Roll No: ----------

UNIVERSITY OF PETROLEUM AND ENERGY STUDIES

End Semester Examination, May 2019

Program	**:**	**B. Tech (APEG)**	**Semester**	**:**	**VI**
Subject (Course)	**:**	**Natural Gas Processing**	**Max. Marks**	**:**	**100**
Course Code	**:**	**PTEG 363**	**Duration**	**:**	**3 Hrs**
No. of page/s	**:**	**6**			

Instructions:

1. All questions are compulsory and marks of each question are indicated against each question.
2. Neat diagrams must be drawn wherever necessary.
3. All the related data figures are attached with the question paper.

Section-A			
S. No.		**Marks**	**CO**
1.	a) What is fugacity? b) Write the procedure to find the water content of natural gas using Equation of state method.	**(2)+(4)**	**CO1**
2.	What are the design variables for the adsorption dehydration processes?	**(6)**	**CO1**
3.	Write the generalized chemical reaction involved during absorption in Alkanol-Amine processes.	**(6)**	**CO2**
4.	What is retrograde condensation? Explain its relevance for NGL recovery processes.	**(6)**	**CO3**
5.	Why membrane separation process is to be preferred over other NGL production processes?	**(6)**	**CO3**

Section-B			
6.	Explain the regeneration cycle of the adsorption dehydration plant with the help of typical temperature-time curve.	**(10)**	**CO1**
7.	A glycol dehydrator plant is to be designed for handling 13.5 MMscfd of the sour gas (N_2 = 8.5%, H_2S = 5.4%, CO_2 = 0.5%, C_1 = 77.6%, C_2 = 5.8%, C_3 = 1.9%, n-C_4 = 0.1%, i-C_4 = 0.1%, i-C_5 = 0.1%). The glycol circulation rate is 4 gal TEG/lb water, lean glycol concentration is 99 %, glycol specific gravity is 1.10, inlet gas temperature is 120^0F, and the absorption tower uses bubble-cap trays. For an exit water content of 10 lb/MMscf gas, determines the followings: a) Maximum gas rate that can flow in the system. b) The actual number of trays needed in the contactor.	**(10)**	**CO1**
8.	Which of the sweetening processes hold the most promising future? Why?	**(10)**	**CO2**
9.	a) What are the main differences in absorption dehydration and adsorption sweetening plants? b) Write the composition of Stretford solution and the importance of each element in the Stretford solution used for gas sweetening.	**(4) + (6)**	**CO2**
10.	Draw and explain the cryogenic refrigeration process used for NGL recovery.	**(10)**	**CO3**
Section-C			
11.	a) Mention three application of using natural gas as a feedstock. b) Write five synthesis gas production technologies. c) Draw the process flow diagram of Haber-Bosch process.	**(3)+(5)+(12)**	**CO4**

