Alexandria University | جامعة الإسكندرية
Faculty of Engineering | كلية الهندسة
Chemical Engineering Department | قسم الهندسة الكيميائية

Mechanical Unit Operations | العمليات المشتركة الميكانيكية
Fourth Year | الفرقة الرابعة
Time: Three Hours | الزمن: ثلاث ساعات
Date: 11/1/2016 | التاريخ: ٢٠١٦/١/١١

Final Examination

Answer the following questions: (Total degrees = 5 x 18 = 90)

1-a) What is meant by the following:

i) Friability
ii) Form drag
iii) Pneumatic conveying
iv) The Pug mill
v) Screen interval.

b) A filtration carried out for 15 min. at a constant rate in a leaf filter is continued as constant pressure afterwards. If one-fourth of the total volume of the filtrate is collected during the constant rate period, find the total filtration time, assuming a negligible filter medium resistance and an incompressible cake.

2-a) " Separation of particles or droplets is often facilitated by first effecting an increase in the effective size of the individual particles by causing them to agglomerate or coalesce, and then separating the enlarged particles ". Comment clearly on this statement with the aid of neat diagrams.

b) Deduce a mathematical expression for determining the volume of liquid contained in a batch centrifuge basket.

c) Particles of 5 cm diameter are crushed to 2 cm diameter in a pair of crushing rolls. If the angle of nip is 32° , find the roll diameters.

3-a) Write short notes on the following:

i) Characteristics of fluidized systems.
ii) The hindered settling in the hydraulic jig.
iii) Methods of removing the filter cake from the rotary drum filter.

b) Give reasons for each of the following:

i) The Dorr classifier is extensively used in conjunction with ball mills.
ii) The operation of Tandem-type trommel is not so efficient as that of a series of simple trommels, or a compound trommel.
iii) The closed circuit grinding system is considered as a preferable method for operating crushers.
iv) In some cases, the operation of the cyclone separator can be improved by running a stream of water down the walls.

ALEXANDRIA UNIVERSIRT

FACULTY OF ENGINEERING

CHEMICAL ENGINERRING DEPARTMENT

PETROLEUM REFINING ENGINEERING JANUARY 2016

BSC STUDENTS FINAL EXAM 3 HOURS

ANSWER ALL QUESTIONS:

A)1) Discuss briefly the following: importance of: pour point for crudes, freezing point & smoke point for jet fuels, viscosity for gas oil, viscosity index for lubricating oils, flash point for petroleum products, differences between gasoline engine & diesel engine (8x1.5 =12 points)

2) How can you tell that coke is starting to be formed inside furnace tubes?

3) Idea of vacuum production by steam jet ejector

4) The different types of vacuum tower operation (wet, dry & damp)

5) Effect of pressure inside the tower on its diam

6) Effect of API of crude on its desalting conditions (temp & amount of water)

7) Types of emulsions & how to break an emulsion

8) Effect of S content of crude on the S content of its fractions

9) Cetane number & octane number

10) Application of bouancy in our life (bouancy force)

11)Barometric condensers and surface condensers

12) Function of side-stream strippers in atmospheric distillation unit

13) Reforming as a good source of hydrogen (12x2.5 = 30 pts)

B) Gas oil (API = 37 & C_p = 2 kJ/kg ° C) is fed to a heat exchanger at 340°C to be cooled down to 70° C by cold water (C_p = 4.2 kJ/kg ° C) fed at 20° C & comes out at 60° C. If the feed rate of the gas oil is 20,000 BPD (barrels/day, 1 barrel = 200 lit), calculate the feed rate of water (ton/h) (8 points)

C) n-hexane (C6H14) is fed at the rate of 600 tons/day to a reforming unit (conversion is only 60% complete), calculate:

a) Product composition in mole%

b) Production rate of H2 gas (m^3/h) (assume products are all gases at 15 atm & 320° C (R = 0.082 lit atm/g mole °C) (9 points)

D) Gasoline (API = 76, average molecular wt = 88) is being produced at the rate of 12,000 BPD from the top of an atmospheric distillation tower at 32° C. If the max allowable vapor velocity at top of that tower is 4m/min, calculate the min tower diam in this case (8 points)

E) A fixed bed catalytic cracking process is using a catalyst with the following data: bulk density = 400 kg/m^3, D = 3 m & H =8 m, life time = 400 hrs. The feed to this process is a gas mixture (av mol wt = 180, 14 atm & 280° C) fed at the rate of 150 m^3/h, calculate catalyst/charge ratio (8 points)

BEST OF LUCK!!!

