Name:

Enrolment No:

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, MAY 2021

Course: Pipeline Transportation of Oil and Gas | **Semester: VIII**

Program: B. Tech. APE (Gas Engineering) | **Time 03 hrs.**

Course Code: CHGS3007P | **Max. Marks: 100**

Instructions: Attempt All Questions

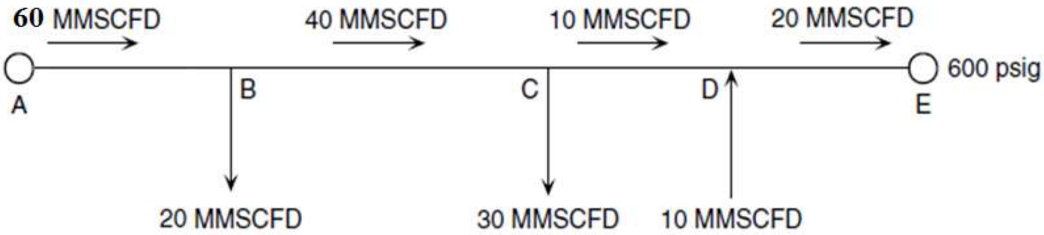
SECTION A

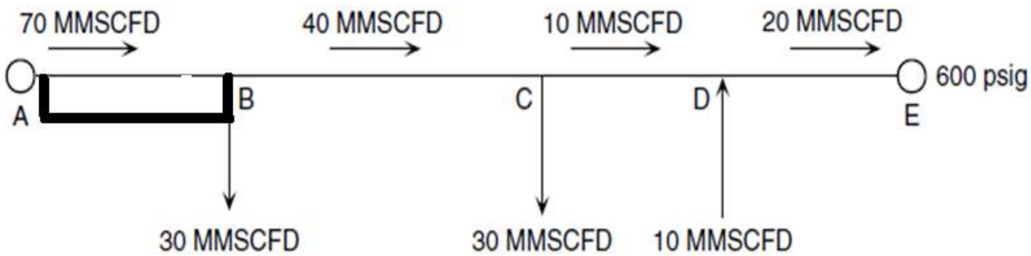
S. No.	ATTEMPT ALL QUESTIONS- APPENDIX ON PAGE NO. 5-7 (5*6=30 MARKS)	Marks	CO
Q.1	Illustrate the term best efficiency point in Centrifugal pumps.	5	CO1
Q.2	Explain the term compressor ratio. What is the recommended values for compressor ratio for reciprocating and centrifugal compressors?	5	CO4
Q.3	Discuss the term 'Class Location 'for cross- country pipelines.	5	CO1
Q.4	Describe 'Affinity Law' for centrifugal pumps.	5	CO3
Q.5	Explain the difference between "Break Horse Power" and "Horse Power" in compressor stations.	5	CO2
Q.6	Explain hydrostatic test pressure in pipelines	5	CO4

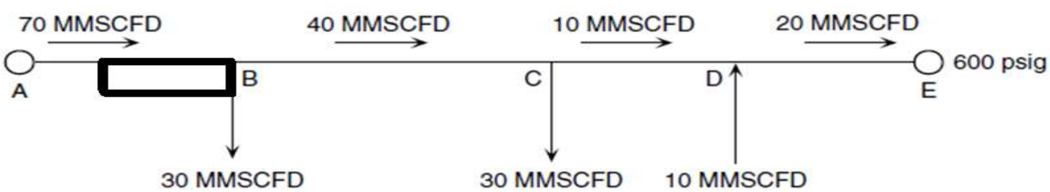
SECTION B
(ATTEMPT ALL QUESTIONS)

Q.7	(a) Explain the advantages of pipeline transportation over other transportation modes (5 crucial points to be mentioned) (b) Discuss the term "Adiabatic efficiency".	10	CO2
Q.8	Calculate the blended viscosity obtained by mixing 20% of liquid A with a viscosity of 10 cSt and 80% of liquid B with a viscosity of 30 cSt at 70°F.	10	CO5
Q.9	(a) Illustrate the term 'Hydraulic Balance in compressors'. (b) Explain the purpose of using 'Mainline valves' in pipeline.	10	CO4
Q.10	Explain SCADA system in pipeline network system	10	CO3
Q.11	Explain in short the pipeline laying activities	10	CO2

