

Selection of Pumps For Process Industries

Proper pump for the right process is the cornerstone of the process industry, where selection of a pump for smooth functioning of the machinery is vital.

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Nowadays it is trend to build larger and larger plants with high capacity and more reliable rotating equipment. Pump being a rotating equipment. Pump being a rotating equipment plays a very important role in process industries, and no plant can be operated successfully without reliable and low energy efficient pumping system. The profits of the plant or company depends upon more reliable and efficient pumping system.

The heart of most process industry is the pump, because in almost all the process industry liquid is to be handled to and fro through various vessels, storage tanks, heights and lengths during the process of operation. In process industries, the liquid handled can be broadly classified as the acid, alkali and neutral with different liquid characteristics, etc.

Selection of right type of pump for different fluid and operating conditions can be daunting because of the large number of options to fit various operating conditions:

Selection criteria

Selection of process pumps can be mainly divided on the basis of liquid characteristics as well as on other following conditions:

- Pumps for viscous liquids
- Pumps for clear liquids
- Pumps for low flow
- Pumps for corrosive liquids
- Pumps for slurry
- Pumps for specific service
- Pumps for high pressure service
- Pump for low energy
- Pumps for low maintenance cost
- Pumps with high standard of safety in operation
- Pumps for specific speed.

Classification of Pumps

Pumps used in process industries may be broadly classified in two main types:

- Dynamic (Kinetic), and
- Positive-displacement.

Dynamic Pumps

Dynamic (kinetic) pumps such as centrifugal pumps are pumps in which energy is imparted to the pumped liquid by means of a moving Impeller or Propeller rotating on a shaft. The kinetic energy imparted to the fluid in terms of velocity by the moving impeller is converted to pressure as the liquid leaves the Impeller and moves through a stationary volute or diffuser casing.

Positive-displacement Pumps

Positive-displacement pumps are those pumps in which energy is imparted to liquid in a fixed displacement volume such as a casing or cylinder by the rotating motion of gears, screws or vanes, by reciprocating pistons or by plunger.

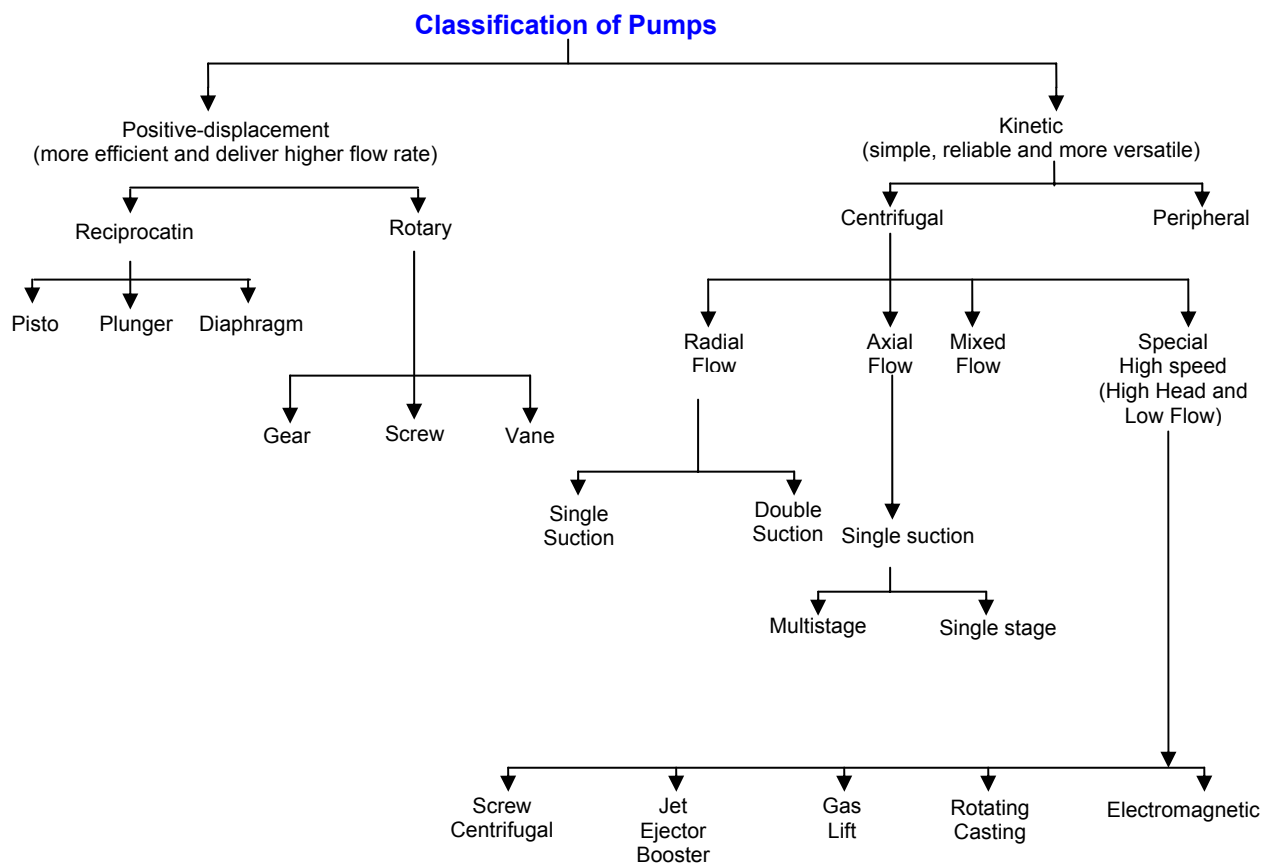
These types of pumps are further classified in following sub classes based on flow, construction and service, etc.

