
University of Petroleum & Energy Studies, Dehradun

Examination	: End Semester Examination May 2018
Program Name	: M. Tech Chemical (PDE)
Semester	: II
Subject Name	: Plant Utilities Equipment and Systems
Duration	: 3 hrs.
Subject Code	: CHPD7017
Max. Marks	: 100
Pages	: 2

Instructions:

1. Put your Roll No. immediately on the question paper, and accompanying chart. You can show your work also on the chart.
 2. Tie the question paper and submit it along with answer script.
 3. Answer all parts of a question at one place only. Mark question number and part number clearly in the left margin. Assume data if necessary, and justify your assumptions.
 4. No student is allowed to leave exam hall in the first hour of exam.
 5. Use of unfair means will lead to immediate disqualification.
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- Q1.** How many types of cooling towers are there. Sketch one of them and explain the air and water flow arrangement. Explain what is meant by range and approach. How do you calculate blow-down and why is blow-down needed? **[10]**
- Q2.** How is the frictional flow of steam through a pipe line described? What are the principles of pipe sizing for steam.? **[10]**
- Q3.** What are the advantages of multistage compression? Show the work savings for perfect intercooling on T-S and P-V diagram and derive formula for optimum interstage pressure. **[10]**
- Q4.** Explain what is meant by cascade refrigeration. Show the cascade with help of a T-S diagram. **[10]**
- Q5.** Write a detailed note on flaring and other safety measures needed in petrochemical plants. **[10]**
- Q6.** Explain in detail the construction of and operating principles of a reciprocating compressor. Draw the T-S and P-V diagram of ideal compression process and write the expressions of work done. **[10]**
- Q7.** A single stage and single acting compressor has following parameters: **[10]**
FADM = 7 m³
Piston speed = 200 m/min
Index of compression, n = 1.25

$P_1 = 1 \text{ bar}$
 $P_2 = 7 \text{ bar}$
 Stroke length = 1.5 (bore)
 Clearance Volume = 1/18 of swept volume
 Find volumetric efficiency, stroke, bore and rpm of compressor.

Q8. From the diagram attached, answer following:

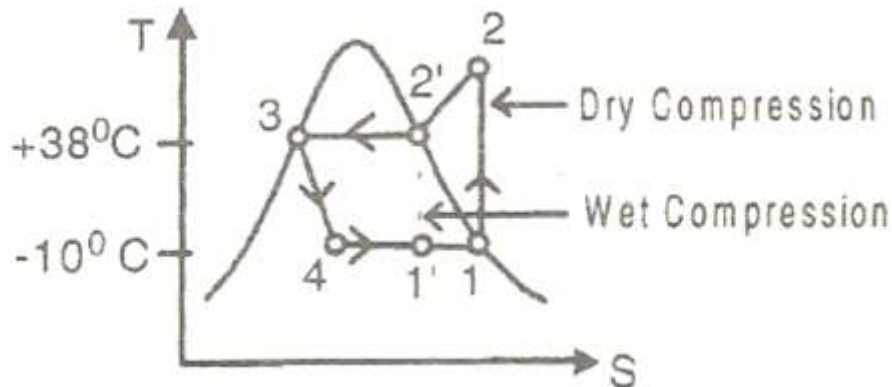
[30]

An ammonia refrigerator is working between -10°C and 38°C , and the vapor is dry at the start of the compression at point 1. There is no undercooling of liquid ammonia and the liquid is expanded through a throttle valve after the condenser. Calculate

- Power per ton of refrigeration
- Coefficient of performance
- Suction capacity of compressor.

Also calculate how are the results will be modified if the cycle starts at 1'.

Ammonia properties at -10°C and 38°C are given in the Table. Also, the C_p for liquid and vapor may be assumed to be $4.75 \text{ kJ/kg}\cdot^\circ\text{C}$ and $3.00 \text{ kJ/kg}\cdot^\circ\text{C}$ respectively.



Temperature $^\circ\text{C}$	Enthalpy kJ/kg			Entropy $\text{kJ/kg}\cdot^\circ\text{K}$		Specific Volume of vapour m^3/kg
	Latent (h_{fg})	Liquid h_f	Vapour h_g	liquid (s_f)	Vapour (s_g)	
-10	1296.47	-808.71	487.76	5.5257	10.4539	0.41949
38	1108.34	-581.57	526.77	6.3111	9.8472	0.08817