



IJEAST

INTERNATIONAL JOURNAL
OF ENGINEERING APPLIED SCIENCE
AND TECHNOLOGY



VOLUME : 7 ISSUE : 11 Print / Issue Publication Date: 14-May-2023



ISSN : 2455-2143



DOI : 10.33564/IJEAST.2023.v07i11.007

Indexed In



WWW.IJEAST.COM

editor@ijeast.com

CENTRIFUGAL COMPRESSORS CONTROL CRITICALITY

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Abstract- This article focused mainly on the importance of anti-surge control of compressor and how to design the recirculation line for turndown of compressors that's referred as surge. Also some recommendations will be made for better design and safety.

Keywords: Anti-surge, Surge, Seals, Lube oil, centrifugal

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

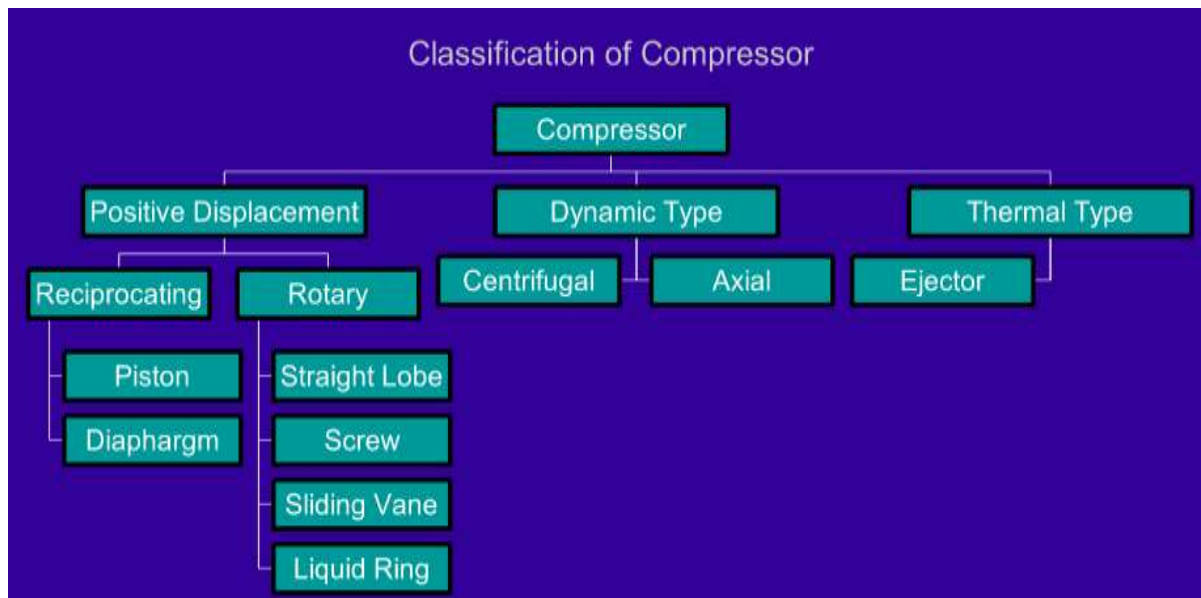


Fig 1: Types of compressors classification

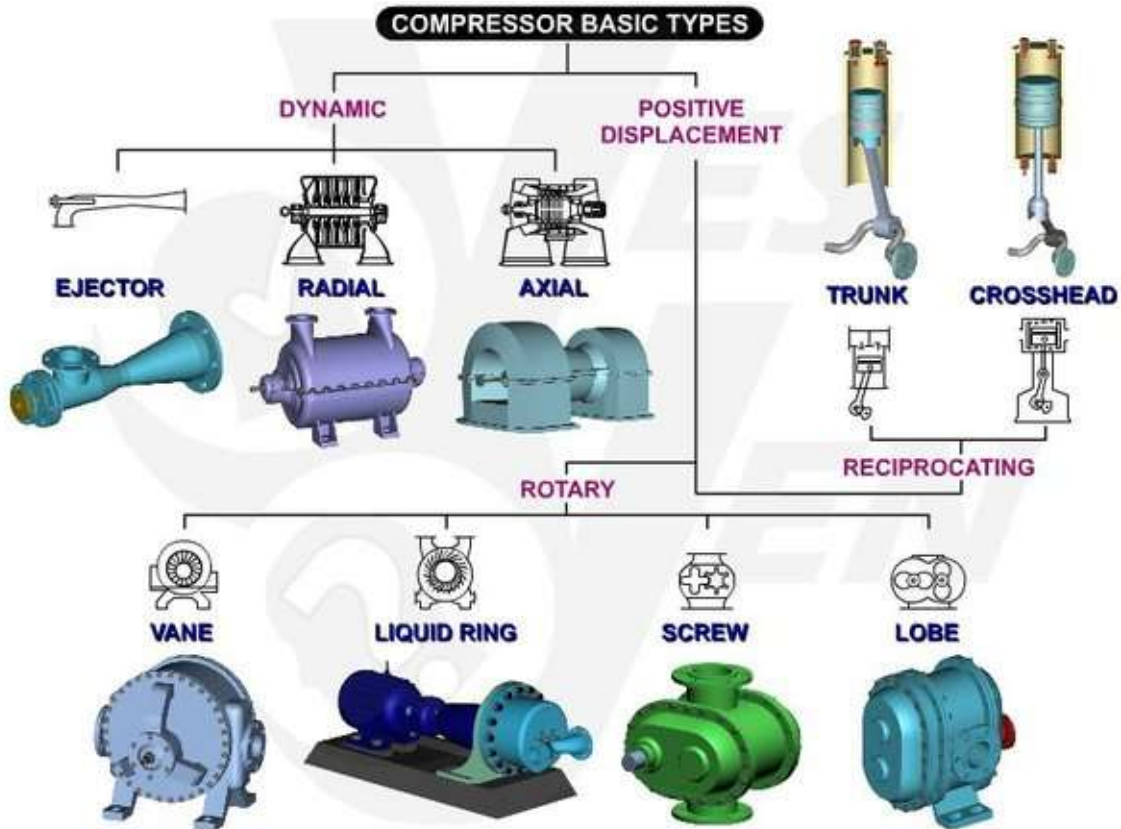


Fig 2: Schematic classification of compressors

II. SURGE AND ITS CONTROL

A. Surge:

The Capacity below which centrifugal compressor performance become unstable.

Factor Responsible for Surging:

- Reduction in suction gas density.
- Reduction in impeller speed.
- Reduction in Compressor Flow.