Figure 1: The Mcketta-Wehe correlation for water content of natural gases

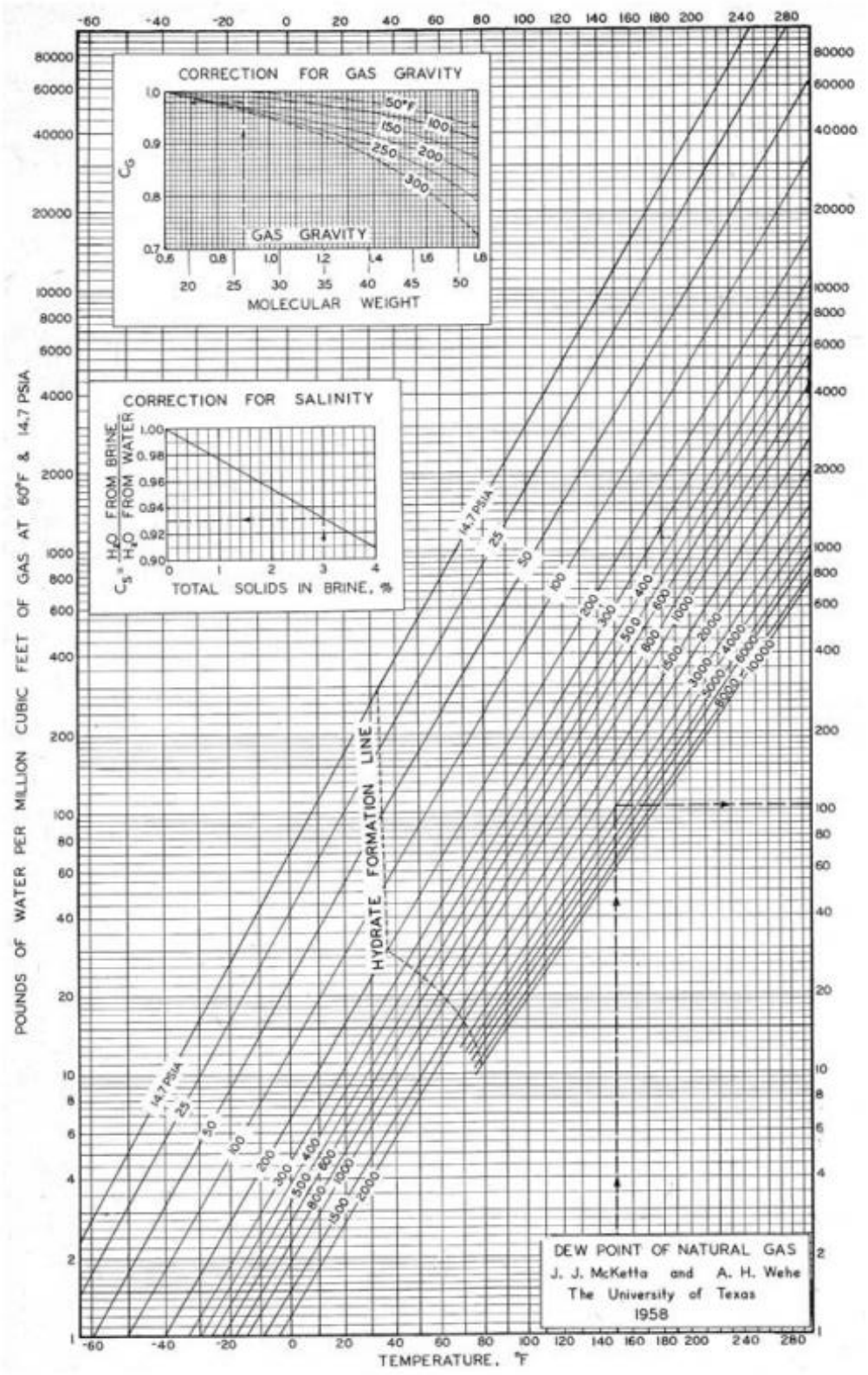


Figure 2: Gas capacity for trayed glycol gas contactor based on 0.7 specific gravity, at 100^0F.

