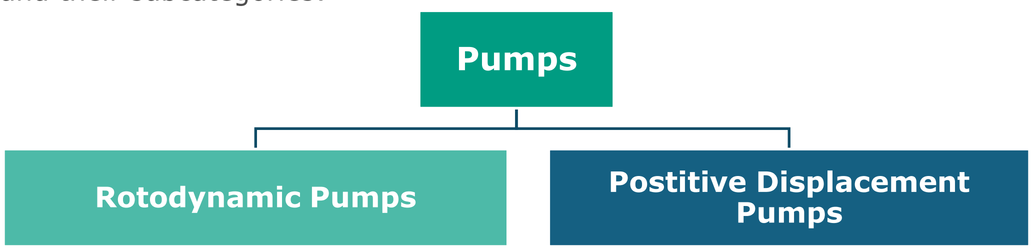
Pump Families

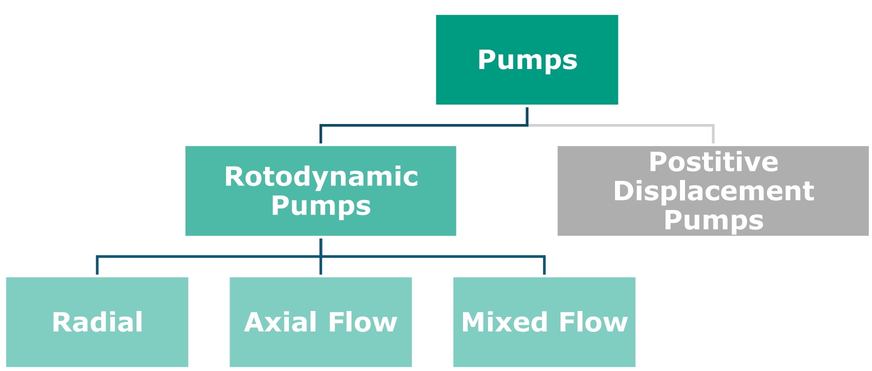
Rotodynamic versus Positive Displacement Pumps

Pumps are essential devices used to move fluids from one location to another, and they can be categorized into two major families based on their operating principles and design characteristics. The two primary families of pumps are **rotodynamic pumps** and **positive displacement pumps**. Here's a closer look at these families and their subcategories:



Rotodynamic Pumps

Rotodynamic pumps, also known as dynamic pumps, use rotational energy to move fluids. These kinetic machines transfer energy to the fluid through a rotating impeller, propeller, or rotor, converting the energy into potential (pressure) energy. Rotodynamic pumps can be categorized by impeller design and flow. The most common types of rotodynamic pumps are radial, axial flow, and mixed flow pumps.



- **Radial (Centrifugal) Pumps**: The most common type of rotodynamic pump, radial pumps primarily use centrifugal force to move fluids. In a centrifugal pump, fluid enters the eye of the impeller and is turned by the impeller vanes to exit perpendicular to the axis of the pump shaft. These pumps provide higher pressure and lower flow than axial flow pumps.
- **Axial Flow Pumps**: These pumps move fluid parallel to the impeller's axis, entering and discharging axially. Axial flow pumps provide lower pressure and higher flow than radial pumps.

This type of pump is sometimes called "propeller" pump because they operate essentially the same as a boat's impeller.

- **Mixed Flow Pumps**: The mixed flow pump is a type of rotodynamic pump that combines characteristics of both the radial and axial flow pumps. The mixed flow pump has a single inlet impeller with the flow entering axially and discharging about 45^{0} of the shaft axis, to the periphery. This type of pump can operate at higher pressure than axial flow pumps while delivering greater flow rates than radial pumps, making them versatile for a range of applications.

