International Journal of Technical Research and Applications e-ISSN: 2320-8163,
www.ijtra.com Volume 11, Issue 2 (MARCH-APRIL 2023), PP. 01-09

CRUCIAL COMPRESSOR SELECTION

Ravi Kiran Dasari
Process Engineering Manager, Audubon Engineering
Houston, USA

***Abstract*— This article focused mainly on the type of compressor to be selected based on industrial applications for better design and safe operations. Also compressor types is very vital in terms proper gas transportation with in time and length of operation.**

***Index Terms*— Positive displacement, centrifugal, rotary, screw, liquid ring, straight lobe.**

I. INTRODUCTION

A compressor is a mechanical device that increases the pressure of a gas by reducing its volume. It is a machine used to supply air or other gas at increased pressure, e.g. to power a gas turbine. Compressors are used in many applications, most of which involve increasing the pressure inside a gas storage container, such as:

- Compression of gases in petroleum refineries and chemical plants
- Storage of gas in high-pressure cylinders
- Cabin pressurization in airplanes
- Air storage for underwater activities
- Filling tires

Other applications include, but are not limited to:

- Refrigeration and air conditioners
- Rail vehicle operation
- Gas turbines
- Powering pneumatic tools
- Pipeline transport of natural gas

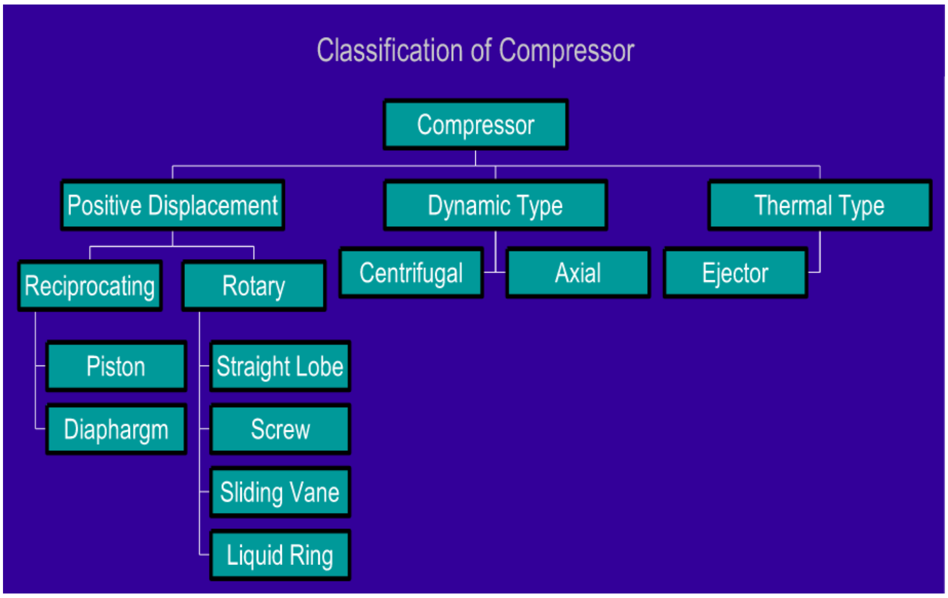

Fig 1: Types of compressors classification

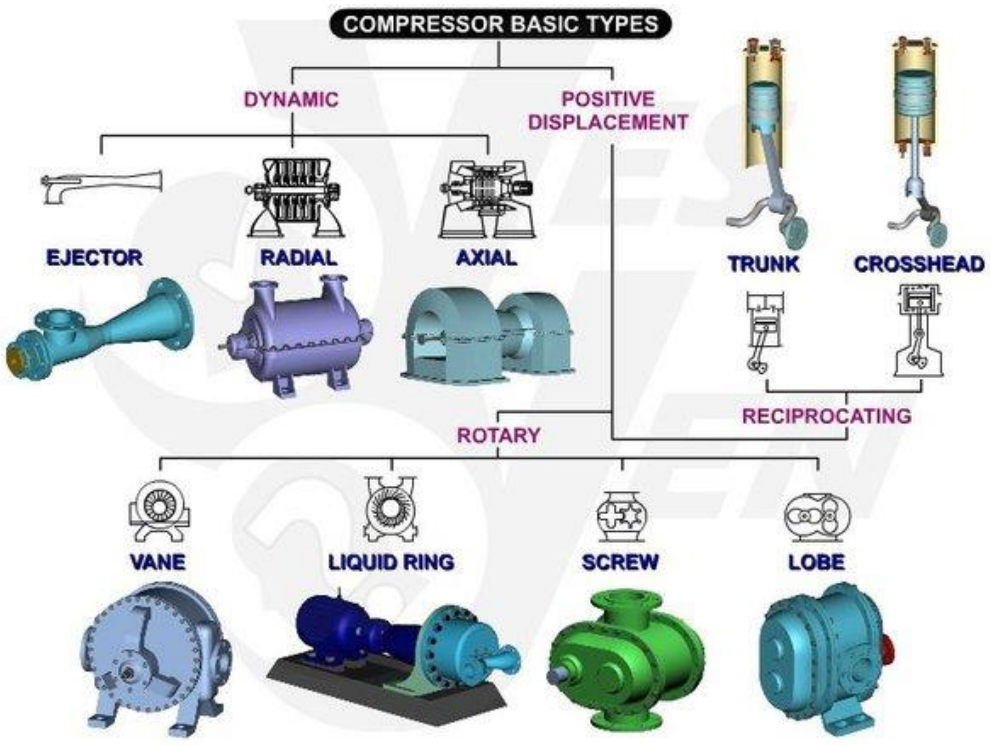

Fig 2: Schematic classification of compressors

<u>Selection of compressor</u>

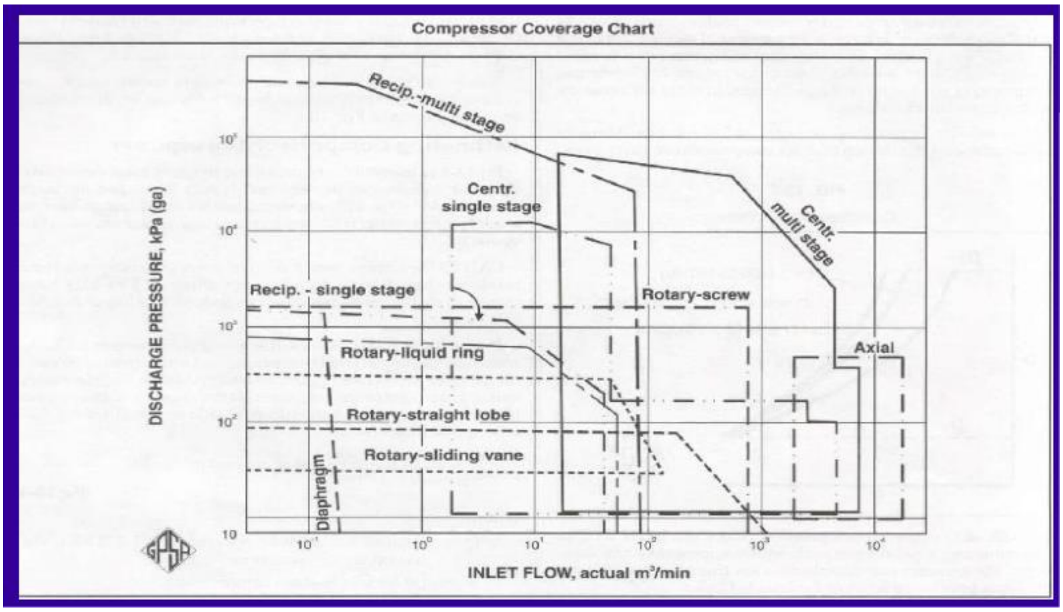

Fig 3: Compressors Selection

Before selecting a compressor, following operating conditions must be specified.

• Gas Characteristic:
– Cp/Cv- K factor.
– Molecular weight-M
– Compressibility factor-Z
• Suction and discharge conditions.