Keys to Pump Selection

Before proceeding to the actual pump selection, it is necessary to have the complete knowledge of the location and the basic job to be performed.

The proper pump selection requires a careful study of the hydraulic system also because it can reduce the following:

- Pump startup problem and time
- Operating problems
- Future maintenance problem
- Operating and maintenance cost
- Process reliability
- Low energy consumption
- Service conditions
- Space problem.



Critical Points for Selection of Pumps

The following points are to be considered at the time of pump selection:

- **Fluid characteristics:** A detailed study of the fluid characteristics is usually the most important factor for the proper selection of pumps. Right type of pump can only be selected based on the experience and knowledge of the selecting engineer and the environment. Fluid characteristics are to be considered as follows:
 - Chemical identity of the fluid pumped such as pH, dissolved oxygen, corrosive or abrasive nature, concentration, suspended solids and temperature, etc.
- **Absolute Viscosity:** It plays an important role while selecting the pump. It causes the liquid to resist flow, the higher the viscosity, the greater the head loss due to friction in the pipeline and in the pump casing as well as in the whole system. The suction head and the available Net Positive Suction Head (NPSH) both decreases with an increase in liquid viscosity for the same pumping

rate. At the same time, discharge and total head both increases with an increase in liquid viscosity for the same pumping rate.

In other words, the power requirement also increases with liquid viscosity.

- **Specific Gravity:** It affects the pump life along with performance of the pump.
- **Temperature:** The operating temperature at the pump is an important factor affecting overall performance of the pump. While considering temperature, the combined ambient and liquid temperature along with the temperature rise due to evaluation of head from the resistance in the system shall be taken into consideration. As per general experience, pumps can perform efficiently with trouble-free operation over an approximate temperature of up to 80°C.
- Lubricating quality of liquid handled.
- **Space available for pump:** It helps in selecting the pump, ie, horizontal or vertical. It also influences the model and size of the pump.
 - Ease in operation and maintenance
 - Lubricating system
 - Availability of spare parts
 - Cost factor
 - Reliability
 - Environmental-friendly
 - Efficiency of pump at duty point
 - Arrangement for minimising gland leakage, etc
 - Material of construction, etc
 - Drive system and reliability.

Selection of Pumps Based on Practical Experience

As per practical experience, 'Decision Tree' has been developed for the quick selection of right type of pumps for various types of fluids as per flow and pressure. All the leading designers/selecting engineers may use the following 'Decision Tree' for selection of right type of pump without any problem.