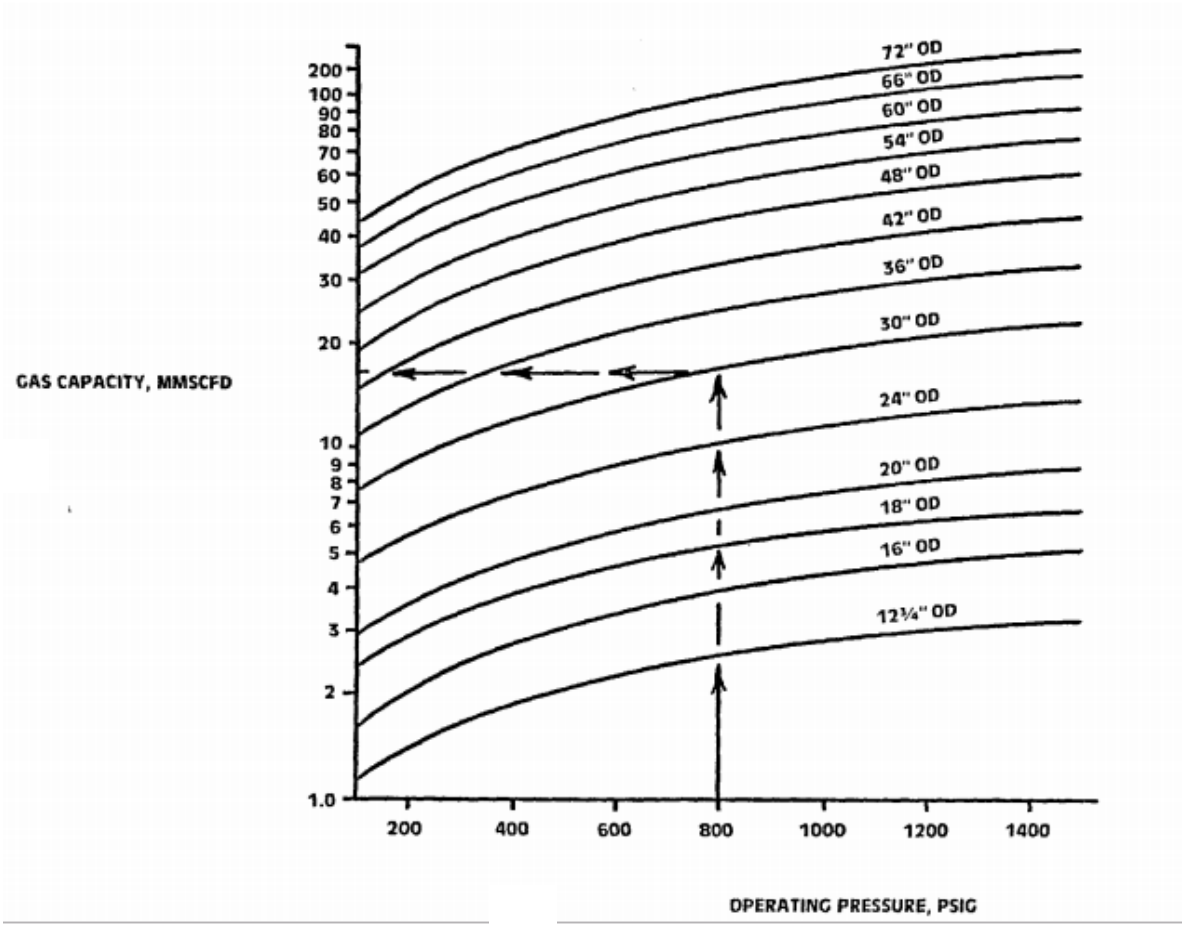


Figure 3: Gas capacity correction factors for trayed glycol-gas contactors

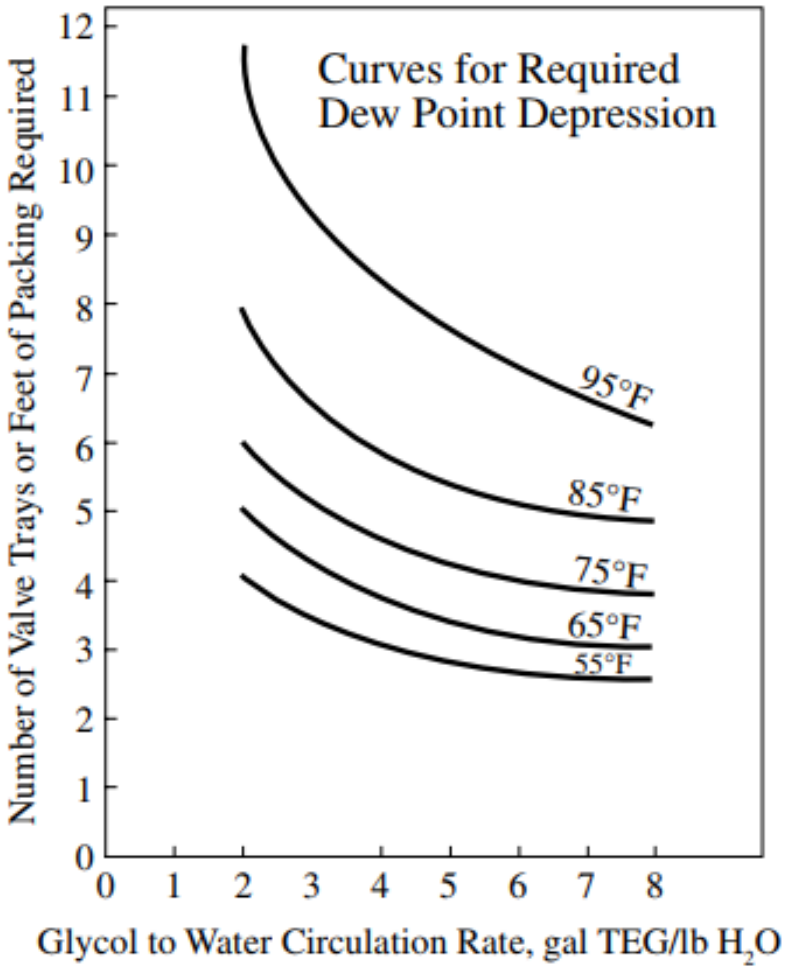
TEMPERATURE CORRECTION FACTORS, C_t

Operating Temperature °F	Correction Factor C_t
40	1.07
50	1.06
60	1.05
70	1.04
80	1.02
90	1.01
100	1.00
110	0.99
120	0.98

SPECIFIC GRAVITY CORRECTION FACTORS C_g

Gas Specific Gravity	Correction Factor C_g
0.55	1.14
0.60	1.08
0.65	1.04
0.70	1.00
0.75	0.97
0.80	0.93
0.85	0.90
0.90	0.88

Figure 4: Trays or packing required for glycol dehydrators



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Section-A			
S. No.		**Marks**	**CO**
1.	Write the steps followed to find the hydrate formation temperature using Katz et al. method.	**(2)+(4)**	**CO1**
2.	What are the process variables that must be considered for designing adsorption dehydration plant?	**(6)**	**CO1**
3.	List all the step chemical reactions that takes place in carbonate process.	**(6)**	**CO2**
4.	Why fractionation play an important role in NGL production?	**(6)**	**CO3**
5.	Write the selection criterion of NGL recovery processes	**(6)**	**CO3**
Section-B			
6.	Explain the regeneration cycle of the adsorption dehydration plant with the help of typical temperature-time curve.	**(10)**	**CO1**