– Temperature
– Pressure.
• Capacity to be handled- kg/hr or Am3/hr.
Lower flow & higher pressure-- Reciprocating Compressor
Higher flow & lower pressure-- Centrifugal compressor.

II. COMPARISION BETWEEN CENTRIFGUAL AND RECIPROCATING COMRPESSOR

A. Advantage of centrifugal compressor.

- Lower installed cost.
- Lower maintenance.
- Greater continuity of service.
- Greater volume capacity per unit plot area.
- Adaptability to high-speed
- Low maintenance cost drivers.

B. Advantage of reciprocating compressor.

- Greater flexibility in capacity and pressure.
- Higher compression efficiency and lower power cost.

III. RECIPROCATING TYPE

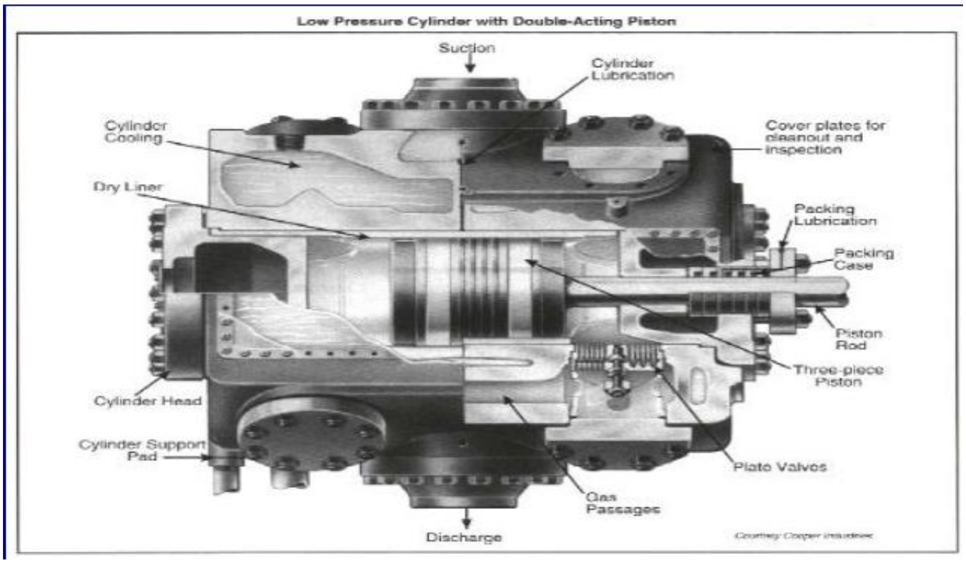

Fig 4: Piston type

A. Piston Type compressor

Operating Principle: Gas is drawn into the cylinder by the movement of the piston from the clearance volume position to stroke volume position (suction stroke) & compressed by the reverse movement of the piston (discharge stroke) and this movement forces gas out from the cylinder.

Pressure range: 1 kg/cm2 to 1000 kg/cm2 (g).
• Capacity range: 3000-5000 m3/hr.
• Pressure ratio: Generally max. 4 per stage.

• *Importance of Safety Valve:*
The characteristic curve of the reciprocating compressor is very steep i.e. variation of pressure is large with a small change in flow. Hence if the discharge of reciprocating compressor is throttled then the pressure can theoretically shoot up to infinity. Hence the safety valve at the discharge of the compressor.

• *Change in gas demand:*
When demand of the gas changes, compressor is loaded/unloaded by the capacity control system.

• If compressor operation is desired to be in range of 0-25, 25-50, 50 -75 or 75-100 % then valve on spill back line is opened to maintain the correct flow rate in addition to loading/unloading.

Change in Molecular Weight:
• Change in molecular weight changes the density and hence the discharge pressure. In case of increase in molecular weight, there is increase in discharge pressure and flow and hence power. The pressure can be regulated by opening of the spill back valve. Converse is true when molecular weight decreases.