SECTION-C **(ATTEMPT ANY ONE QUESTION)** **MISSING DATA ARE TO BE SUITABLY ASSUMED**			
Q.12	A pipeline from origin station A to delivery point B is 48 miles long and is 18 inch in nominal diameter, with a 0.281 inch wall thickness. It is constructed of 5LX-65 grade steel. At origin station A, crude oil of specific gravity 0.85 and 10 cSt viscosity enters the pipeline at a flow rate of 6000 bbl./hr. At first intermediate station C (milepost 22) a new stream of crude oil with a specific gravity of 0.82 and 3.5 cSt viscosity enters the pipeline at a flow rate of 1000 bbl./hour. The mixed stream then continues to another intermediate station D (milepost 32) where 3000 bbl./hour is stripped off the pipeline. The remaining volume continues to the end of the pipeline at delivery station B. **(a)** Evaluate the pressure required at origin station A and the composition of the crude oil arriving at terminus B at a minimum delivery pressure of 50 psi. Assume elevations at A, C, D, and B to be 100, 150, 250, and 300 feet, respectively. Use the Modified Colebrook-White equation for pressure drop calculations and assume a pipe roughness of 0.002 in. **(b)** Calculate the pump HP required to maintain this flow rate at A, assuming 50 psi pump suction pressure at A and 80% pump efficiency? **(c)** If a positive displacement (PD) pump is used to inject the stream at C, solve for pressure and HP are required at C?	**20**	**CO5**
Q13	In a gas distribution pipeline, 60 MMSCFD enters the pipeline at A, as shown in Figure. If the delivery at B is increased from 20 MMSCFD to 30 MMSCFD by increasing the inlet flow at A, keeping all-downstream flow rates the same, ***calculate the looping necessary if entire length AB is looped to ensure pressures are not changed throughout the pipeline***. Pipe AB is NPS 14, 0.250 in. wall thickness; BC is NPS 12, 0.250 in. wall thickness;	**20**	**CO3**







Pipe CD is NPS 10, 0.250 in. wall thickness; and DE is NPS 12, 0.250 in. wall thickness. The delivery pressure at E is fixed at 600 psig. The pipe lengths are as follow: AB = 12 miles; BC = 18 miles; CD = 20 miles; DE = 8 miles

The gas gravity is 0.60, and the flow temperature is 60°F. The compressibility factor and transmission factor can be assumed to be 0.85 and 20, respectively, throughout the pipeline. The base pressure and base temperature are 14.7 psia and 60°F, respectively. Also, calculate the loop length if a particular length of AB is looped with a diameter of 10 NPS and 0.25-inch wall thickness.

NPS12=12.75 inches; NPS10= 10.75 inches.

APPENDIX

All Notations have their usual meaning and units

1. Frictional Pressure drop equation in oil pipelines

$$Pm = 0.0605fQ^2(Sg/D^5)$$

2. Pressure drop equation for gas pipelines

$$Q = 77.54\left(\frac{T_b}{P_b}\right)\left(\frac{P_1^2 - P_2^2}{GT_f LZf}\right)^{0.5} D^{2.5}$$

3. Reynolds Equation for Gas Pipelines

$$\mathrm{Re} = 0.5134\left(\frac{P_b}{T_b}\right)\left(\frac{GQ}{\mu D}\right) \quad \text{(SI)}$$

$$\mathrm{Re} = 0.0004778\left(\frac{P_b}{T_b}\right)\left(\frac{GQ}{\mu D}\right) \quad \text{(USCS)}$$

4. Reynolds No. for Crude Oil Pipelines

a) **R=92.24 Q/ (ν D)**

Where: Q=Flow rate, bbl/day; D=Internal diameter, in.; ν = Kinematic viscosity, cSt

b) **R=353,678 Q/(νD)**

Where: Q=Flow rate, m^3/hr.; D=Internal diameter, mm; ν= Kinematic viscosity, cSt

D=Pipe internal diameter, in.

5. Modified Colebrook White Equation

$$\frac{1}{\sqrt{f}} = -2\log_{10}\left(\frac{e}{3.7D} + \frac{2.825}{\mathrm{Re}\sqrt{f}}\right)$$

6. Coversion Equations for SSU to Centistokes

$$Centistokes = 0.226(SSU) - \frac{195}{SSU} \qquad 32 \le SSU \le 100$$

$$Centistokes == 0.220(SSU) - \frac{135}{SSU} \qquad SSU \succ 100$$

7. Horsepower required to compress gas in compressor

$$HP = 0.0857\left(\frac{\gamma}{\gamma-1}\right)QT_1\left(\frac{Z_1+Z_2}{2}\right)\left(\frac{1}{\eta_a}\right)\left[\left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}-1\right]$$

8. Adiabatic Efficiency of Compressor

$$\eta_a = \left(\frac{T_1}{T_2-T_1}\right)\left[\left(\frac{z_1}{z_2}\right)\left(\frac{P_2}{P_1}\right)^{\frac{\gamma-1}{\gamma}}-1\right]$$

9. BHP required to pump the liquid $$BHP = \frac{QP}{2449E}$$

Q = flow rate (barrel per hr.) **P** = Differentia pressure (psi)

10. Equivalent diameter equation

$$D_e = D_1\left[\left(\frac{1+Const}{Const}\right)^2\right]^{1/5} \qquad Const = \sqrt{\left(\frac{D_1}{D_2}\right)^5\left(\frac{L_2}{L_1}\right)}$$

11. Head to pressure conversion:

$$Head = \frac{2.31psig}{G}(USCS)$$

12. Specific gravity of blended liquids

$$S_b = \frac{Q_1 S_1 + Q_2 S_2 + ...Q_n S_n}{Q_1 + Q_2 + ...Q_n}$$

13. Viscosity of blended liquids

$$\sqrt{v_b} = \frac{Q_1 + Q_2 + Q_3....}{\left(\frac{Q_1}{\sqrt{v_1}} + \frac{Q_2}{\sqrt{v_2}} + \frac{Q_3}{\sqrt{v_3}}.....\right)}$$