfer of high viscosity fluids such as thick oils, slurries, sewage and pastes. Thanks to their internal clearances, some types such as progressive cavity pumps and peristaltic pumps, are also excellent at applications handling mediums containing high levels of solids. Screw and vane pumps on the other hand and are ideal for pumping relatively clean fluids.

Being lower speed pumps than the centrifugal design, rotary positive displacement pumps with larger pumping chambers such as progressive cavity, lobe and peristaltic pumps are typically low shear pumps that provide a smooth flow. This allows them to pump shear sensitive products that need their structure to remain intact and cannot lose their stickiness and retain their properties.

Positive displacement pumps are able to handle variations in pressure, flow and viscosity and remain efficient, unlike centrifugal pumps which do not operate well off the center of their curve. As their flow rate remains constant (proportional to the speed of operation), smooth and low pulsating despite changes in the pressure, positive displacement pumps such as peristaltic, piston and diaphragm pumps are ideal solutions for dosing applications as it allows accurate metering to be carried out.

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