



UNIVERSITY COLLEGE TATI (UC TATI)

FINAL EXAMINATION QUESTION BOOKLET

COURSE CODE	: DTC 3183
COURSE	: PLANT OPERATIONS
SEMESTER/SESSION	: 2-2022/2023
DURATION	: 3 HOURS

Instructions:

1. This booklet contains 5 questions. Answer **ALL** questions.
2. All answers should be written in answer booklet.
3. Write legibly and draw sketches wherever required.
4. If in doubt, raise your hands and ask the invigilator.

DO NOT OPEN THIS BOOKLET UNTIL YOU ARE TOLD TO DO SO

THIS BOOKLET CONTAINS 8 PRINTED PAGES INCLUDING COVER PAGE

QUESTION 1

a) Calculate the nominal pipe wall thickness (ASME 31.3) for the following conditions. (6 marks)

- Design T = 800°F.
- Design P = 1600 psig.
- Pipe outside diameter = 15 in.
- Material: ASTM A335, Gr. P11 (1¼ Cr - ½ Mo), Seamless.
- Corrosion allowance = 0.0625 in.

Formula:
$$t = \frac{P \times D}{2(SE + PY)}$$

$$t_m = t + CA$$

$$t_{nom} = \frac{t_m}{0.875}$$

b) Estimate the class rating for a flange for the following conditions: (4 marks)

- Pipe Material: 1¼ Cr - ½ Mo
- Design Temperature: 400°F
- Design Pressure: 830 psig

c) List three (3) type of gaskets that commonly used in industry: (3 marks)

d) Give the suitable application for the following types of flanges: (3 marks)

- i. Weld neck flange.
- ii. Slip on flange.
- iii. Blind flange.

e) One of the major hazards in chemical plant is fire. Explain two (2) general methods to eliminate or reduce fire hazard. (4 marks)

QUESTION 2

- a) A pressure vessel which contains methane at the pressure of 4 atm must be shut down and somebody needs to enter it for inspection purpose.
- i. Produce the steps to prepare the confine space for safe entry of personnel. (6 marks)
 - ii. Show the requirement of O₂, LEL and toxicity for atmospheric test reading for confined space entry. (2 marks)
- b) Hydrostatic test will be conducted for heat exchanger during annual shut down to access its strength before it is placed in service.
- i. Prepare the general procedure for hydrostatic test. (5 marks)
 - ii. Calculate the hydrostatic test pressure given the design pressure of heat exchanger is 15 bar. (3 marks)
- c) Name four (4) types of non-destructive testing. (4 marks)

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QUESTION 3

- a) Sketch a diagram for a standard centrifugal pump with the following fittings and instruments: butterfly valves for suction & discharge pipe, a check valve, drains & vent valves, a strainer, flexible joints for suction & discharge pipes, and a pressure gauge. (6 marks)
- b) Demonstrate the steps to start a centrifugal pump. (6 marks)
- c) Determine the procedure to change over the operation of the operating pump to standby pump without interrupting the rest operation of the chemical process. (4 marks)
- d) Show how cavitation occurs in a centrifugal pump and explain two (2) ways to avoid cavitation. (4 marks)

QUESTION 4

- a) i. Illustrate a typical diagram for instrument air system. (5 marks)
- ii. Differentiate the use of instrument air and service air (2 marks)
- b) Chemicals are added to equipment cooling water system. Explain the function of the following chemicals to the system: biocide, caustic soda & dispersion agent. (3 marks)
- c) Refer to the process heater diagram (Figure 1), show the procedure to start up the process heater safely. (6 marks)

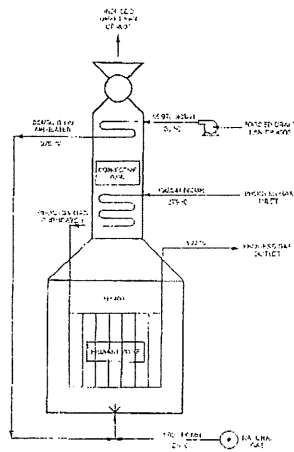


Figure 1

- d) Find the parts of the following heat exchanger (Figure 2): Shell, Fixed Tube Sheet, Channel, Nozzle, Baffle. (4 marks)

