7

APPENDIX A

Leak power calculation

7 APPENDIX A

The theoretical power consumption due to a 10 mm leak with rough edges will be calculated by using Equation 4. This equation is provided again for reference purposes.

$$P_{electrical} = \frac{\frac{A \cdot C_{discharge} \cdot n \cdot p_{line} \cdot T_{inlet}}{T_{line} \cdot \eta_{comp} \cdot (n-1)} \cdot \left[\left(\frac{p_2}{p_1}\right)^{(n-1)/n} - 1\right] \cdot \left(\frac{2}{k+1}\right)^{\frac{1}{k-1}} \cdot \sqrt{kR*1000\left(\frac{2}{k+1}\right)T_{line}}}{\eta_{motor}}$$

Where:

$P_{electrical}$	= Electrical power (kW)
A	= Minimum cross-sectional area
$C_{\text{discharge}}$	= Discharge coefficient
n	= Polytropic compression exponent
p_{line}	= Line pressure (kPa)
T_{inlet}	= Inlet temperature (Kelvin)
T_{line}	= Line temperature (Kelvin)
η_{comp}	= Compressor efficiency
p_2	= Compressor discharge pressure (kPa)
p_1	= Compressor inlet pressure (kPa)
k	= Specific heat ratio
R	= Gas constant (0.287 kJ/kg.K)

The electrical power consumption will be calculated according to the following input parameters:

$A \quad = \dfrac{\pi \times 0.01 \times 0.01}{4}$

$C_{\text{discharge}} \quad = 0.65$

$n \quad = 1.3$

$p_{line} \quad = 589$ kPa

$T_{inlet} \quad = 293$ K

$T_{line} \quad = 303$ K

$\eta_{comp} \quad = 0.8$

$p_2 \quad = 589$ kPa

$p_1 \quad = 89$ kPa

$k \quad = 1.4$

$R \quad = 0.287$ kJ/kg.K

Equation 4 can then be populated as follows:

$$P_{electrical} = \frac{\dfrac{\pi \times 0.01 \times 0.01}{4} \times 0.65 \times 1.3 \times 589 \times 293}{303 \times 0.8 \times (1.3 - 1)} \times \left[\left(\frac{589}{89} \right)^{(1.3-1)/1.3} - 1 \right] \times \left(\frac{2}{1.4+1} \right)^{\frac{1}{1.4-1}}$$

$$\times \sqrt{1.4 \times 287 \left(\frac{2}{1.4+1} \right) \times 303} \times \frac{1}{0.9}$$

$P_{electrical} = 19$ kW

The theoretical power consumption due to a 200 mm open ended pipe will be calculated by using Equation 4. The electrical power consumption will be calculated according to the following input parameters:

$A = \dfrac{\pi \times 0.2 \times 0.2}{4}$

$C_{\text{discharge}} = 0.97$

$n = 1.3$

$p_{line} = 589$ kPa

$T_{inlet} = 293$ K

$T_{line} = 303$ K

$\eta_{comp} = 0.8$

$p_2 = 589$ kPa

$p_1 = 89$ kPa

$k = 1.4$

$R = 0.287$ kJ/kg.K

Equation 4 can then be populated as follows:

$$P_{electrical} = \frac{\dfrac{\pi \times 0.2 \times 0.2}{4} \times 0.97 \times 1.3 \times 589 \times 293}{303 \times 0.8 \times (1.3-1)} \times \left[\left(\frac{589}{89} \right)^{(1.3-1)/1.3} - 1 \right] \times \left(\frac{2}{1.4+1} \right)^{\frac{1}{1.4-1}}$$

$$\times \sqrt{1.4 \times 287 \left(\frac{2}{1.4+1} \right) \times 303} \times \frac{1}{0.9}$$

$P_{electrical} = 11\ 531$ kW