PROF DR HASSAN FARAG

Alexandria University **Faculty of Engineering** **Fourth Year**		جامعة الإسكندرية كلية الهندسة

January 2016 — يناير 2016

Chemical Process Industries — صناعات العمليات الكيميائية

F I N A L E X A M — امتحان نهائي

Time allowed: 3 Hours — الزمن: 3 ساعات

Part I : Inorganic Industries

Answer all questions:

Question 1

a. Illustrate by chemical equations only the mechanism for the catalysis leading to ammonia.

b. Comment on the following statements:

i) A too high space velocity is not recommended in ammonia synthesis.

ii) Although there are many sources of CO_2 , three are the most important for commercial production.

iii) One of the reversible reactions long used for the concentration of carbon dioxide is:

$$Na_2CO_3 + CO_2 + H_2O \dashrightarrow 2\ NaHCO_3$$

Question 2

a. Write briefly on the following:

i)Purification of CO_2 produced from fermentation processes.

ii) Methods of production of hydrogen

iii) Discuss the factors affecting converting the carbon monoxide according to the equation:

$$CO + H_2O \dashrightarrow CO_2 + H_2 \qquad \Delta H = -36.6\ kJ$$

b. Draw a flow diagram showing the manufacture of chlorine by electrolysis of brine.

Question 3 :

a. Draw a simplified flow diagram for the contact sulfuric acid process.

b. Comment on the temperature of transort of liquid sulfur.

c. Compare between the different raw materials for sulfuric acid manufacture.

d. Explain the use of 98-99% H_2SO_4 and not pure water in absorption of SO_3.

e. Explain the advantages of spray burner over rotary burner in sulfur burning.

Question 4 :

a. Discuss the integration between H_2SO_4 manufacture and power generation in sulfuric acid plants with reference to the new chemical complex at Fayoum.

b. Drive the relation between K_p and degree of conversion for the conversion of SO_2 to SO_3. Discuss the factors affecting degree of conversion.

ALEXANDRIA UNIVERSITY

FUCULTY OF ENG INEERING

CHEMICAL ENGINEERING DEPARTMENT

Chemical Process industries

Fourth year

January 2016

Time : one hour and half

Answer the following questions:

Note- chemical equation and chemical structure is necessary :

1_ Define the following, illustrate your answers with chemical reactions and chemical Structure whenever possible.

i-Spent acid in case of nitration and sulfonation.

ii- Solubilized Vat dye (Indigosole dye).

iii- Shape retention of synthetic fibers.

iv-Elastomer.

v-Direct dye.

Vi-Nylon salt.

2-Give reasons for the following:

i-Branched dodecyle benzene is not suitable for synthesiss of detergent.

ii-Bleeding of dyed fabrics on using it.

iii- Nylon fibers are known with Polyamide Fibers.

iv- Mixing of polyester with cotton or wool.

v-Ozone cracking of rubber.

vi-On dyeing with reactive dye a certain percent of direct dye is present.

3-Write short notes on two of the following:

i-Dyeing of polyester fibers.

ii-Role of carbon black in rubber tyers.

iii- Methods of spinning of synthetic fibers.

Alexandria University
Faculty of Engineering

Chemical Engineering Depertment
December, 2015

جامعة الإسكندرية
كلية الهندسة

قسم الهندسة الكيمائية
ديسمبر ٢٠١٥

Natural Gas Engineering
Fourth year
Time allowed: 60 minutes CHE 414

هندسه الغاز الطبيعى
الفرقه الرابعه
الزمن : ٦٠ دقيقة

Answer ALL the following questions

1. Answer the following: (25 marks)

I. Discuss briefly using sketch whenever possible

1) Mist Extraction or Coalescence Section.
2) Liquid Accumulator Section
3) LNG storage tanks
4) Re-gasification LNG
5) Cascade refrigeration cycle

II. Compare between:

1) Refrigeration, Cryogenics, Chilling
2) Methods used for chilling natural gas
3) Methods used to remove oil from gas in separators
4) Methods used to remove gas from oil in separators