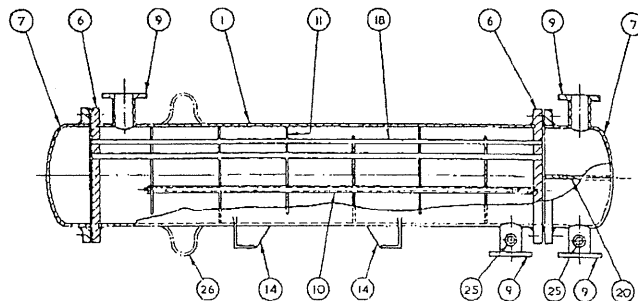


FIG. 12.3. Fixed-tube plate (based on figures from BS 3274: 1960)

Figure 2

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QUESTION 5

Please refer to the following chemical recycle plant diagram (Figure 3). The plant main feedstock is waste oil.

- Before the plant can be started up, purging must be carried out to reduce the O₂ content less than 0.5% to avoid explosion hazard inside the system. Recommend how to carry out this activity. (4 marks)
- To avoid explosion hazard outside the system, leak test or tightness must be carried out. Explain this activity in detail. If leak is found, what action must be taken? (3 marks)
- All the above are parts of activities prior to start up. Decide three (3) more activities before startup. (3 marks)
- Prepare in detail the startup activities of the dehydration unit after all activities prior to start up have been carried out. The aim of the unit is to reduce water content in waste oil less than 0.5% volume at the outlet of Flash Drum (V-201). (10 marks)

Normal operation condition in V-201:

- Pressure: 3.3 barg & Temperature: 176°C
- Condenser (EA-502) consists of 2 fans for cooling purpose
- Reboiler (E-201) use therminol 66 for heating purpose

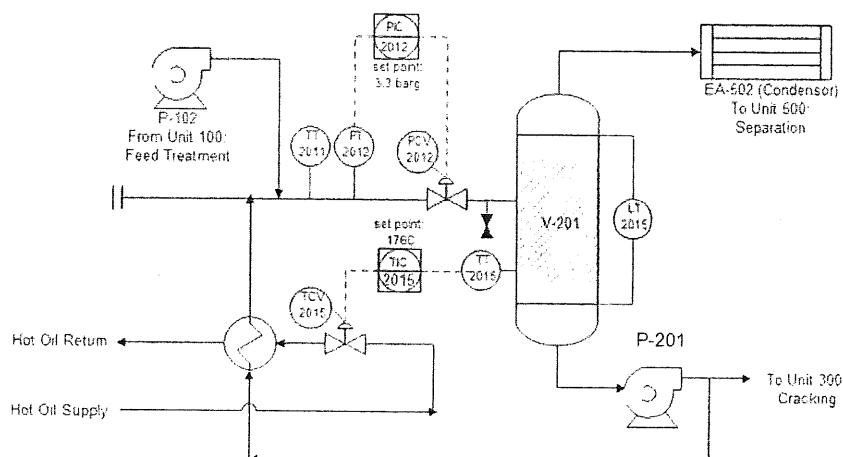


Figure 3

-----End of question-----

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APPENDIX

Material	Spec. No./Grade	Basic Allowable Stress S, ksi. At Metal Temperature, °F.														
		100	200	300	400	500	600	700	800	900	1000	1100	1200	1300	1400	1500
Carbon Steel	A 106 B	20.0	20.0	20.0	20.0	18.9	17.3	16.5	10.8	6.5	2.5	1.0				
C - ½Mo	A 335 P1	18.3	18.3	17.5	16.9	16.3	15.7	15.1	13.5	12.7	4.	2.4				
1¼ - ½Mo	A 335 P11	20.0	18.7	18.0	17.5	17.2	16.7	15.6	15.0	12.8	6.3	2.8	1.2			
18Cr - 8Ni pipe	A 312 TP304	20.0	20.0	20.0	18.7	17.5	16.4	16.0	15.2	14.6	13.8	9.7	6.0	3.7	2.3	1.4
16Cr - 12Ni-2Mo pipe	A 312 TP316	20.0	20.0	20.0	19.3	17.9	17.0	16.3	15.9	15.5	15.3	12.4	7.4	4.1	2.3	1.3

