



Centrifugal Pump Analysis for Petroleum Applications

An Online Continuing Education Course for Engineers

Course Number: O-5003

Credit: 5 Hours / 5 PDH / 5 CPD

Centrifugal Pump Analysis

E. Shashi Menon, P.E.

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1. Introduction

Centrifugal pumps are used to increase pressure in a liquid for the purpose of transporting the liquid through piping and other devices for use in an industrial process. With the higher pressure, the liquid can be transported in short or long pipelines for delivery to an ultimate destination. Examples include water pipelines, refined petroleum and crude oil pipelines.

The pressure generated by the pump is gradually depleted as the liquid flows through the pipeline, due to friction in the pipe, as well as any elevation increase from the point of origin to the destination point. The liquid as it enters the pump has a certain amount of energy, due to its initial pressure (pressure energy), position (potential energy) and its velocity (kinetic energy). The potential energy depends on the location of the liquid from some datum, such as sea level. The kinetic energy is due to the motion of the liquid. The sum of three components is the total energy of the liquid. As the liquid comes out of the pump, energy is imparted by the rotating element (impeller) in the pump and the liquid pressure increases. The velocity of the liquid also changes from that at the pump inlet. In a centrifugal pump, the liquid is accelerated by centrifugal force during its passage through the rotating pump impeller and finally at the exit, the kinetic energy is converted to pressure energy as it exits the pump volute into the discharge piping.

This is demonstrated in Figure 1. Also shown on the right side of this figure is a cut-away view of a centrifugal pump coupled to an electric motor driver.

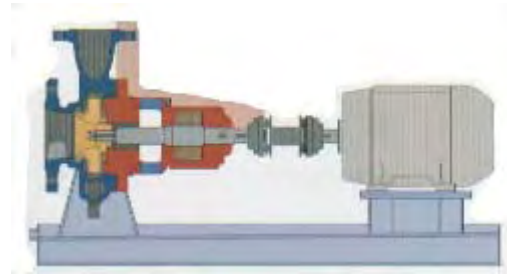
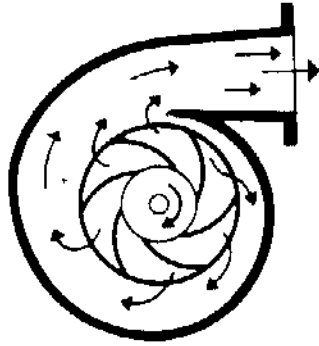


Figure 1 - Centrifugal Pump

2. Types of pumps

In addition to centrifugal pumps, other types of pumps used in the industry include reciprocating and rotary pumps. These are also called positive displacement (PD) pumps, since they provide a constant volume displacement, regardless of the pressure generated. Centrifugal pumps on the other hand, provide variable flow rates over a range of pressures. Rotary pumps include gear pumps and screw pumps used with high viscosity liquids. Examples of these pumps are shown in Figure 2

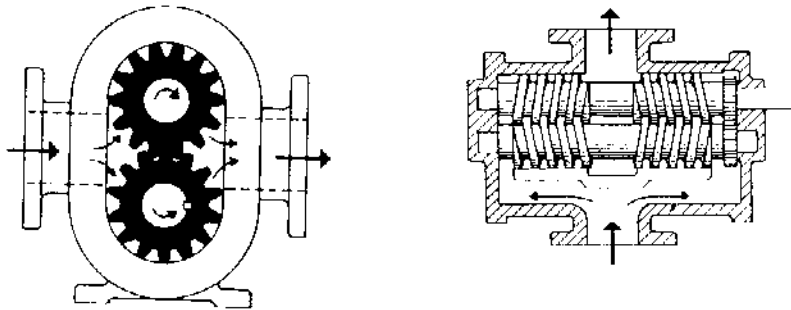


Figure 2 - Gear Pump and Screw Pump

Most pipelines transporting water and petroleum products today use centrifugal pumps due to their flexibility in flow rates and pressures. Also, their maintenance cost is less compared to PD pumps. However, PD pumps have better efficiency, compared to centrifugal pumps. In this course we will concentrate only on the performance and applications of centrifugal Pumps.

Centrifugal pumps may consist of the following types:

- (a) Radial Flow Pumps
- (b) Axial Flow Pumps
- (c) Mixed Flow Pumps

Radial flow pumps generate pressure purely by centrifugal force of the liquid due to rotation of the pump impeller. Axial flow pumps develop pressure by propelling or lifting the liquid by the pump impeller vanes. Mixed flow pumps use a combination of radial and axial flow pumps. When high heads are required, radial flow pumps are used. Axial flow and mixed flow pumps are generally used with low head - high capacity systems.

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The corr... SI system are as follows - length in meters (m) or kilometers (km). Mass in kilograms (kg), flow rate in m³/hr or liters per second (L/s). Pressure in kilopascal (kPa), Megapascal (MPa) or Bar. Temperature in degrees Celsius (C). In addition, pipe diameter is referred to in inches (in.) and millimeters

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