7.	A glycol dehydrator plant is to be designed for handling 14 MMscfd of the sour gas (N_2 = 8.5%, H_2S = 5.4%, CO_2 = 0.5%, C_1 = 77.6%, C_2 = 5.8%, C_3 = 1.9%, n-C_4 = 0.1%, i-C_4 = 0.1%, i-C_5 = 0.1%). The glycol circulation rate is 4 gal TEG/lb water, lean glycol concentration is 99 %, glycol specific gravity is 1.0, inlet gas temperature is 120^0F, and the absorption tower uses bubble-cap trays. For an exit water content of 10 lb/MMscf gas, determines the followings: a) Maximum gas rate that can flow in the system. b) The actual number of trays needed in the contactor.	**(10)**	**CO1**
8.	a) Write chemical reactions involved in sponge iron process and Alkanolamine process? b) List the different Claus process configuration with reference to H_2S mole % in acid gas.	**(6) + (4)**	**CO2**
9.	a) How the activity of hot potassium carbonate solution can be increased? b) What is a LO-CAT process? Write the chemical reactions involved in the process.	**(5) + (5)**	**CO2**
10.	Draw and explain the internal refrigeration process used for NGL recovery.	**(10)**	**CO3**
Section-C			
11.	a) Explain the reason of preferring natural gas as a feedstock. b) Mention three synthesis gas production technologies. c) Write the significance of shift conversion in Haber Bosch process. d) Draw the block diagram of ammonia production from natural gas. e) Write the steps followed in steam cracking process for ethylene production from ethane and propane.	**(2)+(3)+ (6)+(6)+ (3)**	**CO4**