Spec. No.	Class (or Type)	Description	E _i
Carbon Steel			
API	...	Seamless pipe	1.00
5L	...	Electric resistance welded pipe	0.85
	...	Electric fusion welded pipe, double butt, straight or spiral seam	0.95
		Furnace butt welded	
A 53	Type S	Seamless pipe	1.00
	Type E	Electric resistance welded pipe	0.85
	Type F	Furnace butt welded pipe	0.60
A 106	...	Seamless pipe	1.00
Low and Intermediate Alloy Steel			
A 333	...	Seamless pipe	1.00
	...	Electric resistance welded pipe	0.85
A 335	...	Seamless pipe	1.00
Stainless Steel			
A 312	...	Seamless pipe	1.00
	...	Electric fusion welded pipe, double butt seam	0.85
	...	Electric fusion welded pipe, single butt seam	0.80
A 358	1, 3, 4	Electric fusion welded pipe, 100% radiographed	1.00
	5	Electric fusion welded pipe, spot radiographed	0.90
	2	Electric fusion welded pipe, double butt seam	0.85
Nickel and Nickel Alloy			
B 161	...	Seamless pipe and tube	1.00
B 514	...	Welded pipe	0.80
B 675	All	Welded pipe	0.80

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Materials	Temperature, °F					
	900 & lower	950	1000	1050	1100	1150 & up
Ferritic Steels	0.4	0.5	0.7	0.7	0.7	0.7
Austenitic Steels	0.4	0.4	0.4	0.4	0.5	0.7
Other Ductile Metals	0.4	0.4	0.4	0.4	0.4	0.4
Cast iron	0.0

Material Groups		Product Forms					
Material Group Number	Nominal Designation Steel	Forgings		Castings		Plates	
		Spec. No.	Grade	Spec. No.	Grade	Spec. No.	Grade
1.1	Carbon	A105	--	A216	WCB	A515	70
		A350	LF2	--	--	A516	70
		--	--	--	--	A537	C1.1
1.2	Carbon	--	--	A216	WCC	--	--
		--	--	A352	LCC	--	--
		--	--	A352	LC2	A203	E
	2½ Ni	--	--	A352	LC3	A203	E
	3½ Ni	A350	LF3	A352	LC3	A203	E
1.9	1Cr - ½Mo	A182	F12	--	--	--	--
	1¼ Cr - ½Mo	--	--	A217	WC6	--	--
	1¼ Cr - ½Mo - Si	A182	F11	--	--	A387	11
1.10	2¼ Cr - 1Mo	A182	F22	A217	WC9	A387	22

Material Group No.	1.8			1.9			1.10		
	150	300	400	150	300	400	150	300	400
Classes									
Temp., °F									
-20 to 100	235	620	825	290	750	1000	290	750	1000
200	220	570	765	260	750	1000	260	750	1000
300	215	555	745	230	720	965	230	730	970
400	200	555	740	200	695	885	200	705	940
500	170	555	740	170	695	805	170	665	885
600	140	555	740	140	605	785	140	605	805
650	125	555	740	125	590	785	125	590	785
700	110	545	725	110	570	710	110	570	755
750	95	515	685	95	530	675	95	530	710
800	80	510	675	80	510	650	80	510	675
850	65	485	650	65	485	600	65	485	650
900	50	450	600	50	450	425	50	450	600
950	35	320	425	35	320	290	35	375	505
1000	20	215	290	20	215	190	20	260	345