III. Select type of glycol in the following conditions for dehydration showing your reason

1) Natural gas transmission in which recovery is not important
2) Injected glycol contacts hydrocarbon liquids
3) Severe vapor losses and injected glycol contacts hydrocarbon liquids

IV. What are the problems caused by the following contaminants in dehydration system

1) Free Water
2) Oils or Hydrocarbons
3) Brine
4) Solids
5) Downhole Additives

V. Answer the following

1) What is the composition of hydrate?
2) What are the Advantages and Disadvantages of Downhole Regulators?
3) What are the Advantages and Disadvantages of *Indirect Heaters*?
4) How you select glycol injection nozzle? And its location choice?
5) What are Propane Refrigeration Problems?

VI. What is the function of the following

1) Straightening Vanes
2) Float Shield
3) Water Jets and Sand Cones

Solve the following problems

1. A casing annulus is filled with gas under the following conditions: Gas gravity = 0.65 V=1500 ft^3 P_{av}=1000 psia T_{av}=200°F How much gas in standard cubic feet, must be removed to drop the pressure to 800 psia? Assume gas behaves as a perfect gas. **(5 marks)**
2. Two adsorbents are used in the dehydration of natural. The feed gas containing 0.5% water went to complete dryness. The bed is packed with granules of Activated alumina of particle diameter of 0.13 in and the bulk density is 42.5 lbm/ft^3. For rate of 10^5 ft^3/min of the feed gas at 100°F and atmospheric pressure, calculate: **(10 marks)**
   a. Amount of Activated alumina used.
   b. If you use molecular sieve, what will be the amount used.
   c. Bed dimensions. For each case
   d. Pressure drop across the bed For each case

Data
Gas molecular weight = 27 g/gmol
Gas viscosity = 0.02782 lb/hr
Permeability coefficient of the bed = 10^{-7} ft^2
$U=B(\Delta P/\mu L)$

3. A natural gas containing H_2S is to be treated using pure MEA ($HOCH_2CH_2NH_2$, S.G.=1.015) fed to the top of a plate absorption tower containing 10 actual plates (overall plate efficiency is 30%), Y_e= 0.5X, L_m/G_m=1.15, and H_2S mole fraction in the outlet gas from the tower top is 0.001. Find graphicaly the mole fraction of H_2S in the feed stream. If MEA feed rate was 200m^3/h, H_2S -N.G. mixture is at 1.1 atm, 30°C (R=0.082 atm.liter/(mole.K)) and the maximum allowable gas velocity in the tower is 1.5 m/s, calculate minimum tower diameter. (Recalculate if the H_2S was substituted by CO_2 under same conditions and all flow rates and concretions) **(10 marks)**

4. Use the inlet conditions and the outlet pressure supplied in the following table to compute
   a. The outlet temperature and work generated per lb of gas inlet. Assume the gas is pure methane, use P-H diagram. **(5 marks)**
   b. COP of the cycle
      i. Perform Calculations if turbo expander used for expansion **(5 marks)**
      ii. Perform Calculations if J-T is used over same pressure drop and inlet temperature. **(5 marks)**

	Expander	Compressor
Inlet flow rate lb/hr (kg/hr)	221000 (100243)	208000 (94347)
Inlet gas rate, MMscfd ($MMSm^3$/d)	115.6 (3.27)	115.2 (3.26)
Molar mass	17.46	16.5
Inlet pressure, psia (bar)	1080 (74.5)	470 (32.4)
Inlet temperature °F (°C)	-50 (-46)	60 (16)
Outlet pressure, psia (bar)	30 (2.1)	576 (39.7)
Outlet temperature °F (°C)	-113.6 (-80.9)	93.5 (34.2)
Liquid formation, wt%	19.3	-
Efficiency, %	83	74
Speed, rpm	22000	22000
Power, bhp (bkW)	1380 (1029)	135007)

5. It's required to calculate the actual number of plates of a tray tower absorber for the purpose of dehydration of a natural gas. **(10 marks)**

The following data are available:

- Assume a natural gas stream saturated with water vapor at 500 psia and 90°F.
- The aim of the dehydration is to reduce the water content to 10 lb/MMscf and the dew point to 28°F.
- TEG will be used as a solvent and will be provided from the regenerator at maximum possible concentration as determined by its operation conditions:
  1. Atmospheric pressure operation.
  2. Maximum allowable reboiler temperature 400°F.
- The circulation rate of the glycol in the absorption tower will be taken as 4 gal/lb water absorbed.
- The Murphree efficiency of the trays = 40%.

