

2.12 Volumetric efficiency:

The clearance volume in a compressor reduces the intake capacity of the cylinder. This leads to a term called volumetric efficiency.

The volumetric efficiency is defined as the volume of free air sucked into the compressor per cycle to the stroke volume of the cylinder, the volume measured at the intake pressure and temperature or at standard atmospheric conditions, ($p_s = 101.325 \text{ kN/m}^2$ and $T_s = 288\text{K}$)

$$\begin{aligned} \text{Volumetric efficiency, } \eta_{\text{vol}} &= \frac{\text{Volume of free air taken in per cycle}}{\text{Stroke volume of the cylinder}} \\ &= \frac{\text{Effective suction volume}}{\text{Swept volume}} = \frac{(V_1 - V_4)}{(V_1 - V_3)} = \frac{V_1 - V_4}{V_s} \end{aligned}$$

Clearance ratio: Clearance ratio is defined as, the ratio of clearance volume to swept volume. It is denoted by the letter C.

$$\text{Clearance ratio, } C = \frac{\text{Clearance volume}}{\text{Swept volume}} = \frac{V_c}{V_s} = \frac{V_c}{V_1 - V_3}$$

$$\text{Pressure ratio, } R_p = \frac{\text{Delivery pressure}}{\text{Suction pressure}} = \frac{p_2}{p_1} = \frac{p_3}{p_4}$$

2.13 Multi-stage air compressor:

In a multi stage air compressor, compression of air takes place in more than one cylinder. Multi stage air compressor is used in places where high pressure air is required. Fig. shows the general arrangement of a two-stage air compressor. It consists of a low pressure (L.P) cylinder, an intercooler and a high pressure (H.P) cylinder. Both the pistons (in L.P and H.P cylinders) are driven by a single prime mover through a common shaft.

Atmospheric air at pressure p_1 taken into the low pressure cylinder is compressed to a high pressure (p_2). This pressure is intermediate between intake pressure (p_1) and delivery pressure (p_3). Hence this is known as intermediate pressure.

The air from low pressure cylinder is then passed into an intercooler. In the intercooler, the air is cooled at constant pressure by circulating cold water. The cooled air from the intercooler is then taken into the high pressure cylinder. In the high pressure cylinder, air is further compressed to the final delivery pressure (p_3) and supplied to the air receiver tank.