- More discharge pressure required than possible from the available kinetic energy.

Effect of Surging:

- Excessive vibration in compressor
- High deviation in discharge pressure.
- Drastic over heating of the machine.
- Ingress of liquid from suction KOD.

B. Anti Surge Control System

Anti-surge Control system (ASC):

Operating Principle: To provide a minimum flow through the compressor suction at all speeds which is higher than the surge.

This is achieved by the following ways:

- Recirculating back the quantity form the discharge to the suction (intercooler is required).

- Venting the quantity.(air)
- Reducing the compressor speed in case of variable speed drive.

III. SEALS & SEALING SYSTEMS

Sealing system is mainly used to prevent the leakage of the gas from the compressor between rotating and stationary parts of the compressor.

- Selection of Sealing system depends on following factors:
- Nature of gas. i.e corrosive, hazardous,flammable
- Permissible leakage quantity.
- Cost of the gas.
- Different types of Sealing systems:

– Labyrinth seal

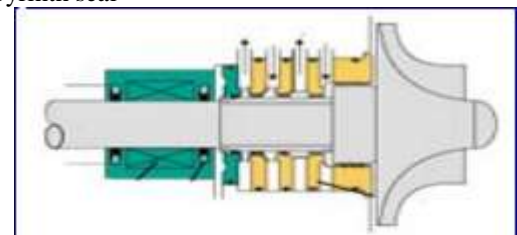


Fig 3: Labyrinth seal

when leakage in atmosphere is tolerated.