Supplementary Data

- Specific gravity of TEG = 1.119
- 1 ft^3 = 7.4805 gal
- Equilibrium line (500 psia gas , 90°F) slope = 0.164

Supplementary data

$V_g = 0.75\ V_T = 0.75 \times K\sqrt{\frac{\rho_L - \rho_g}{\rho_g}}$; $\rho_g = \frac{2.7\ \gamma_g}{ZT(o_R)}$

$K(P\ psig) = 0.35 - 0.0001(p-100)$ ft/sec

$V_L = Q_L \times t_{residance}$

$API = \frac{141.5}{S.G.} - 131.5$

1 bbl = 5.615 ft^3

$T_c = 168 + 325\ \gamma_g - 12.5\ \gamma_g^2$

$P_c = 677 + 15\ \gamma_g - 37.5\ \gamma_g^2$

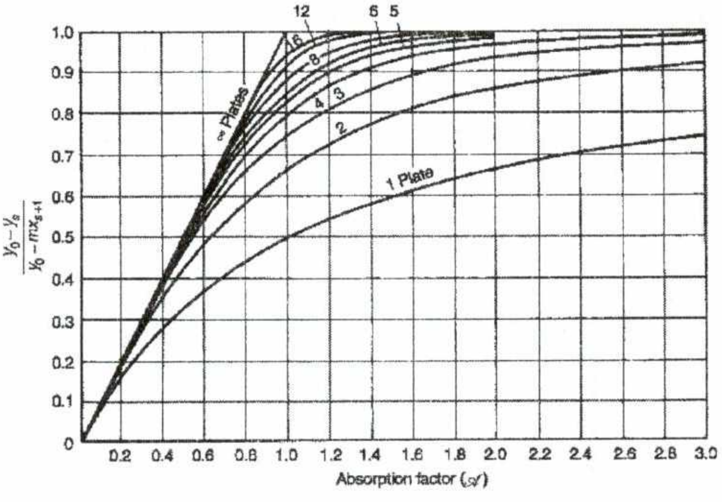
$K = \frac{(9.4+0.02M)T^{1.5}}{209+19M+T}$

$X = 3.5 + 986/T + 0.01M$

$Y = 2.4 - 0.2X$

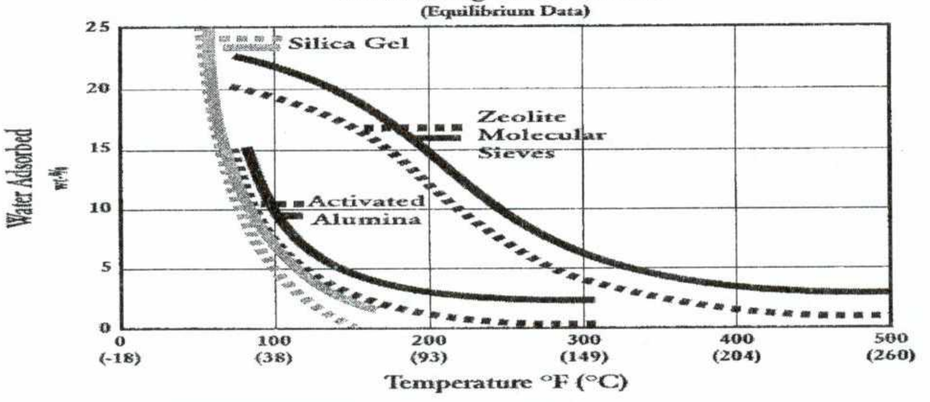
$\mu_g = 10^{-4} K \exp[X(\rho/62.4)^Y]$

Atomic weights [C:12 H:1 N:14 O:16 S:32]



Graphical representation of the effect of the absorption factor and the number of plates on the degree of absorption

Water Vapor Adsorption Isobars at 10mm Hg Partial Pressure
(Equilibrium Data)



Drying power of silica gel, zeolite molecular sieves and activated alumina under various operating temperatures

