UNIVERSITY OF PUNE

[4364]-259

B. E. (Petrochemical Engineering) Examination - 2013

Natural Gas Technology

(2003 Pattern)

[Total No. of Questions: 8] **[Total No. of Printed Pages :2]**

[Time : 3 Hours] **[Max. Marks : 100]**

Instructions :

*(1) Answers to the **two sections** should be written in **separate answer-books**.*

(2) Answer 3 question from each section.

(3) Figures to the right indicate full marks.

(4) Neat diagram must be drawn wherever necessary.

(5) Use of non-programmable calculator and steam tables is allowed.

(6) Assume suitable data, if necessary.

Q1	A	Discuss the gas reserves estimation	8
	B	Elaborate on production of natural gas reservoirs	8
Q2	A	Discuss associated gas	6
	B	Explain in detail phase diagram for a retrograde gas.	8
	C	Elaborate on critical properties of natural gas	4
Q3	A	Explain in details hydrate production methods	8
	B	Discuss phase diagram for hydrate formation.	8
Q4		Write short notes on	16
	A	Hydrate inhibitors	
	B	Hydrate formation during drilling	
	C	Water content of natural gas	
	D	Kinetics of hydrate formation	

SECTION-II

Q5	A	Explain in detail solvent absorption for natural gas.	8
	B	Give different properties of a suitable solvent	8
Q6	A	Elaborate on gas compressor design on mollier charts	8
	B	Explain the parts of reciprocating compressor	6
	C	With the help of a diagram, discuss the pitot tube for flow measurement.	4
Q7	A	Describe with flow sheet, CO2 removal process	6
	B	Discuss LNG transport chains.	6
	C	Elaborate on multiphase transport of natural gas	4
Q8		Write short notes on natural gas storage and pipelines	16

Total No. of Questions : 8 **[Total No. of Printed Pages :2]**

B.E. (Petrochemical)

(2003 Pattern)

Refining Operations

[Time : 3 Hours] **[Max. Marks : 100]**

Instructions :

*(1) Answer **03 question from each section.***

*(2) Answers to the **two sections** should be written in **separate answer-books**.*

(3)Figures to the right indicate full marks.

(4) Use of Electronic packet calculator is allowed.

(5) Neat diagrams must be drawn whenever necessary.

(6) Assume suitable data, if necessary.

Section –I

Q1. (a) Explain crude desalting operation in adequate detail. (12)

(b) Explain in brief the technological necessity of crude desalting. (04)

Q2. (a) Discuss in detail the products and working of vacuum distillation unit. (18)

Q3. Discuss environment specification of any four fuel products and how they are met through appropriate refinery operations (16)

Q4. Write notes:

(a) Product of refinery. (08)

(b) Indian energy scenario. (08)

Section -II

Q5. Explain Hydrocracking operation in detail. (16)

Q6. Describe FCCU operation in detail. (18)

Q7. Explain detail how elemental sulphur is recovered from waste streams in modern refineries. (16)

Q8. Write notes (Any Two).

(a) Properties of lubes. (08)

(b) Hydrogen Production. (08)

(c) Flexi-Coker. (08)

UNIVERSITY OF PUNE

[4364]-253

B. E. (*PETROCHEMICAL*) Examination - 2013

REACTION ENGINEERING - II

(*2003* Pattern)

[Total No. of Questions: 8] **[Total No. of Printed Pages :2]**

[Time : *3* Hours] **[Max. Marks : 100]**

Instructions :

*1) Answer **any three** questions from each I and three questions from section II*

2) *Answers to the **two sections** should be written in **separate answer-books**.*

3) Use of steam tables and electronic calculator is allowed.

4) *Black figures to the right indicate full marks.*

5) Assume suitable data, if necessary.

SECTION - I

Q1		Explain the possible kinetic mechanism for the gas phase reaction. A→ R+S taking place over a solid catalyst. Derive two independent kinetic expressions based on the mechanism suggested by you.	18
Q2		Derive expression for Thiele Modulus for a cylindrical porous catalyst in case of a first order reaction kinetics.	16
Q3	a)	In a laboratory experiment to determine pore volume and porosity of a catalyst per unit weight, following data was obtained. For 110 gm of catalyst sample, volume of helium displaced was 70 cm^3 whereas volume of mercury displaced was 150 cm^3. Calculate density of catalyst and void volume per Kg catalyst.	10
	b)	Explain BET method in short.	06
Q4	a)	Discuss the effects of strong pore diffusion, if present, on rate of reaction studies at laboratory level. Take any suitable kinetics as the basis for your discussion.	08
	b)	Give an account of important reactions, catalysts used and	08

reactors employed in hydroprocessing of crude fractions.