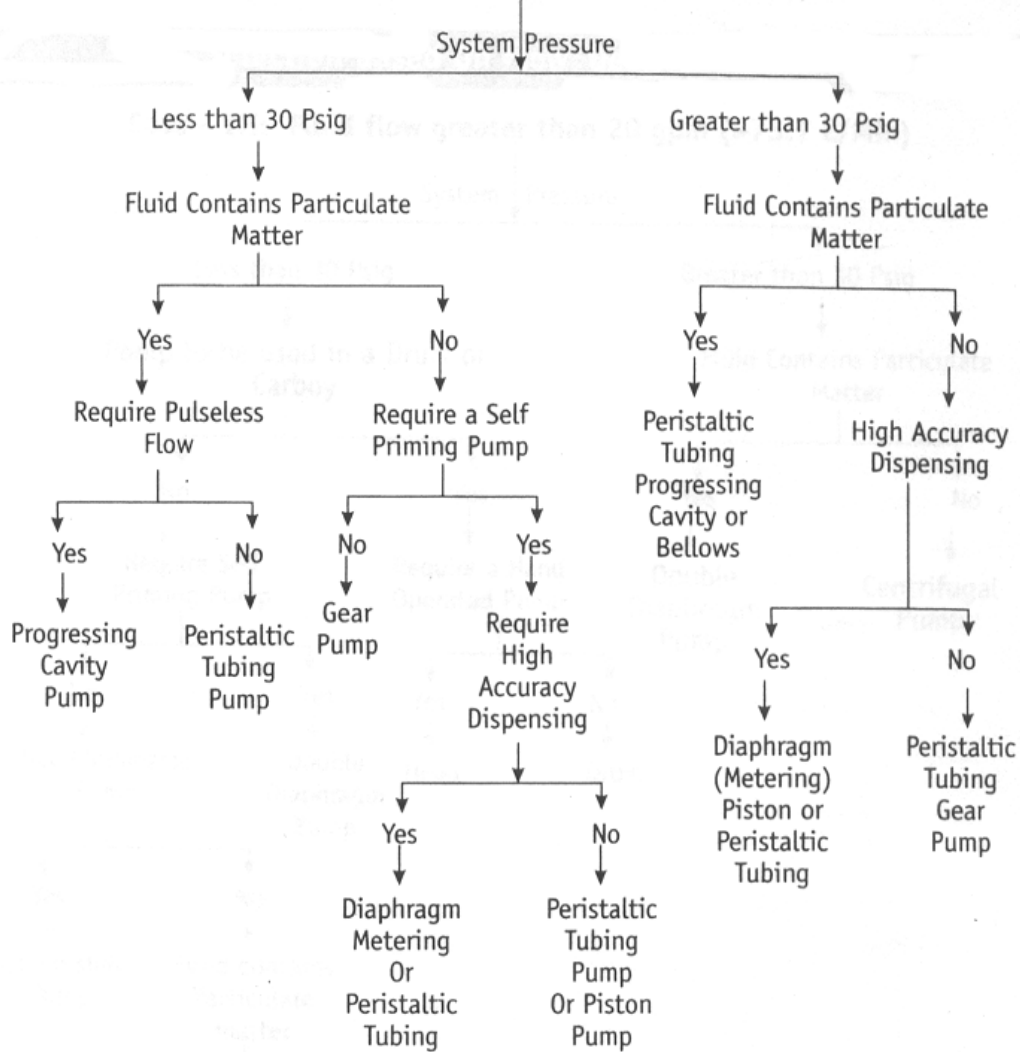
'Decision Tree' can be made in three types which are listed below, based on pump service requirement. Follow the decision tree as per the arrows indicated in the figures. This decision tree can be used as a rough guideline for the selection of right type of pump by considering fluid viscosity, temperature, installation requirements and fluid chemical compatibility.