Sealing System

– Carbon ring Seal or Mechanical Seal

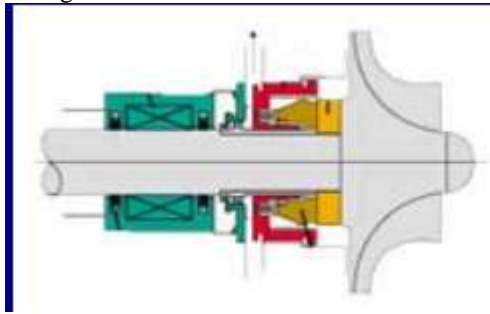


Fig 4: Carbon Ring seal

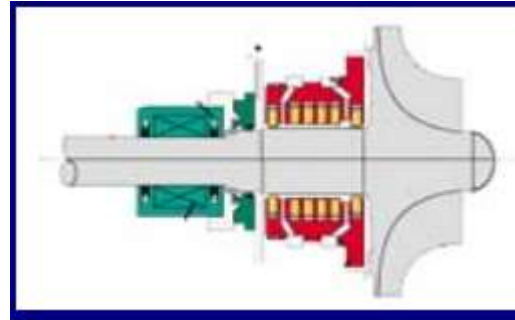


Fig 5: Dry gas seal

- For moderate pressure application.
- Permits less leakage than labyrinth seals.

– Liquid Film shaft seals:

For Poisonous and inflammable gases

– Dry gas Seals:

- for higher pressure application.
- For costly and hazardous gas
- nearly zero leakage.

IV. LUBE OIL SYSTEM

• Lube Oil System:

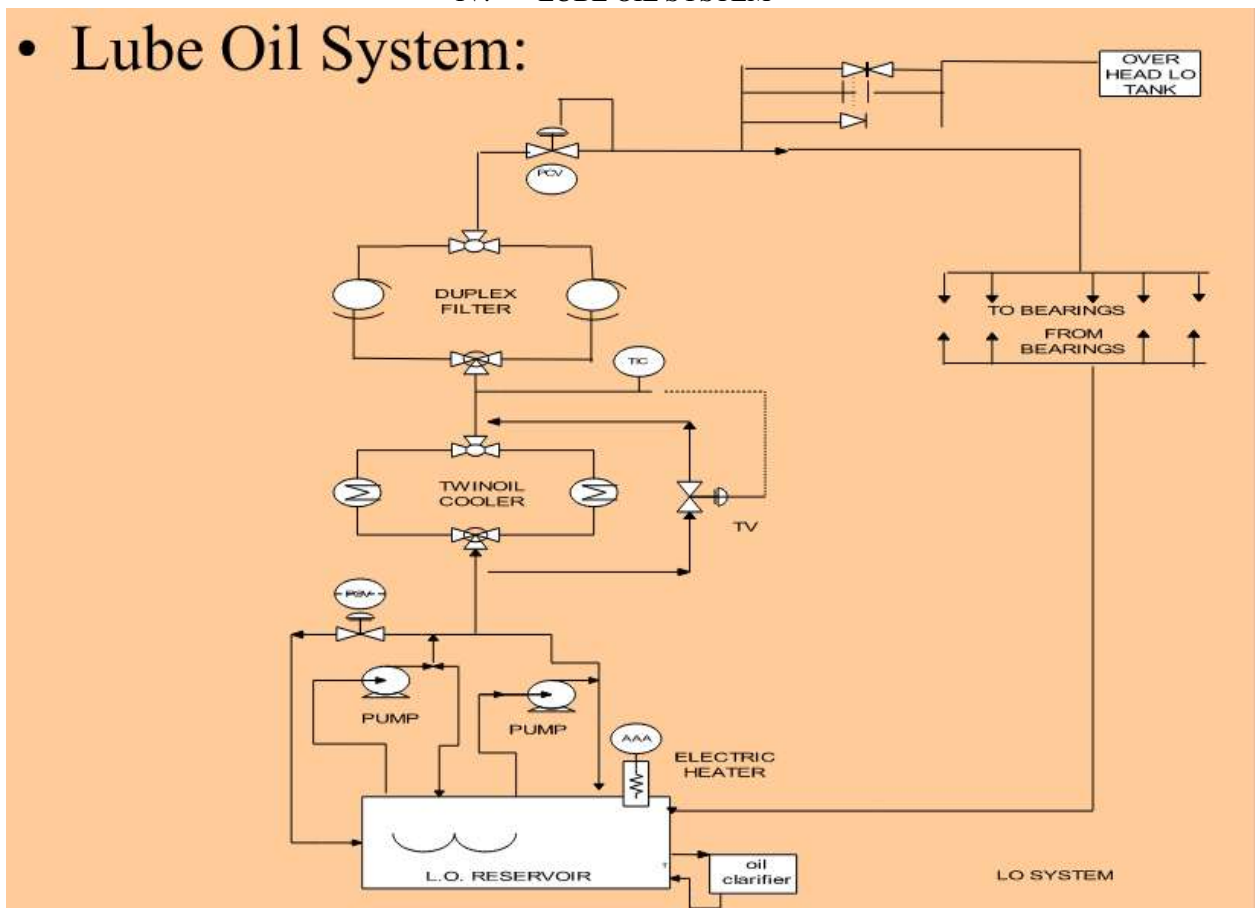


Fig 6 : Lube oil schematic

• Lube oil is used for the lubrication of bearings at the drive end and the non drive end. The Lube oil creates a hydrodynamic film between shaft and bearing which creates a lift of a shaft. The inefficiencies (losses) in the compressor appear as heat loads at the bearings.

Oil acts as a carrier medium of the heat load in addition to lubrication.

• The major components used in lube oil system are:

- Reservoir Tank
- pumps (main & Auxiliary)
- Cooler
- Filters
- Pressure Control Valves.

Interaction of compressor with downstream loop equipment

• Consider the following typical arrangement of the compressor with downstream equipment.

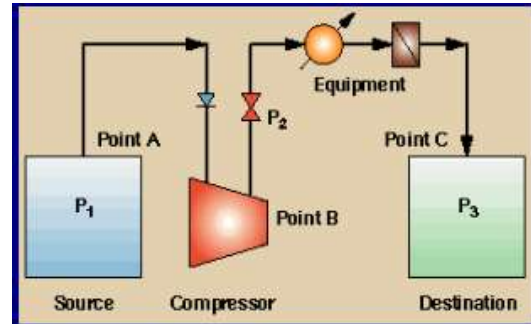


Fig 7: Typical arrangement of compressor

- For different changes in the system, operating point of the compressor can be changed
- Discharge control valve/recycle Valve
- Changing the speed of the driver
- Combination of both.