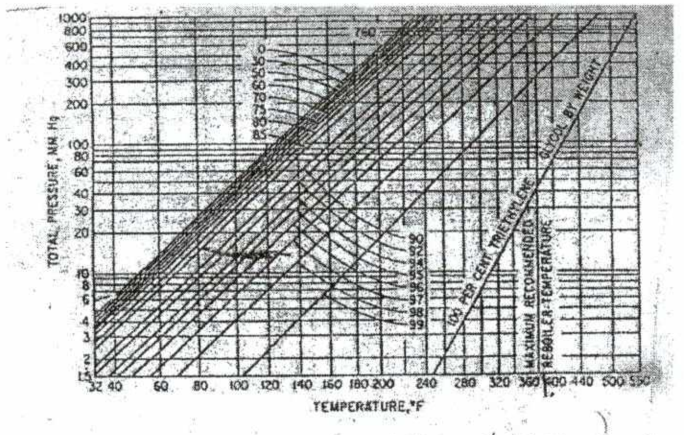


Fig.5: The vapor pressure for different glycol solution concentrations in case of TEG

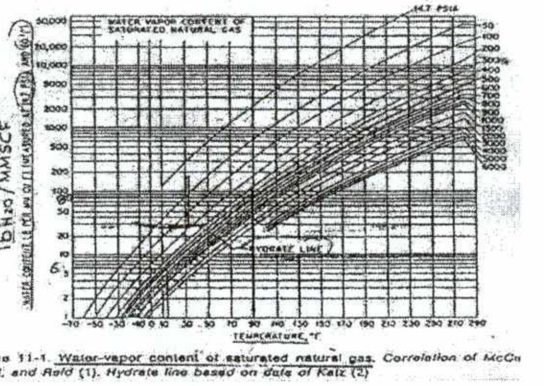


Figure 11-1. Water-vapor content of saturated natural gas. Correlation of McCa... Boyd, and Reid (1). Hydrate line based on data of Katz (2)

Units equivalences

Length

1 m = 3.28084 ft = 39.37 in
1 cm= 0.01 m
1 ft = 12 in = 0.3048 m
1 in = 2.54 cm = 0.083333 ft
1 km = 1000 m = 0.621371 mi
1 angstrom (°A) = 10^{-10} m
1 micron (μ) = 10^{-6} m
1 mi = 5280 ft = 1.609344 km = 1760 yd
1 mm = 10^{-3} m
1 yd = 3 ft = 36 in

Mass

1 g = 10^{-3} kg
1 kg = 1000 g = 2.20462 lb_m
1 lb_m = 0.453592 kg
1 slug = 14.5939 kg = 32.174 lb_m
1 ton = 907.185 kg = 2000 lb_m
1 oz = 28.349 g

Time

1 day = 24 h = 8.64 × 10^4 s
1 ms= 10^{-3} s
1 ps = 10^{-12} s
1 h = 60 min = 3600 s
1 μs = 10^{-6} s
1 min = 60 s
1 ns = 10^{-9} s

Temperature

Temperature conversion formulas:
K = °C + 273.15
°F = 1.8 °C + 32
°R = 1.8 K
°R= °F + 459.67
°C = (°F − 32)/1.8
1°C = 1 K = 1.8 °F = 1.8 °R
1 °F = 1 °R = 0.555556 °C = 0.5555556 K
This is temperature difference

Area

1 acre = 43560 ft^2 = 4.046856 × 10^{-3} km^2 = 1.5625 × 10^{-3} mi
1 yd^2 = 0.092903 m^2

Volume

1 gallon (gal) = 0.133681 ft^3 = 3.78531 liter (l or L) = 4 qt
1 liter = 1000.028 cm^3 = 1.05672 qt
1 pint (pt) = 0.125 gal = 0.473163 liter = 0.5 qt

Density

1 g/cm^3 = 1000 kg/m^3 = 62.428 lb_m/ft^3
1 kg/m^3 = 10^{-3} g/cm^3 = 0.062428 lb_m / ft^3
1 lb_m / ft^3 = 0.0160185 g/cm^3 = 16.0185 kg/m^3