Quick Check List of Questions to be followed at the time of Proper Selection of Process Pumps

A well established or proven way to select right type of pump is to define the operational requirements based on experience. Following points are to be considered while selecting a proper or right type of pump for required operation or service:

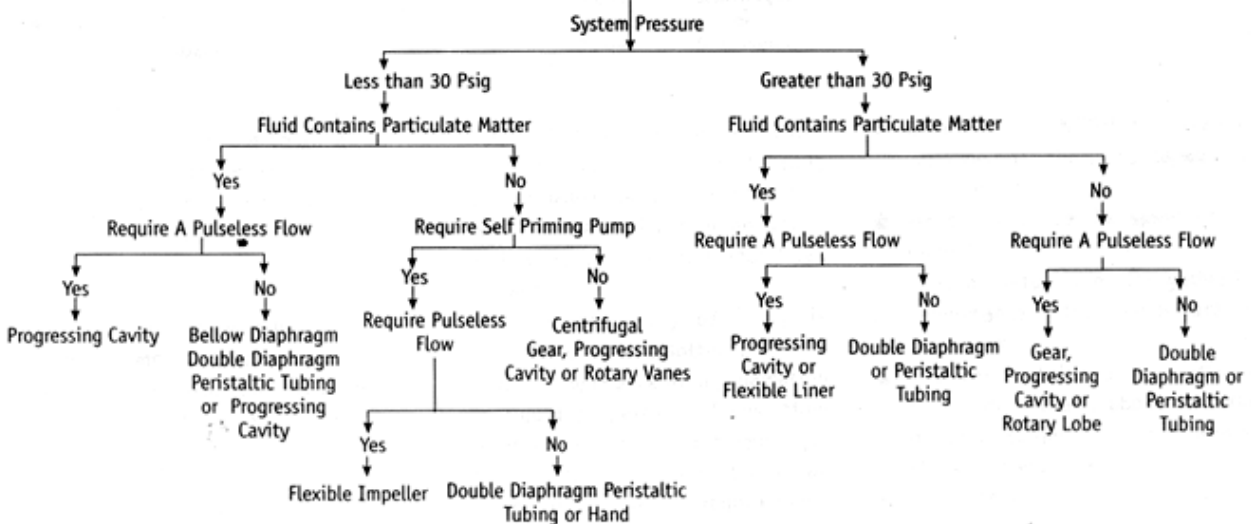
Selection Of Pumps Based On Flow 'Decision Tree'

Case - I: Fluid flow less than 1 gpm (3.8 L/Min)



Selection Based On Flow 'Decision Tree'

Case - II: Fluid flow 1 to 20 gpm (3.8 L/Min to 75.7 L/Min)



▪ **What are the flow and pressure requirements?**

Record the following:

- **Specific Flow Rate**
 - Normal or optimum
 - Maximum
 - Minimum
- **Available/Desired Pressure**
 - Fluid Inlet Pressure
 - Discharge Pressure Required
 - Fluid Vapour Pressure
 - System Back Pressure
(Pumping must overcome this)
 - Total System Pressure.

▪ **What are the properties of fluid to be pumped?**

- Fluid chemical compatibility with pump material
- Viscosity
- Shear sensitivity
- Temperature
- Fluid particulate matter
- Corrosive/Erosive property
- Specific gravity
- Any other specific property.

▪ **What is the accuracy requirement?**

In general Positive-displacement Pumps are used for high accuracy applications and metering Pumps for accuracy tighter approximately $\pm 1\%$

▪ Whether the liquid is dangerous?

