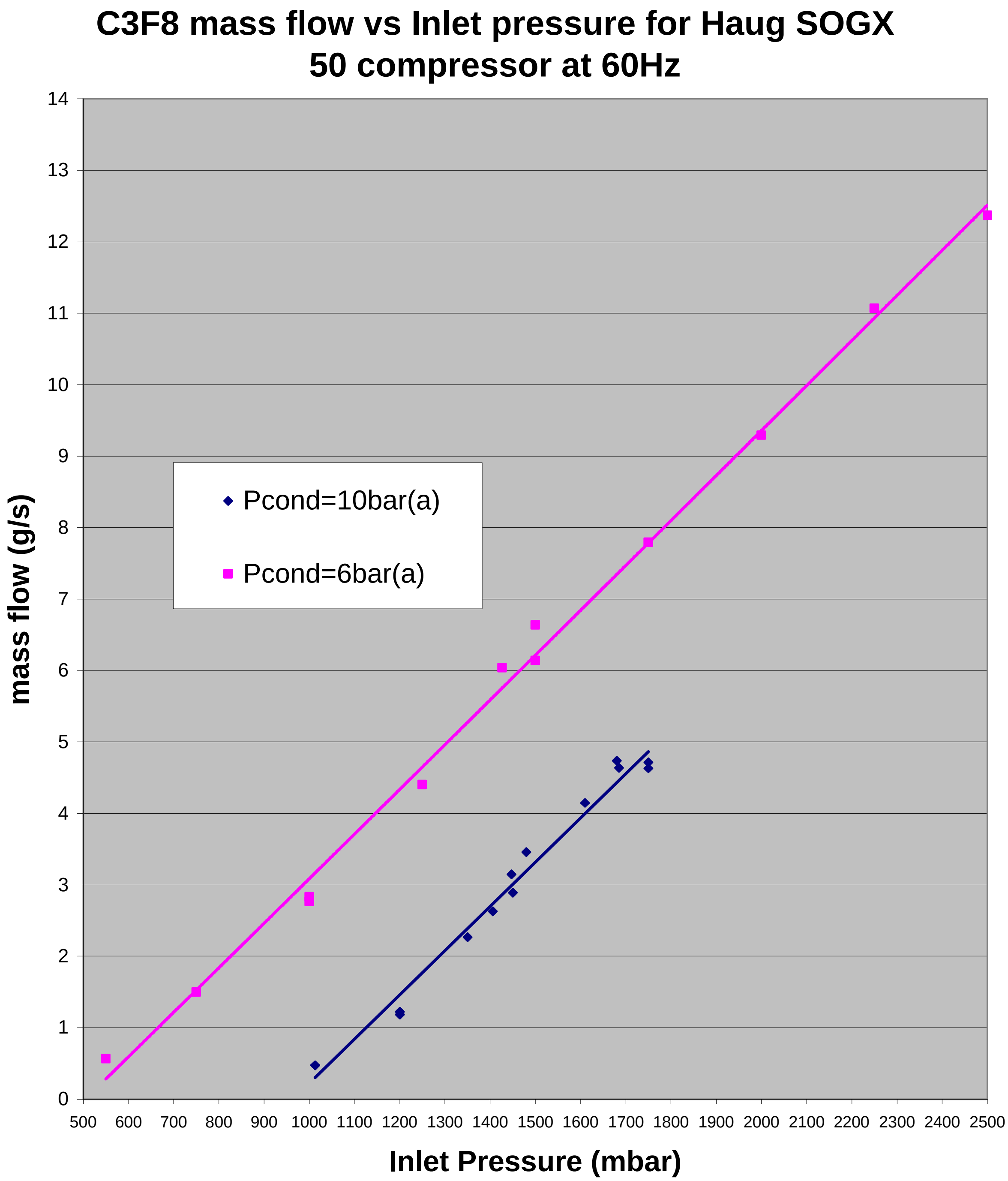

C3F8 mass flow vs Inlet pressure for Haug SOGX 50 compressor at 60Hz
mass flow (g/s)
Inlet Pressure (mbar)
Pcond=10bar(a)
Pcond=6bar(a)
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
500 600 700 800 900 1000 1100 1200 1300 1400 1500 1600 1700 1800 1900 2000 2100 2200 2300 2400 2500

Comments:

It can be seen that the mass flow is a function of both inlet and outlet pressures:

$$\dot{m} = f(P_{in}, P_{out})$$

And also that it depends more on P_{in} than on P_{out},

$$\frac{\partial \dot{m}}{\partial P_{OUT}} \approx \frac{5-2}{10-6} = 0.75 gs^{-1}/bar$$

$$\frac{\partial \dot{m}}{\partial P_{IN}} \approx \frac{4-2}{1.6-1.3} = 6.7 gs^{-1}/bar$$

Theoretical background

Let ***p*** be the percent clearance of the compressor,

$$p = \frac{Vc}{V_{MAX} - Vc} \times 100 \qquad \textbf{(a)}$$

Where:

- $\boldsymbol{V_{MAX}}$ is the maximum volume in the cylinder, which occurs when the piston is at one end of its stroke.
- $\boldsymbol{Vc}$ is the minimum volume, or clearance volume, which occurs at the other end of the piston stroke

The ***clearance volumetric efficiency*** is

$$h_{VC} = \frac{Volume\_of\_vapour\_drawn\_in}{swept\_volume} = \frac{V_{MAX} - V_{OPEN}}{V_{MAX} - V_C} \times 100 \qquad \textbf{(b)}$$

Where $\boldsymbol{V_{OPEN}}$ is the volume in the cylinder at which the pressure is low enough for the suction valve to open. **($\boldsymbol{V_{MAX}}$ -$\boldsymbol{V_{OPEN}}$) is the volume of gas drawn into the cylinder and ($\boldsymbol{V_{MAX}}$ -$\boldsymbol{V_C}$) is the total volume swept by the cylinder.**

(a) and (b) can be combined to give:

$$h_{VC} = 100 - p\left(\frac{V_{OPEN}}{V_C} - 1\right) \qquad \textbf{(c)}$$

If an ***isentropic expansion*** is assumed for the gas trapped in the clearance volume, i.e. between $\boldsymbol{V_c}$ and $\boldsymbol{V_{OPEN}}$,

$$\frac{V_{OPEN}}{V_C} = \frac{r_{OUT}}{r_{IN}} = \left(\frac{P_{OUT}}{P_{IN}}\right)^{1/K} \qquad \textbf{(d)}$$

Where $\boldsymbol{r_{IN}}$ is the density at the compressor inlet and $\boldsymbol{r_{OUT}}$ at its outlet and ***k*** is the coefficient of isentropic expansion

Thus,

$$h_{VC} = 100 - p\left(\frac{r_{OUT}}{r_{IN}} - 1\right) = 100 - p\left(\left(\frac{P_{OUT}}{P_{IN}}\right)^{1/k} - 1\right) \qquad \textbf{(e)}$$

The volumetric flow is:

$$\dot{V} = N \times V_{SWEPT} \qquad \textbf{(f)}$$

Where, as seen above $\mathbf{V_{SWEPT} = V_{MAX}\text{-}V_C}$ and **N** is the number of cycles per second

The mass flow is

$$\dot{m} = \dot{V} \times h_{VC} \times r_{IN} = N \times V_{SWEPT} \times \left[100 - p\left(\left(\frac{P_{OUT}}{P_{IN}}\right)^{1/k} - 1\right)\right] \times r_{IN} \qquad \textbf{(g)}$$

ρ_{IN} is of course, a function of P_{IN}.