Comparison of Rotodynamic Types Based on Impellers and Flow

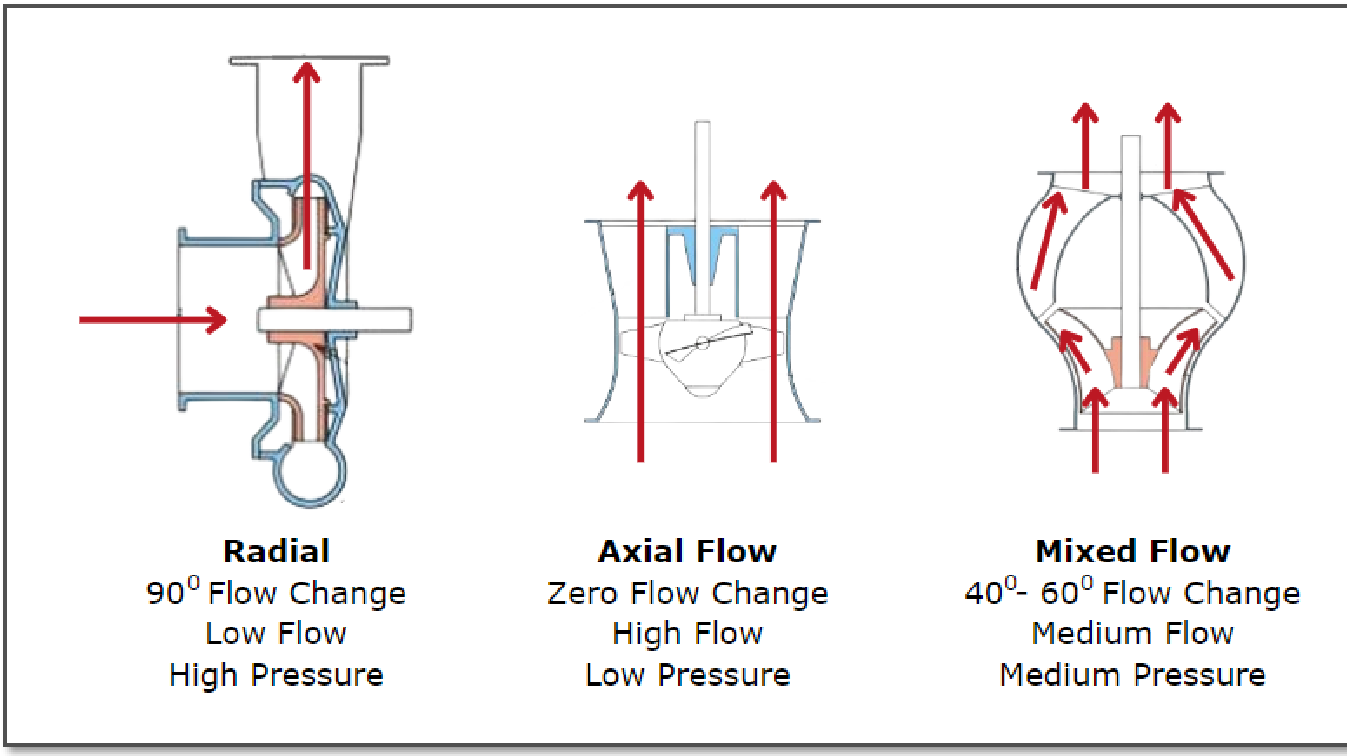
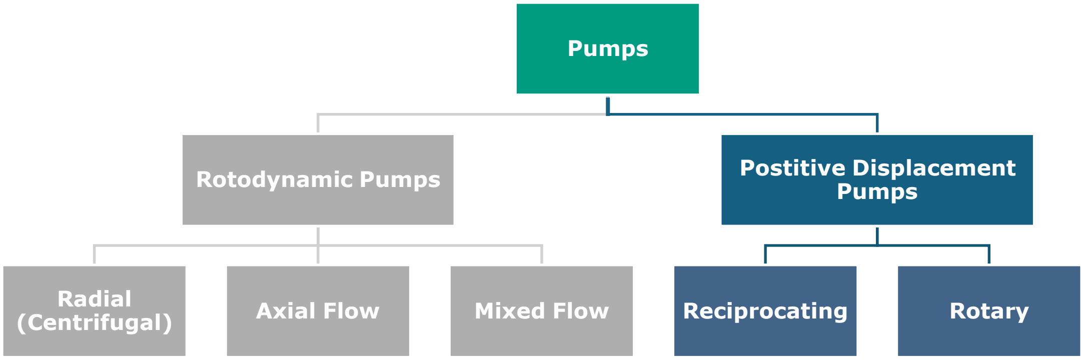


Image source: Wikimedia Commons (adapted) Radial Pump, Axial Flow, and Mixed Flow

Positive Displacement Pumps

Positive displacement pumps are machines where chambers fill (suction) and empty (discharge) each cycle of operation. They operate by moving fluid repeatedly enclosing a fixed volume and moving it mechanically through the system, delivering a near constant flow rate regardless of the system pressure. A straightforward example of this type of pump is a syringe, which draws a precise amount of medicine (fluid) and then delivers that exact amount into a patient.

Positive displacement pumps are ideal for high-viscosity fluids and applications requiring precise flow control. Most of these pumps can be placed into two categories: reciprocating and rotary.



- **Reciprocating Pumps**: These pumps work by the repeated back-and-forth, reciprocating (stroke) movement of either a piston, plunger, or diaphragm.

- **Rotary Pumps:** These pumps use the actions of rotating cogs or gears to transfer fluids, rather than the back-and-forth motion of reciprocating pumps.