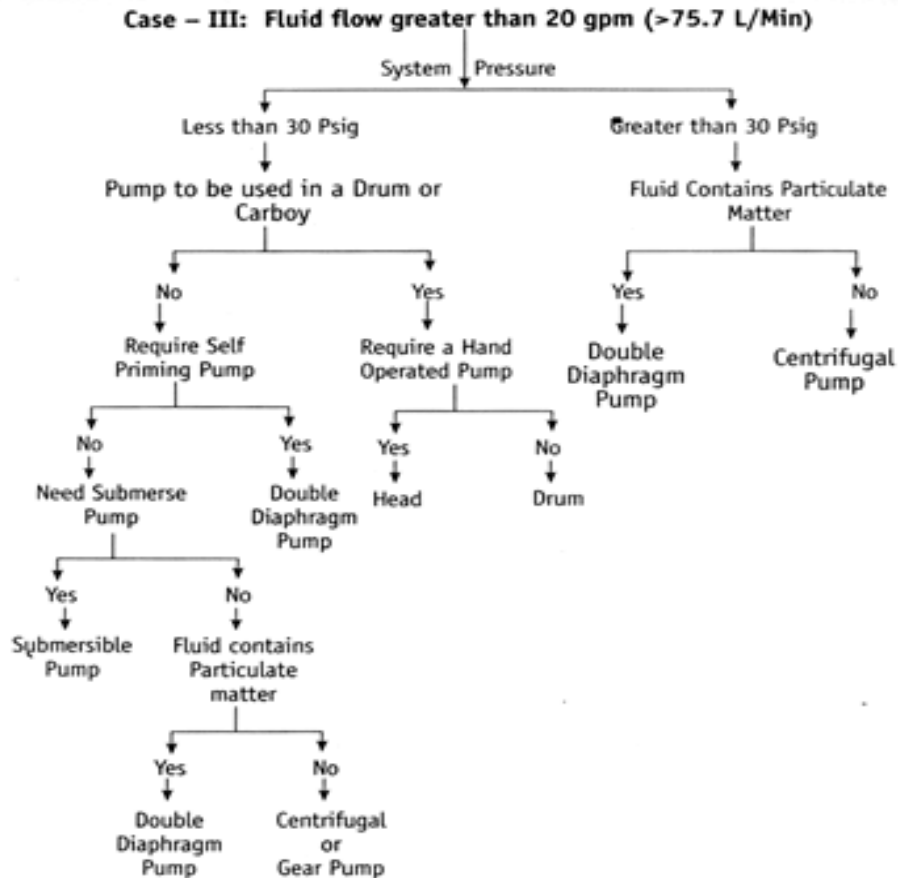
If it is dangerous then what are the safety measures for process as well as for operating personnel or environment?

- Whether the installation is temporary or permanent? It helps to decide the material of construction and system economics.
- Whether the piping layout has been decided? If yes, then piping losses are to be calculated for establishing correct head or pressure requirement.
- What is the material of piping system and what are the frictional head losses?
- Whether the duty of pump is continuous or intermittent?
- Is there any chance for any deviation in liquid properties? If yes, then what are the limits and frequency?
- Whether the pump output is to be varied as per process requirement? If so, then what are the maximum and minimum flow rates for various liquids?
- What is the NPSH required for variables? Is the pump capable for such NPSH?
- What is the specific speed of the pump?

It is a useful index for getting a general idea of the type of pump to be chosen.

- Will the installation of pump be indoor or outdoor, above or below grade or subjected to any unusual climatic condition?
- Does the construction performance meet certain company specification or standard preferences?
- Will special pump design construction be required to handle the fluid?
- Are the space required and weight of the pump considered critical?
- Does the installation requires a vertical or horizontal pump? In case of a vertical pump then a dry or wet pit be used?

Selection Based On Flow 'Decision Tree'



- Whether spare parts are easily available, and if not so, then what the available arrangements?
- Ensure that mean flow velocity should not exceed the following:
 - 2.0 ft/sec for pump speed up to 250 rpm
 - 1.5 ft/sec for pump speed up to 330 rpm.
 - 1.0 ft/sec for pump speed up to and above 330 rpm.

This will normally require suction piping one or two pipe size larger than the pump suction connection. It is also to be ensured that the piping should be such that the natural frequency of any span should be greater than 1.5 times the pump pulsation frequency.

- Is there suction stabilizer installed adjacent to the pump suction?
- Whether the liquid is required to be heated before the pump can start operation? If it is so then steam jacket or other means of heating the system must be considered.

Conclusion

As the process of industrialisation and modernisation gathers momentum in the environment of liberalisation or globalization, the demand for pumps and its connecting parts is expected to be enhanced, hence extra care is to be taken at the selection of right type of pump for desired pumping service for obtaining reliability as well as profitability in the present competitive industrial market. One consideration should be given to the characteristics of liquid handled as well as chemical compatibility with pump material for efficient and reliable service of pump. Low operating and maintenance cost along with energy efficient pump should be given preference while selecting the right type of pump for process industries.

Reference Book:

Chemical Engineering World,
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