1 ZT37 VSD Compressor Minimum Flow Compression

At minimum speed of VSD operation the first stage of compression operates as follows:

- Ambient Temperature: 300K (Assumed)
- Ambient Pressure: 101,325 Pa (Assumed)
- Compressed Air Flow Rate: 87.2 acfm (CAGI Data sheet: equivalent to 0.0412 m^3/s)
- Element 1 Outlet Pressure: 2.5 barg

We can normalise to standard temperature and pressure we can calculate the number of moles of air being compressed. This is useful when applying the ideal gas equation:

$$PV = nRT \tag{1}$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \tag{2}$$

$$V_2 = \frac{101,325 * 0.0412 * 273.15}{300 * 100,000} = 0.038m^3 \tag{3}$$

One mole of gas occupies 22.7 l at standard temperature of pressure.

$$\frac{0.038}{.0227} = 1.67\text{moles} \tag{4}$$

2 Isothermal Compression

For isothermal compression, the temperature remains constant. As this is the only variable on the right hand side of Equation 1, pressure is inversely proportional to volume during compression. We can calculate the volume of the gas as it is compressed to 2.5 barg by:

$$V = \frac{nRT}{P} \tag{5}$$

The P-V and T-V diagrams for this compression are given in Figure 1.

3 Adiabatic Compression

For adiabatic compression, no heat is transferred between the system and its surroundings. Furthermore if the process is idealised to be reversible (i.e. frictionless) the process is said to be adiabatic.

For this type of compression the following relationship holds true:

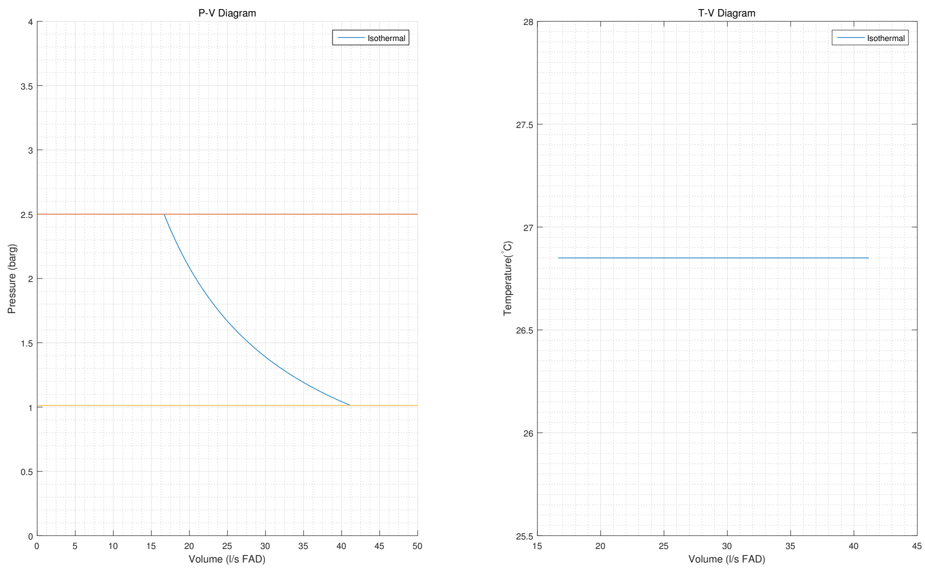

Figure 1: Isothermal Compression

$$PV^{\gamma} = Constant \tag{6}$$

In this equation. γ refers to the specific heat ration $\left[\frac{C_p}{C_v}\right]$ of air. This value is dimensionless and is 1.4 for air.

Therefore for the initial conditions above we can calculate:

$$101,325 * 0.0412^{1.4} = Constant(C) = 1,165.66 \tag{7}$$

We can therefore calculate the volume of the gas as it is compressed to 2.5 barg using:

$$V = \left(\frac{C}{P}\right)^{\frac{1}{\gamma}} \tag{8}$$

Using Equation 2 we can calculate the temperature as the pressure increases and the volume decreases.