LNCT GROUP OF COLLEGES

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Subject: ME- 603 (Turbomachinery)

Unit: IV

Topic: Compressor

Introduction of Compressor:

Compressor is a power consuming thermodynamic device which converts mechanical energy into head or pressure energy. Generally, compressor is used for supplying high pressure compressed air, the compressed air is one of the best sources of storing energy. It stores the mechanical energy in the same way as it is stored in a clock spring when spring is wound. The mechanical energy if put into air in the form of work in reversible process is returnable as work. Thus a machine which receives air from the atmosphere with the aid of some mechanical means and then delivers it to a vessel for storage is known as compressor.

Working Principle of the compressor:

The function of the compressor is to compress the gasesand vapours from low pressure to higher pressure. According to the second law of thermodynamics, this only possible when the work is done on the gas by an external agency, such as prime mover, electric motors etc. Thus, a compressor sucks gas at low pressure (atmospheric air in case of aircompressor), compresses it up to a certain pressure and delivers it at high pressure storage vessel called receiver from the where it may be carried by a pipe line to wherever it is desired. The used of compressor in to start large diesel engines, to supercharge I. C. engines, to operate blast furnace and gas turbine plant.

Classification of compressors:

The compressors may be classified in following ways –

(i) According to the way of pressure developed
(a) Reciprocating compressor (b) Rotary compressor

(ii) Further rotary compressors are of different types (a) Roots blower compressor (b) Vane blower compressor (c) Centrifugal blower compressor (d) Axial flow compressor

(iii) According to the action
(a) Single acting compressor (b) Double acting compressor

(iv) According to numbers of stages
(a) Single stage compressor (b) Multi stage compressor

Application of compressor:

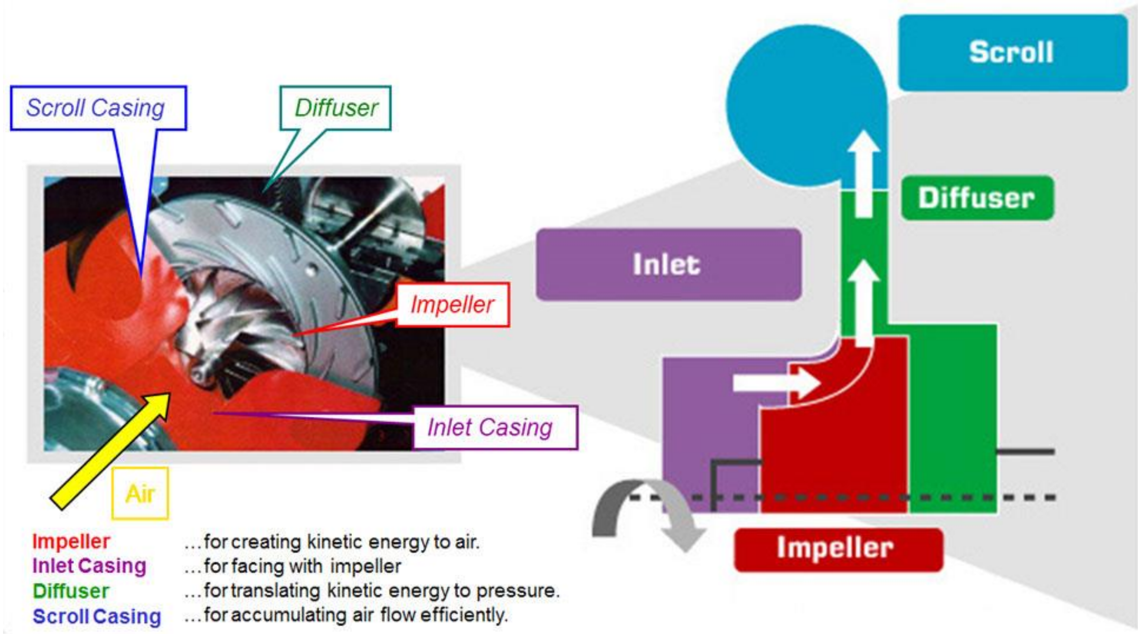
(i) To derive compressed air engines used in coal mines.
(ii) To inject fuel spray into the cylinder of a diesel engine.
(iii) To operate drills hammers, air brakes for locomotives and railway carriage, water pump and paint sprays.
(iv) To clean workshop machines, generators, automobile vehicles etc.
(v) To operate blast furnace, gas turbine plant, Bessemer convertors used in steel plant etc.
(vi) To cool large buildings and air aircrafts.
(vii) To super charge I.C. engines

Centrifugal Compressor

Principle

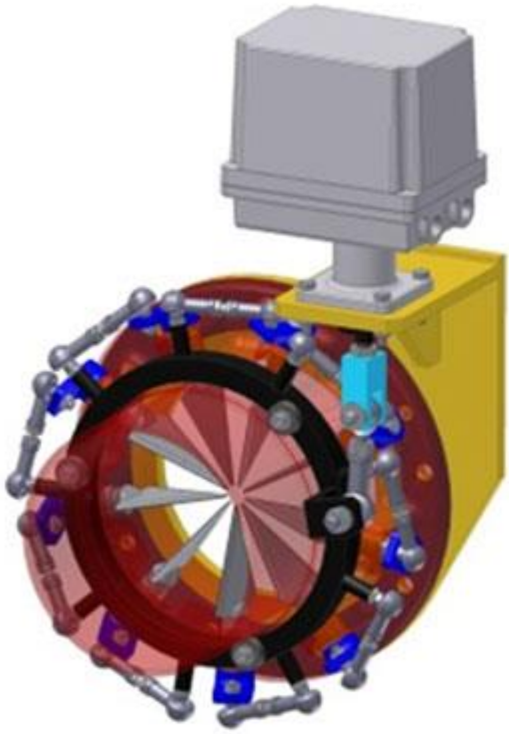
The Principle of Centrifugal Compression: Aero-Dynamics

1. The air reaches the centre of the impeller.
2. Air is forced outward by centrifugal force.
3. Diffuser gradually reduces the air velocity.
4. Velocity energy is converted to higher pressure.

