# CHAPTER ONE

# CLASSIFICATIONS OF PUMPS

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## 1.1 What Is a Pump?

A pump is a machine or device for raising, transferring, or compressing fluids. Pumps represent the largest single use of power in industry (31%) by motor driven equipment. Process variables, including pressure and flow of gases and liquids, have long been regulated using mechanical clutches, throttles, and adjustable inlet guide vanes. Pumps often operate as a variable torque load, a load that increases as the speed increases. These mechanisms waste energy, require frequent maintenance, and provide inaccurate control.

## 1.2 Pumps Classifications

In general, pumps can be divided into two major categories: dynamic or kinetic and positive displacement.

Dynamic pumps continuously add energy to increase the fluid velocities. Displacement pumps periodically add energy to the fluid forcing an increase in pressure. Displacement pumps are divided into reciprocating and rotary types depending on the nature of the movement of the pressure-producing member.

The following figure explains the difference in the performance of the different kinds of pumps, and offers a classification of them in accordance with the power required for the application.

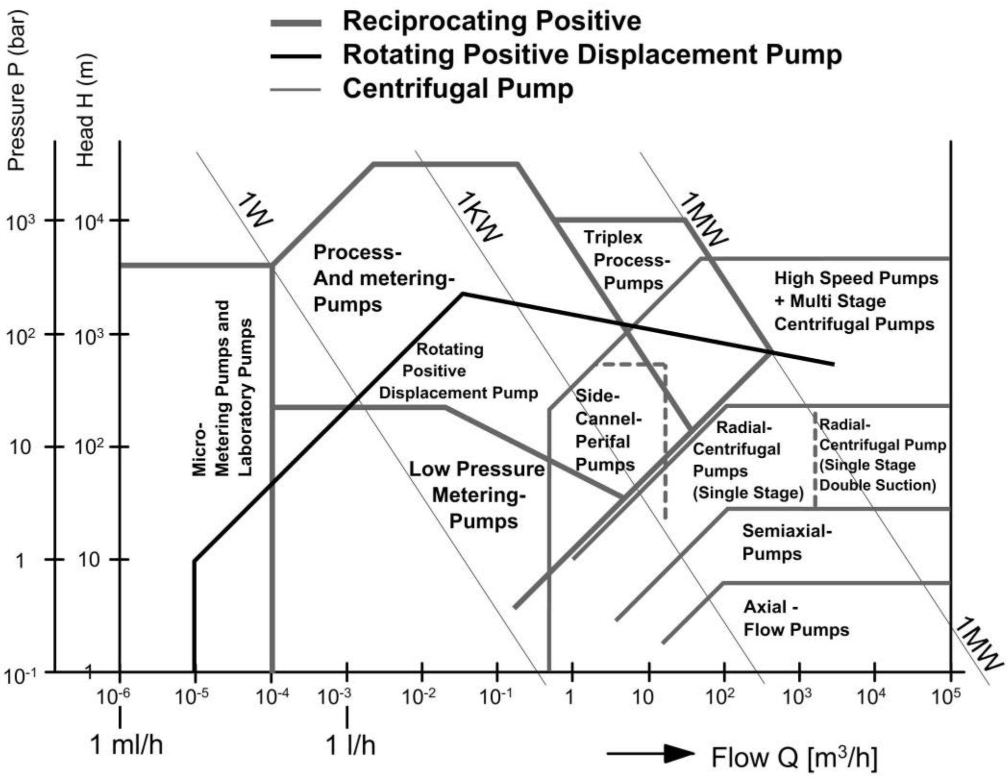


Figure 1.1 – Classification of pumps according to performance

Another classification of pumps is shown in the next figure it is concerned with the impeller diameter and the relative speed of the pump.

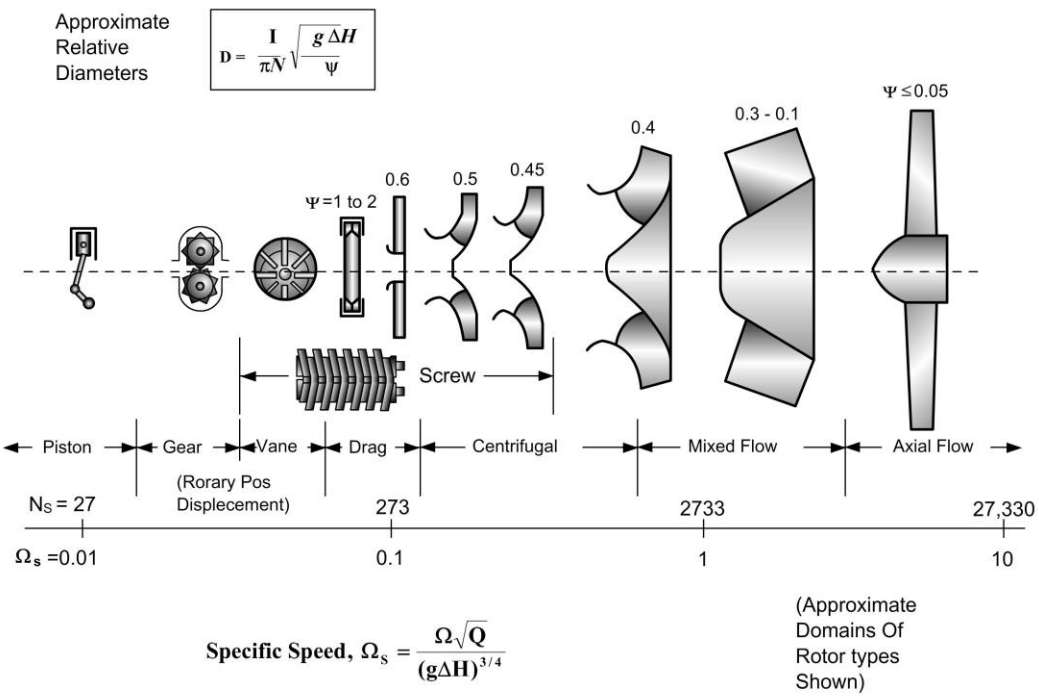


Figure 1.2 – Classification of pumps according to impeller diameter

Dynamic pumps can further be subdivided into centrifugal and special-effect pumps.