Single speed drive with Suction/Discharge control valve

Incoming flow decreases

Incoming flow decreases below surge

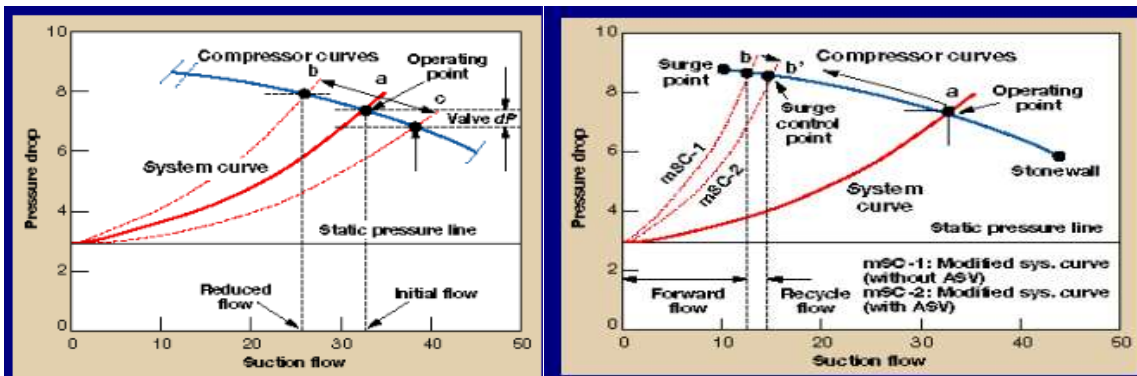


Fig 8: compressor curves for incoming flow decreases

Control valve closes, operating curve moves left ASV opens and control valve closes
 Variable speed compressor drive

Cases:

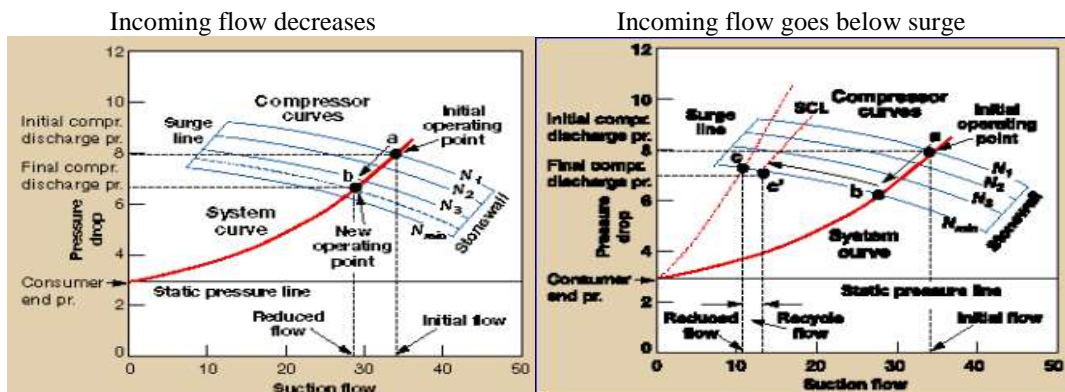


Fig 9: compressor curves for variable speed compressor drive

Driver slows down

Operating point changes by the action of Combination of speed control, control valve and ASV.

Molecular Weight changes

• As the molecular weight decreases it leads to the lower discharge pressure and curve shifts right downward and vice versa for the increase in the molecular weight.

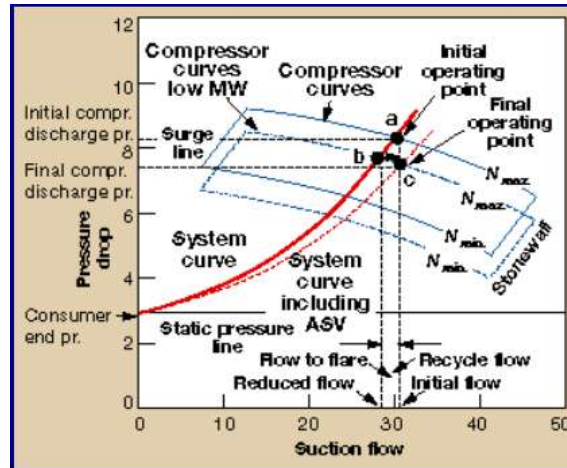


Fig 9: compressor curves for molecular weight increase

V. CONCLUSION

It is recommended to have anti-surge line sized full compressor to avoid start-up issues. Seal system is very critical for safe and reliable operations, also lube oil system is the critical part for operation to be efficient.

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