SECTION - II

Q5 Gas A and liquid B react in a sparged reactor. The reaction is very slow, first order and occurs in bulk liquid. Write a mathematical model for the steady state operation of this reactor. State all your assumptions clearly. Check if it is analytically solvable for exit concentrations of A and B. If yes, provide the solution in terms of the other operating parameters. 16

Q6 An acidic impurity A in a gaseous stream is to be removed so as to reduce its partial pressure from 350 Pa to 50 Pa (total pressure is 150 KPa) by reacting it with a base B dissolved in water in a packed tower operated in a counter-current manner. Overall gas side mass transfer coefficient is 0.011 mol/hr.m^3.Pa Gas side resistance to mass transport in absence of the reaction is 25% whereas the liquid film contributes the remaining 75% resistance. Henry's constant 22 Pa.m^3/mol. L/G ratio is 5 times the minimum required in absence of B. Calculate minimum concentration of B needed at the top of the water to ensure minimum height of the tower. Also calculate this minimum height 18

Q7 a) derive time-conversion relationship for a cylindrical particle reacting with a gas in a uniform atmosphere. Assume ash film diffusion to be controlling the overall rate. 10

b) Spherical particle of ZnS with initial diameter of 1.55 cm is subjected to oxidation in presence of atmospheric air. Roasting reaction yields SO_2 gas as also the layer of solid ZnO. Molar density of solid may be assumed to be 0.048 mol/cm^3. Diffusivity of gas through the product layer is 0.075 cm^2/s. Calculate the time required to convert the particle by 90%. 06

Q8 a) Explain the mechanism responsible for catalyst deactivation. 08

b) Discuss how the appropriate selection of g-L reactors can be made based on Hatta Number.

UNIVERSITY OF PUNE
[4364]-254
B. E.(Petrochemical)Examination - 2013
PROCESS DYNAMICS SIMULATION & CONTROL(412404)
(2003 Pattern)

[Total No. of Questions:] **[Total No. of Printed Pages :4]**
[Time : 3 Hours] **[Max. Marks : 100]**

Instructions :

*(1) Answer **any three** from each section.*
*(2) Answers to the **two sections** should be written in **separate answer-books**.*
(3) Black figures to the right indicate full marks.
(4) Use of logarithmic tables, slide rule, Mollier charts, electronics pocket calculator is allowed.
(5) Assume suitable data, if necessary.

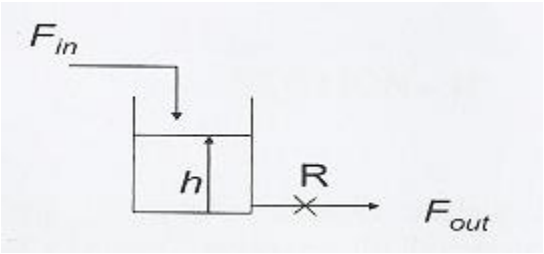
SECTION-I

Q1 a) With the help of suitable example explain the need of process control [8]

For Chemical and Petrochemical Industries.

b) Derive transfer function for output to input (F_{out}/F_{in}) of the following[8]

system. Obtain the final response in time domain as well.



Q2 a) What are Servo and Regulatory control problems-Discuss with help [8]

of neat diagram.

b) What is linearization? Why liberalized approximate models are [8]

useful for process control purposes?

Q3 a) Define following with help of neat diagrams: [8]

Damping Factor, Rise Time, Response Time, Steady State Gain

b) With the help of neat sketch explain the proportional, derivative and integral modes of a PID controller. [8]

Q4 a) Discuss Servo and Regulatory control problems with diagrams. [8]

b) Derive the mathematical expression of a simple U-tube manometer. Comment on dynamics of the system. Obtain the transfer function as well. [8]