Force

1 dyne (dyn) = 10^{-5} N = 7.233 × 10^{-5} poundal
1 lb_f = 4.44822 N = 32.174 poundal = 0.45359 kg_f
1 N = 0.224809 lb_f = 7.233 poundal
1 poundal = 0.031081 lb_f = 0.138255 N
1 kg_f = 9.80665 N
1 ton_f = 9.96402 kN = 1016.05 kg_f

Pressure

1atm =2116.224 lb_f/ft^2 =1.013×10^5 Pa =14.696 psi = 1 kg_f/ cm^2 = 1.0132 bar
= 760 mmHg = 10.33 m H_2O = 29.9213 inHg
1 lb_f/ft^2 = 47.88 Pa = 6.94444×10^{-3} psi
1 psi (lb_f/in^2) = 6894.8 Pa = 144 lb_f/ft^2 = 0.07031 kg_f/cm^2
1 N/cm^2 = 10^4 Pa
1 pascal (Pa) = 1 N/m^2 = 2.08856×10^{-2} lb_f/ft^2
1 mmHg = 2.7845 lb_f/ft^2
1 inHg = 3.38639 kPa = 0.491 lb_f/in^2
1 ft H_2O = 2.98907 kPa = 0.030 kg_f/ cm^2 = 22.3997 mmHg

Energy

1 Btu = 777.649 ft.lb_f = 1054.35 J = 0.251996 kcal = 1.05506 kJ
1 erg = 1 dyn cm = 1.0×10^{-7} J
1 ft. lb_f = 1.28593×10^{-3} Btu = 1.35582 J
1 hp.h = 2546.14 Btu = 1.98×10^6 ft. lb_f = 2.68452×10^6 J
1 J = 0.737562 ft. lb_f = 2.3006×10^{-4} kcal = 0.277778×10^{-6} kW.h
1 kcal = 3.96832 Btu = 3085.96 ft. lb_f = 4184 J = 4.184×10^{10} erg
1 kW.h = 3409.52 Btu = 2.65522×10^6 ft. lb_f = 3.6×10^6 J = 3.6 MJ

Power

1 Btu/h = 3.92752×10^{-4} hp = 0.292875 W
1 hp = 550 ft. lb_f/ sec = 745.7 W
1 kW = 1.34102 hp = 1000 W
1 kcal/s = 5.61084 hp = 4184 W
MW = 10^6 W
1W = 1 J/s = 0.737562 ft. lb_f/sec = 1.34402×10^{-3} hp

Heat Capacity

1 Btu/lb_m°F = 1 cal/g °C = 1 kcal/kg.K = 777.649 ft.lb_f/ lb_m°R = 4184 J/kg K
1 ft. lb_f / lb_m°R = 1.28593×10^{-3} Btu/lb_m°F = 1.28593 kcal/kg°C
1 J/kg.K = 2.39006×10^{-4} Btu/lb_m°F = 2.39006×10^{-4} kcal/kg°C

Thermal conductivity

1 Btu/h.ft.°F = 4.1364×10^{-4} kcal/s.m.°C = 1.7307 W/m.K
1 kcal/s.m.°C = 2417.56 Btu/h.ft.°F = 4184 W/m.K
1 W/m.K = 2.390006×10^{-4} kcal/s.m.°C

Viscosity

1 Pa.s = 1 kg/m.s = 2419.1 lb_m/ft.h = 10 poises
1 poise = 1 g/cm.s = 0.1 Pa.s = 241.91 lb_m/ft.h = 0.067197 lb_m/ft.sec
1 centipoise (cp) = 0.01 poise = 0.001 Pa.s = 2.4191 lb_m / ft. h
1 kg/m.s = 10 g/cm.s = 1 Pa.s = 2419.1 lb_m/ft.h = 0.67197 lb_m/ft.sec
1 lb_m/ft.h = 0.413377 cp = 4.13377×10^{-4} kg/m.s = 2.7778×10^{-4} lb_m / ft. sec
= 4.13377×10^{-4} Pa.s = 4.13377×10^{-3} poise
1 lb_m/ft.sec = 1488.16 cp = 3600 lb_m/ft.h = 1.48816 Pa.s = 14.8816 poises