## 1.3 Centrifugal Pumps

Centrifugal pumps depend on centrifugal forces for their operation. The centrifugal pump consists of a rotating impeller sealed in housing. The impeller is connected to a drive unit that supplies energy to spin the impeller. As the impeller spins an area of low pressure is created in the center of the impeller. This low pressure allows water to be forced into the housing from atmospheric pressure on the water in the supply tank.

At the entrance to the pump housing, vanes or impellers rotate and draw liquid into the pump through a central inlet. After the water enters the housing, the spinning action of the impeller transfers energy to the water as velocity head or kinetic energy.

The centrifugal forces are generated by the rotating impellers force the water or solids away from the center and force it out of the housing through the discharge opening at the outside edge of the housing. The water then travels out of the pump through the pump discharge. This process continues as long as the impeller continues to rotate and a supply of water is available.

The advantages of the centrifugal pump are: its simple construction and operation, space requirements and constant rotary action.

The centrifugal pump consists of a single rotating element inside a simple one-piece casing that can be made from a variety of materials to fit a variety of needs. The construction does not require all moving parts to be constructed to close tolerances, therefore, the amount of wearing on the moving parts is reduced and the operating life is extended. Through the design of the impeller and housing, the centrifugal pump can be made to pass solids due to the relatively large clearance between the impeller and the housing.

The amount of space which is required for the centrifugal pump is much lesser than other types of pumps in part because of having fewer moving parts. Fewer parts enhance its reliability and reduce maintenance requirements. The centrifugal pump also has some disadvantages. The pump is not a self-priming pump. This is not a disadvantage if the pump can be placed directly into the wet well. If, however, the pump is placed in a dry well, a priming pump must be placed ahead of the centrifugal pump. The pump's efficiency is directly related to the head capacity of the pump. The highest performance efficiency is available for only a very small section of head-capacity curve.

Centrifugal pumps can further be classified as horizontal and vertical:

**A. Horizontal Pumps:**

- For pressure:
  - Horizontal single stage (overhung)
  - Horizontal multi-stage
- For impeller design
  - Radial flow
  - Mixed flow
  - Axial flow
- For flow
  - Single suction
  - Double suction

**B. Vertical Pumps:**

- Vertical in line pump
- Vertical sump pump
- Vertical can pump
- Vertical turbine pump
- Vertical submersible pump
- Vertical well pump

## 1.4 Positive Displacement Pumps

Positive Displacement Pumps are "constant flow machines"; they have an expanding cavity on the suction side and a decreasing cavity on the discharge side. Liquid flows into the pumps as the cavity on the suction side expands and the liquid flows out of the discharge as the cavity collapses. The volume is constant given each cycle of operation.

The positive displacement pumps can be divided in two main classes:

- Reciprocating
- Rotary

The positive displacement principle applies whether the pump is any of the following:

**A. Reciprocating**

- Piston
- Plunger
- Diaphragm

**B. Rotary**

- Gear
- Screw
- Progressive Cavity
- Vane
- Lobe

Positive Displacement Pumps, unlike a Centrifugal or Roto-dynamic Pumps, will produce the same flow at a given speed (RPM) no matter the discharge pressure.

A Positive Displacement Pump must not be operated against a closed valve on the discharge side of the pump because it has no shut-off head like Centrifugal Pumps. A Positive Displacement Pump operating against a closed discharge valve will continue to produce flow until the pressure in the discharge line are increased until the line bursts or the pump is severely damaged or both.

### 1.4.1 Reciprocating Pumps

Typical reciprocating pumps are

- Plunger pumps
- Diaphragm pumps

Plunger pumps comprise of a cylinder with a reciprocating plunger in it. In the head of the cylinder the suction and discharge valves are mounted. In the suction stroke the plunger retracts and the suction valves opens causing suction of fluid into the cylinder. In the forward stroke the plunger push the liquid out the discharge valve.

With only one cylinder the fluid flow varies between maximum flow when the plunger moves through the middle positions, and zero flow when the plunger is in the end positions. A lot of energy is wasted when the fluid is accelerated in the piping system. Vibration and "water hammers" may be a serious problem. In general the problems are compensated by using two or more cylinders not working in phase with each other.

In diaphragm pumps the plunger pressurizes hydraulic oil which is used to flex a diaphragm in the pumping cylinder. Diaphragm valves are used to pump hazardous and toxic fluids.

### 1.4.2 Rotary Pumps

Typical rotary pumps are:

- Gear pumps
- Lobe pumps
- Vane pumps
- Progressive cavity pumps

- Peripheral pumps
- Screw pumps

In gear pumps the liquid is trapped by the opening between the gear teeth of two identical gears and the chasing of the pump on the suction side. On the pressure side the fluid is squeezed out when the teeth of the two gears are rotated against each other. The motor provides the drive for one gear.

The lobe pump operates similar to the gear pump, but with two lobes driven by external timing gears. The lobes do not make contact.

Progressive cavity pumps consist of a metal rotor rotating within an elastomer-lined or elastic stator. When the rotor turns progressive chambers from suction end to discharge end are formed between the rotor and stator, moving the fluid.