B. Diaphragm Type compressor

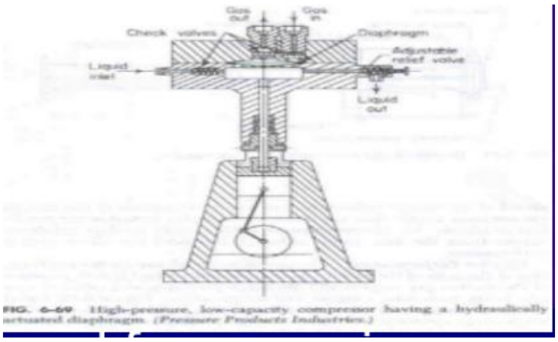

Fig 5: Diaphragm type

- It is mainly used for corrosive gases and for higher discharge pressure and lower throughput.
- Compressor throughput: up to 17 m3/hr.
- Discharge pressure: up to 2000 bar (g).
- Pressure ratio: max. 10 per stage.

IV. ROTARY TYPE

A. Straight lobe

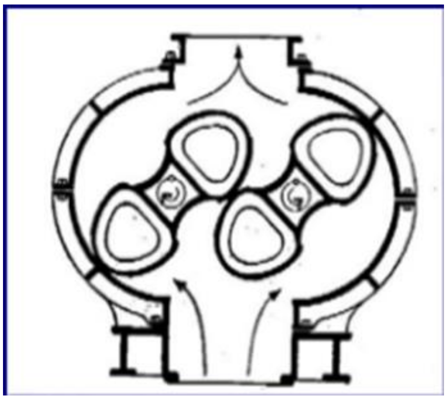

Fig 6: Straight Lobe type

Operating Principle: The straight lobe compressor is a rotary positive displacement machine in which compression is achieved by rotation of two lobes which are meshed with each other. Compressed gas flows from suction to discharge to the space between the casing & lobe.

Discharge Pressure: max. Up to 0.84 kg/cm2 (g).

Capacity of the Compressor: max. Up to 25500 m3/hr.

B. Screw Compressor

Fig 7: Screw type

Operating Principle: the screw compressor comprises of two rotors (1) male rotor (2) female rotor which mesh into each other. One of the rotors is connected to driver. Usually in a screw compressor, oil is injected along with suction gas, the oil-gas mixtures gets progressively compressed along the length of the screw and issues out from the compressor where it is separated in a separator.

Capacity: Max. Up to 42500 m3/hr.

Pressure ratio: 4 or higher than that.

C. Sliding Vane

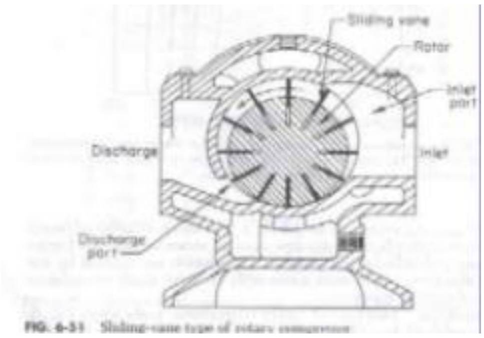

Fig 8: Sliding Vane type

Operating Principle: The compressor comprises a rotor, which is located within a larger bore diameter cylinder, but with its location being eccentric to that of the cylinder. In a rotor are a number of slots in which are located vanes. These vanes are free to move within the slots, hence Compressor name of "sliding vane".

- Discharge Pressure: max. Up to 9 kg/cm2 (g)...
- Capacity of compressor: max. Up to 3400 m3/hr.
- Permissible Pressure Ratio: max. Up to 4 per stage.

D. Liquid ring compressor

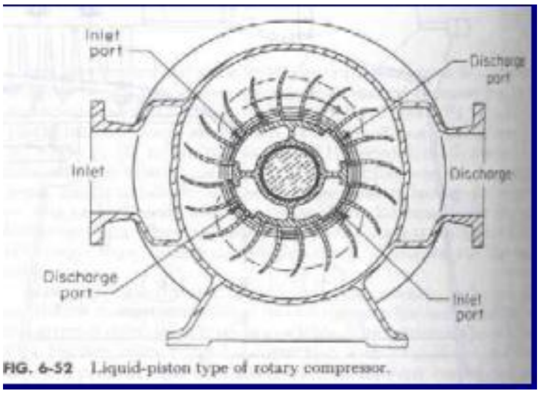

Fig 9: Liquid ring type

Operating Principle: In single chamber compressor, there is a circular casing with a rotor mounted in it. With its center of rotation eccentric to the center of casing. The diameter of

Rotor is such that the tip of rotor is near the casing. Casing contains quantity of liquid, which form seal between rotor and casing. When rotor is rotated, liquid is thrown outward by centrifugal force and it follows the contour of its outer casing as rotor pushes liquids outwards at all time. This results in gas-phase which is formed between liquid, rotor and casing at inner diameter of rotor.