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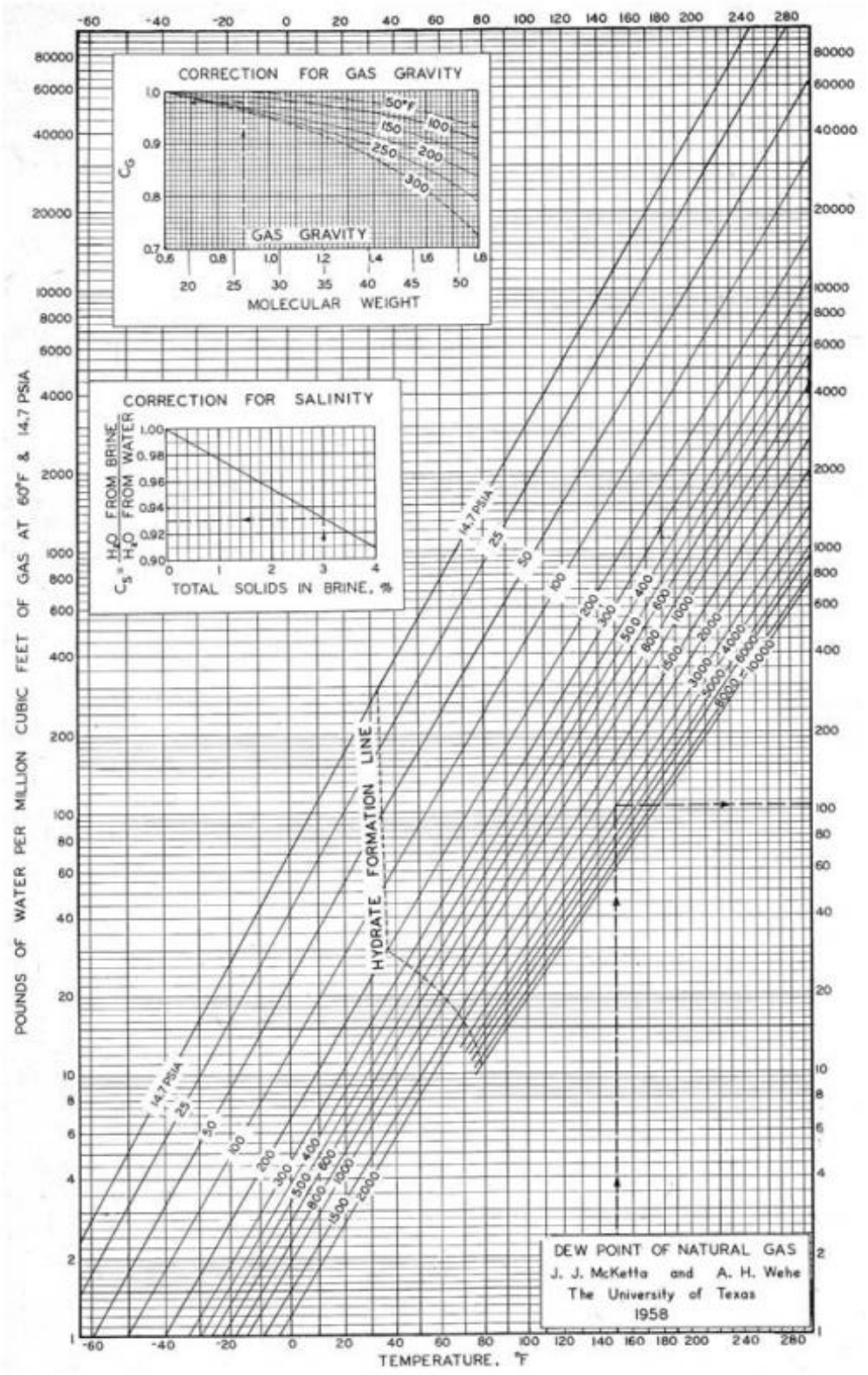