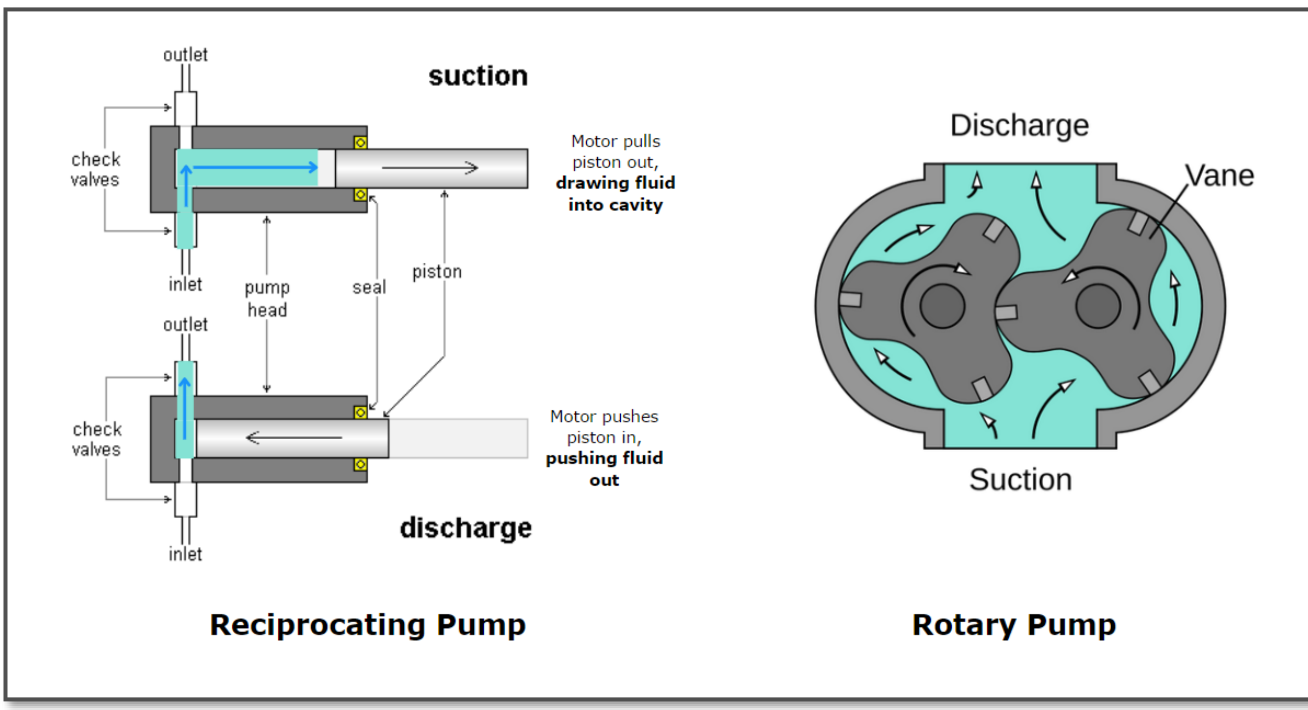


Image source: Wikimedia Commons (adapted) Reciprocating and Rotary Pump

Rotodynamic and positive displacement pumps are each designed with distinct mechanisms and operating principles to move fluids. These differences in design lead to unique performance characteristics, making each type better suited for specific applications. The following table highlights key differences between rotodynamic and positive displacement pumps.

Difference between the Rotodynamic & Positive Displacement Pumps

Rotodynamic Pumps	Positive Displacement Pumps
Operate using the principle of centrifugal force, which transfer the fluid's kinetic energy into pressure energy.	Operate by repeatedly enclosing a fixed volume of fluid and mechanically moving it through the system, providing a nearly constant flow rate regardless of system pressure.
Must be primed, with fluid in system before starting.	Can not handle intermittently dry periods and can start without being primed by liquid in the pump.
Flow rate varies based on pressure.	Flow rate is constant, regardless of pressure changes.
Suitable for high-flow, low-pressure applications.	Suitable for moderate-flow and moderate-pressure applications.
Handles low viscosity fluids due to frictional losses.	Handles high viscosity and shear sensitive fluids due to inner clearance.
Flow rate rapidly decreases with increasing viscosity, even any moderate thickness, due to friction losses inside pump.	Flow rate increases with increasing viscosity.
Efficiency peaks at a specific pressure, any variation decreases efficiency dramatically.	Efficiency is less affected by pressure but tends to increase as pressure increases.
Does not operate well when right or left of **best efficiency point** on the **centrifugal pump curve**, causing damage and cavitation.	Can run at any point on pump curve without damage or efficiency loss.

Conclusion

Understanding the major families of pumps and their subcategories is crucial for selecting the right pump for a specific application. Each pump type has its unique operating principles, advantages, and limitations, making it essential to evaluate the requirements of the fluid being moved, the system's pressure and flow needs, and the specific operational conditions. By leveraging the appropriate pump technology, industries can enhance efficiency and reliability in fluid management. To learn more regarding rotodynamic versus positive displacement pumps, please visit **The Hydraulic Institute**.

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Wilo is a manufacturer of numerous types of radial (centrifugal) pumps. Discover our efficient pumps and pumps systems for a sustainable future at **Products & expertise | Wilo** or have a quick glance of the **WILO Product Guide**.

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