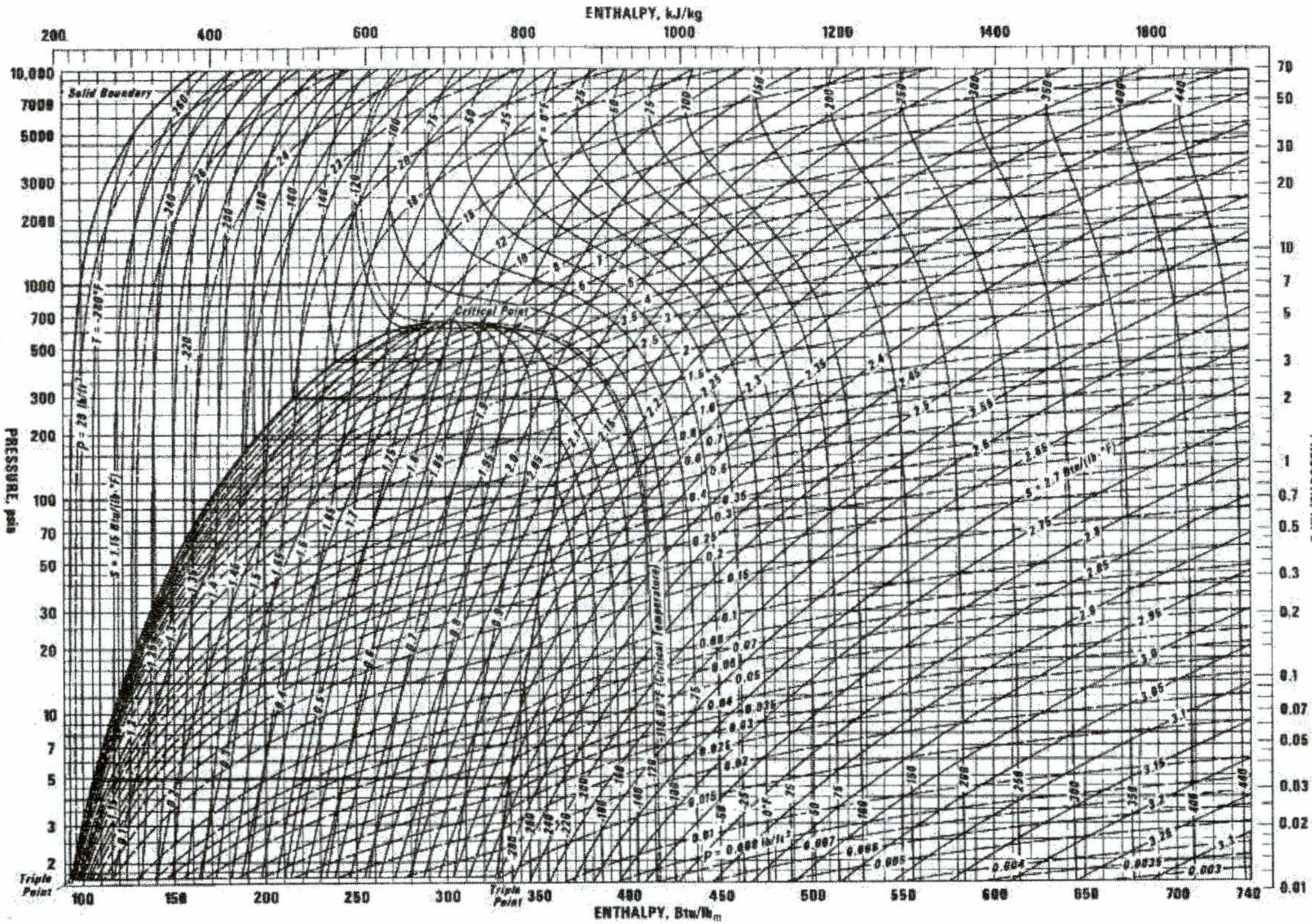
Viscosity (kinematic)

1 centistokes = 10^{-6} m^2/s = 0.01 stokes
1 stokes = 1 cm^2/s = 10^{-4} m^2/s
1 ft^2/h = 2.7778×10^{-4} ft^2/sec = 0.258064 stokes
1 ft^2/sec = 3600 ft^2/h = 929.03 stokes
1 m^2/s = 3.875×10^4 ft^2/h = 10.7639 ft^2/sec = 10^4 stokes

Examiner: **Dr. Moustapha Salem**

Pure methane P-H Diagram

ترفق مع كراسة الإجابة



Best of luck