# APPLIED THERMODYNAMICS (SKMM 2423)
# TEST 2 (Sem 1 2016/2017)
# 06/11/2016
# (9:00 am – 10:00 am)

## ANSWER THE QUESTIONS

**Question 1** ***(5 marks)***

a) What is the function of air compressor?

b) List two types of positive displacement air compressor and describe three different comparisons between them.

**Question 2** ***(10 marks)***

A single-stage, single-acting air compressor operates at 1000 rpm delivering air at 25 bar. Conditions at the entrance and during induction are assumed the same at 1.013 bar and 15°C, and the free air delivery (FAD) is 0.25 $m^3$/min. The clearance volume is equivalent to 3% of swept volume and the stroke/bore ratio is 1.2/1. Index of compression and expansion is 1.3.

a) Sketch and label the pressure-volume (*P-V)* diagram.

b) Calculate the size of cylinder bore and stroke, [m].

c) Calculate the volumetric efficiency, [%].

d) Determine the indicated power, [kW].

e) Calculate the isothermal efficiency, [%].

# SKMM 2423

## Test 2

### Question 1

a) The function of air compressor is to take a definite quantity of fluid and deliver it at a required pressure. — (1)

b) → 2 types → ① Reciprocating type
② Rotary or screw type. — (1)

→ Comparison.

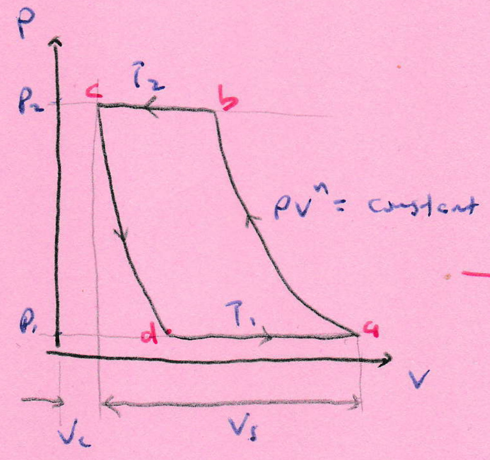
| Reciprocating | Rotary / Screw |
|---|---|
| - low mass flow rate due to pulsating operation | - High mass flow rate due to continuous operation. |
| - high pressure ratio | - Low pressure ratio |
| - high efficiency | - Low efficiency. |
| - bigger size & heavy | - Smaller size & light |
| - Complex mechanical design | - Simple mechanical design. |

any three (3) ——— (3)

Question 2



(a)




— (1)

Given:

$N = 1000$ rpm

$P_2 = 25$ bar

$P_1 = 1.013$ bar

$T_1 = 15^\circ C = 288$ K

$\dot{V} = 0.25\ m^3/min$

$V_c = 0.03 V_s$

~~B/S~~ $= 1.2 = S/B$

~~B = 1.25~~ $S = 1.2B$

$n = 1.3$

(b) for ideal gas:

$V_s = V_a - V_c$

$$\frac{V_d}{V_c} = \left(\frac{P_2}{P_1}\right)^{1/n}$$

$$\frac{V_d}{0.03 V_s} = \left(\frac{25}{1.013}\right)^{1/1.3}$$

$V_d = 0.353 V_s$ — (1)

Volume induced $= V_a - V_d$

$= V_s + V_c - V_d$

$= V_s + 0.03 V_s - 0.353 V_s$

$= 0.677 V_s$

vol. induced per stroke $= \frac{0.25}{1000} = 0.00025\ m^3$

$\therefore 0.00025 = 0.677 V_s$

$V_s = 0.000369\ m^3$ — (1)

$V_s = \frac{\pi}{4} B^2 S$

$0.000369 = \frac{\pi}{4} B^2 (1.2B)$

$B = 0.0732$ m # — (1)

$S = 1.2B$

$= 1.2(0.0732)$

$= 0.0878$ m #. — (1)

(c) Vol. Eff $= \frac{V_a - V_d}{V_s} = \frac{0.677 V_s}{V_s} = 67.7\%$ # — (1)

(d) $p\dot{V} = \dot{m}RT$

$101.3(0.25) = \dot{m}(0.287)(288)$

$\dot{m} = 0.306$ kg/min.

$$\frac{T_2}{T_1} = \left(\frac{P_2}{P_1}\right)^{\frac{n-1}{n}}$$

$T_2 = 288(25/1.013)^{0.3/1.3} = 603.5$ K (2)

$\therefore I.P = \frac{n}{n-1}\dot{m}R(T_2 - T_1) = \frac{1.3}{0.3}\,\frac{0.306}{60}(0.287)(603.5-288) = 2$ kW #

(e) Iso. power $= \dot{m}RT_1 \ln\frac{P_2}{P_1}$

$= \frac{0.306}{60}(0.287)(288)\ln\left(\frac{25}{1.013}\right)$

$= 1.353$ kW

$\therefore$ Iso. Eff $= \frac{\text{Iso Power}}{\text{Ind. Power}}$

$= \frac{1.353}{2}$

$= 67.7\%$ #

(2)