• Discharge Pressure: Max. Pressure upto 5.5 kg/cm2 (g).

• Capacity of the compressor: max. upto 6800 m3/hr.

• Because of the gas-liquid contact the discharge gas-temperature rise is very small and so mainly used for the hazardous gases compression.

V. CENTRIFUGAL COMPRESSOR

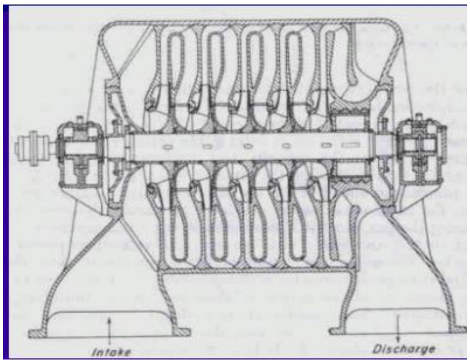

Fig 10: Centrifugal Compressor

Operating principle: Kinetic energy is imparted to the gas by the centrifugal action of impeller and this kinetic energy is converted to the pressure energy by the diffuser or volute.

75 % of kinetic energy is converted at impeller and remaining 25 % is converted through diffuser.

Classification of Centrifugal Compressor

- Single stage Single shaft.
  - For small pressure rise.
- Multistage Single shaft. (Generally used)
  - Horizontal split Casing
- Discharge pressure less than 50 bar
  - Vertical split Casing (Barrel Casing)
- Discharge pressure more than 50 bar.
- Multistage Multi shaft.
- Number of Impeller in each stage:

– Total effective head required / Head Developed per impeller.

– Size of the impeller & clearance between impeller and casing decreases in successive stages because the volume handled decreases as pressure increases.

• Number of Stages:

– Depending upon the discharge temperature of the gas.

– Max permissible discharge temperature

• For hydrocarbon, NH3, CO2 is 150-180 ^{0}C.

• For air. 200 to 230 ^{0}C.

VI. Conclusion

It is recommended to have right selection of compressor types depending on the service nature. They key is to determine what demands are required to meet and also critical to know the past lessons and learn from them as guidance to effectively select for industrial purposes mainly

References

[1] A Study on Design Criteria and Matching Of Turbomachines" 0. E. Balje, Trans ASME J, Eng. for Power Parts B at Jan. 1962 "Compressor Selection For The Chemical Process Industries" R. F. Neerken, Chern Eng. Jan. 20, 1975

[2] "Basic Practice in Compressors Selection" M. 0. Khan, Brown & Root BP-00-01 May 1984

[3] Compressor Handbook for the Hydrocarbon Processing Industries Gulf Publishing Company, Houston 1979

[4] Gulf South Compression Conference Aug. 1983, Louisiana State University Group Discussions.

[5] Ferguson T. B. The centrifugal compressor stage 1963 (Butterworth, London).
Google Scholar

[6] Scheel L. F. Gas and air compressor machinery 1961 (McGraw-Hill, New York and London).
Google Scholar

[7] Richings W. V. ‘Acoustic noise measurement and analysis’, Wireless world 1964.
Google Scholar

[8] The investigation of atmospheric pollution, D. S. I. R. Report (H. M. S. O., London).
Google Scholar

[9] Guignard J. C. ‘Human response to intense low-frequency noise and vibration’, Proc. Instn mech. Engrs 1967–68 182 (Pt 1), 55.
Google Scholar

[10] Brightwell M. A. ‘Rotary compressor cylinder design’, Engineer, Lond. 1964 (October).
Google Scholar