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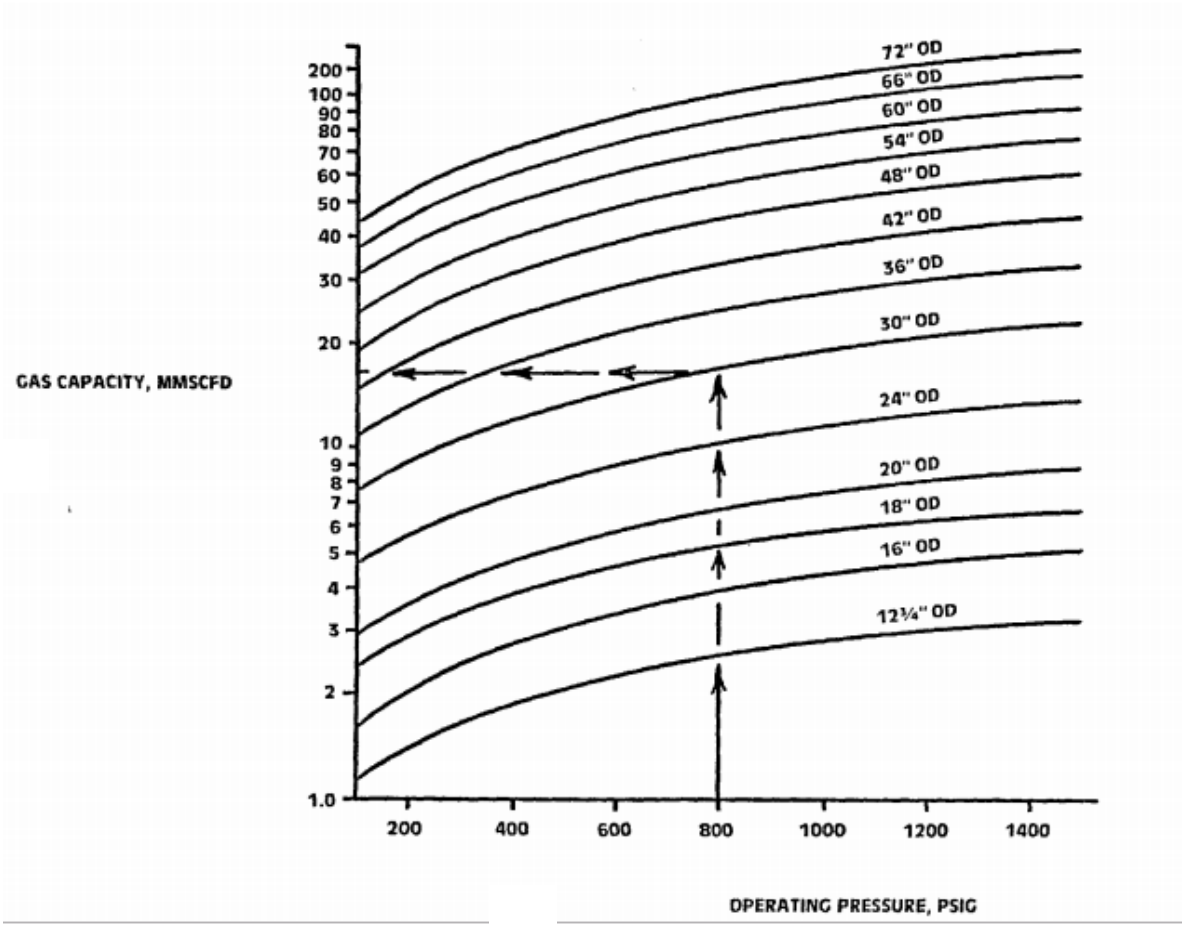

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