LECTURE 35 – COOLING AND DRYING OF COMPRESSED AIR

SELF EVALUATION QUESTIONS AND ANSWERS

1: A compressor delivers 500 m3 of free air per hour at a pressure of 8 bar gauge and a temperature of 60℃ . Atmospheric air at compressor intake has a relative humidity of 70 % and a temperature of 20℃. Determine the amount of water that can be extracted from the compressor plant per hour.

2 : Find the amount of condensate in one hour if 22 kW compressor operates under the following condition a) Air at 60% relative humidity and 30℃ ambient temperature is pressurised to 7 kg/cm^2(7 bar). It is then cooled to 25 ℃. Compressor output is 3 Nm^3/min at 7 kg/cm^2(7 bar)

3 : Air is used at a rate of 2 m^3/min from a receiver at 40℃ and 1000 kPa (gauge). If the atmosphere pressure is 101 kPa (abs) and the atmospheric temperature is 20 ℃. How many m^3/min of free air (standard m^3/min) must the compressor provide?

4: a. Calculate the required size of the receiver that must supply air to pneumatic system consuming $0.9\ m^3/min$ for 10 minutes between 828 kPa and 690 kPa before the compressor resumes operation b. what size is required if the compressor is running and delivering at $0.10 m^3/min$

Q1 Solution: Refer to Table 3.3

At 20 °C and zero bar gauge pressure, 100 m^3 of free saturated air contains 1.73 kg of water. From the definition of RH

$$\text{Relative humidity} = \frac{\text{Amount of water actually present in air}}{\text{Amount of water present in saturated air}} \times 100$$

$$70 = \frac{\text{Amount of water actually present in air}}{1.73} \times 100$$

Amount of water actually present in air = 1.211 kg

Since 400 $m^3$is delivered, water content of air entering the compressor = 1.211 × 5 =6.055 kg

From the Table 3.3, corresponding to 60 °C, and 8 bar compressor output pressure, amount of water per 100 m3 of free saturated air is given by 1.44

Since 400 m3is delivered, water content of air leaving the compressor = 1.44 × 5

=7.2 kg

Therefore the amount of water extracted from the compressor plant per hour is

7.2-6.055=1.145 kg

Q2 Solution:

Refer the nomogram given in the Figure 3.6, locate point 1 which corresponds to inlet temperature of the compressor and erect a perpendicular line to meet 60%RH line. And then draw the horizontal line to cut 6bar pressure line. We get pressure dew point temperature as 60°C. Since the air is cooled to 25 erect a vertical line to cut 6 bar pressure line. From the nomogram water liquid collected is 20.7-3.6 = 17.1 g/Nm^3

Q3 Solution:

$$p_2 = 1000 \text{ kPa(gauge)} = 1101 \text{ KPa(absoulte)}$$

$$p_1 = 101 \text{ KPa(absoulte)}$$

$$T_2 = 40°\text{C} = 40 + 273 = 313 \text{ K}$$

$T_1 = 20°C = 20 + 273 = 293\ K$

$V_2 = 2 \frac{m^3}{min},$

Using General gas law

$$\frac{p_1 V_1}{T_1} = \frac{p_2\ V_2}{T_2}$$

$$\frac{101 \times V_1}{293} = \frac{1101 \times 2}{313}$$

Solving we get $V_1 = 20.40$ standard $\frac{m^3}{min}$

Q4 Solution: The air receiver size can be determined by using the following equation

$$V_r = \frac{101\ t\ [Q_r - Q_c]}{[p_{max} - p_{min}]}$$

Part a

V_r = receiver size (m^3)

t = time that receiver can supply required amount of air , (min) = 10 min

Q_r = consumption rate of pneumatic system $\left(\text{standard} \frac{m^3}{min}\right) = 0.90\ m^3/min$

Q_c = outflow rate of compressor $\left(\text{standard} \frac{m^3}{min}\right) = 0\ m^3/min$

p_{max} = maximum pressure level in receiver (kPa) = 828 kPa

p_{min} = maximum pressure level in receiver (kPa) = 690 kPa

$$V_r = \frac{101 \times\ 10\ [0.9 - 0]}{[828 - 690]}$$

Solving we get $V_r = 6.586\ m^3$

Part b

The required size of the compressor when the compressor is running and delivering air at$0.170 m^3/min$

$$V_r = \frac{101 \times\ 10\ [0.9 - 0.10]}{[828 - 690]}$$

Solving we get $V_r = 5.855\ m^3 \cong 5.9 m^3$