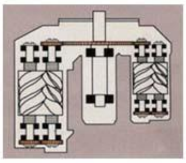
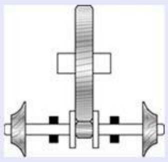


Performance

One of the most important factor to consider for compressor is the efficiency of the compressor at full load. Air consumption in the plant is however always fluctuating, which is why capacity control system is needed to ensure stable operation of the compressor. This is achieved through the Inlet Guide Vane (IGV) that is installed before the air passage of first compression stage to supply air with constant discharge pressure in accordance with plant air consumption requirements.

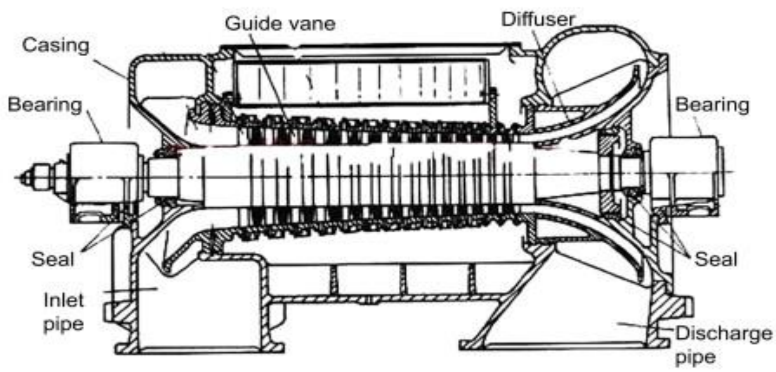


1. Maximized uptime and lower maintenance

	Rotary screw	Centrifugal
Structure of Compressor	 Complicated Structure Periodic replacement is necessary	 Simple structure Capital parts do not need to be replaced
Rotor	 Steel with Soft Coating	 Titanium Alloy or Stainless Steel (High Durability)
Bearing	 Antifriction bearing (needs periodic replacement)	 Tilting pad journal bearing (semi-permanent)

Axial Compressors

Axial compressors can handle large volume flow and are more efficient than centrifugal compressors. However, centrifugals are less vulnerable and, hence, more reliable, have wider operating ranges, and are less susceptible to fouling.



Axial flow compressor structure

Axial compressors should be considered only for air, sweet natural gas, or noncorrosive gases. Axial compressors are basically high-flow, low-pressure machines, in contrast to the lower flow, high-pressure centrifugal compressors (the axial compressors used in gas turbines are often designed for higher pressures and compression ratios).

Axial compressors are generally smaller and significantly more efficient than comparable centrifugal compressors. The characteristic feature of an axial compressor, as its name implies, is the axial direction of flow through the machine. An axial flow compressor requires more stages than a centrifugal due to the lower pressure rise per stage. In general, it takes approximately twice as many stages to achieve a given pressure ratio as would be required by a centrifugal. Although the axial compressor requires more stages, the diametral size of an axial is typically much lower than for a centrifugal. The axial compressor's capital cost is usually higher than that of a centrifugal, but may be justified based on efficiency and size. The axial compressor utilizes alternating rows of rotating and stationary blades to transfer the input energy from the rotor to the gas in order to generate an increase in gas pressure.

A multi-stage axial flow compressor has two or more rows of rotating blades operating in series on a single rotor in a single casing. The casing contains the stationary vanes (stators) for directing the air or gas to each succeeding row of rotating blades. These stationary vanes, or stators, can be fixed or at a variable angle, or a combination of both.

Axial compressor is usually a single inlet, uncooled machine consisting essentially of blades mounted on a rotor turning between rows of stationary blades mounted on the horizontally split casing.

Performance guarantee:

1. Compressors shall be guaranteed for head, capacity, and satisfactory performance at all specified operating points and further shall be guaranteed for power at the normal operating point

2. For variable-speed compressors, the head and capacity shall be guaranteed with the understanding that the power may vary ±4%

3. For constant-speed compressors, the specified capacity shall be guaranteed with the understanding that the head shall be specified for 100.0 and 105.0%; the power consumption shall not exceed stated power by more than 4%. These tolerances are not additive.

4. For compressors handling side loads or for two or more compressors driven by a single drive, the required performance guarantee for each compressor “section” shall be agreed upon by the company and the vendor

Design criteria

The minimum head rise to surge of an axial machine should be specified. The normal operating point shall be at least 10% removed in flow from the surge point.

Gas velocities

General guideline for good design practice indicates an axial velocity for air of 91–137 m/s. For other gases, the axial velocity range is in direct proportion to the speed of sound of the gas compared to air. The internal shape of the machine is usually arranged to give constant gas velocity as the gas travels through.

Volume

The size is determined by the inlet volume. The lower volume limit is approximately 8500 m^3/h but the upper limit practically does not exist, units have been built to handle well above 1,700,000