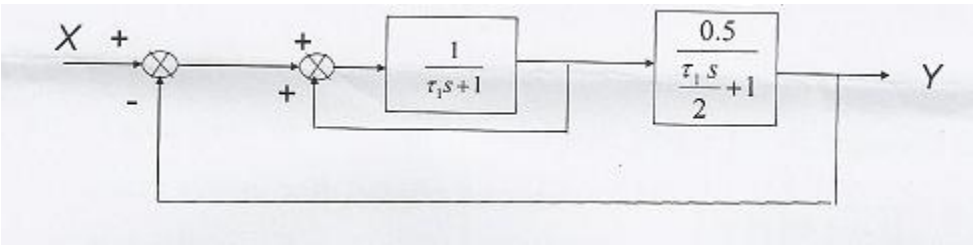
Q5 a) Density of an ideal gas is function of pressure and temperature and can be represented by: $\rho=\frac{M\,p(t)}{RT\,(t)}$, where symbols have their usual significances. [9]

i) Derive the overall lineralized function for density (ρ)

ii) If M=98, T= 376 K, p=211.3 kPa and R=8.314 (kPa.m^3)/kmol.K), obtain the density.

iii) Calculate density of the gas at 104.2 kPa and 120°C temperature with the help of derived linearized equation.

b) Find the overall transfer function of the following system: [9]

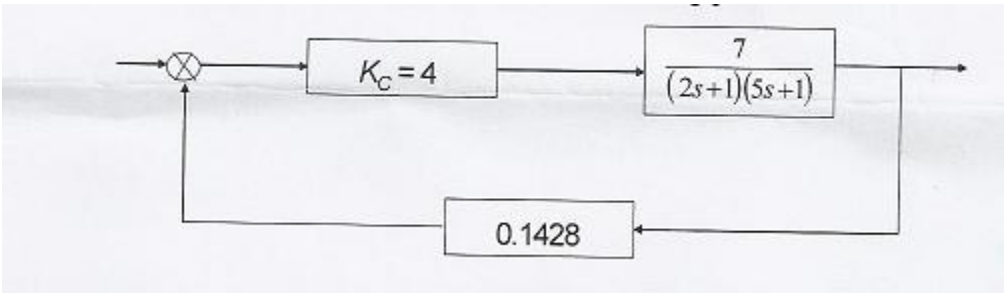


SECTION-II

Q6 a) With help of suitable example explain the application of Feedforward Control Strategy in the Refinery Complex. [8]

b) Discuss the relative Advantages and Disadvantages of PLC based control and DCS based control architecture. [8]

Q7 a) Plot the root locus diagram for the following process: [10]



b) What is meant by Controller Tuning? Discuss any method of proper tuning of industrial controllers. [6]

Q8 a) Consider a feedback control system having the characteristic Equation: $s^3 + 2s^2(2 + K_c)s + \frac{K_c}{\tau_I}$=0 [8]

i) Derive condition of stability for the system with help of Routh-Hurwitz Criterion.

ii) If $K_c = 38$ and τ_I =0.3, comment on stability.

b) With help of neat diagram explain cascade control on an exothermic reaction carried in a jacketed CSTR. [8]

Q9 a) Calculate Amplitude Ratio and Phase Angle for overdamped 2nd order system with transfer function: G(s)=$\frac{2.3}{(3s+1)(0.5s+1)}$ [9]

b) Draw Bode plots for an open-loop process, whose dynamics can be [9]

represented by: $G_{OL} = K_C \left(\frac{1}{2s+1} \right) \left(\frac{1}{s+1} \right)$

the value of Gain K_C can be assumed to be 0.6

Q10 Write short notes on (any four): [16]

i) Plant-wide Control System

ii) Field Bus Technology

iii) Z-Transform

iv) Digital Control Strategy

v) Practical Application of PLC Technique

UNIVERSITY OF PUNE
[4364]-255
B. E. (PETROCHEMICAL ENGINEERING) Examination 2013
ENVIRONMENTAL ENGINEERING
(2003 Course)

[Total No. of Questions:10] **[Total No. of Printed pages :3]**
[Time : 3 Hours] **[Max. Marks : 100]**

Instructions :

(1) *Answers any 3 questions from each section*
(2) *Answers to the two Sections should be written in separate answer-books*
(3) *Neat diagram must be drawn wherever necessary.*
(4) Figures to the right indicate full marks.
(5) Assume suitable data, if necessary.
(6) Use of logarithmic tables slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.

SECTION I

Q.1a) How man had impacted on environment with respect to crude oil production , transport and processing? [8]

b) Discuss the impact of 'Gas Flaring' on environment in detail. [6]

c) Elaborate on 'Adsorption of Gaseous Pollutants on Solids'. [2]

Q.2a) Explain impact of Petroleum & Petrochemical industry on environment starting from crude oil production to refining. [6]

b)Describe Aquatic Ecosystem with neat diagram. [6]

c) How solid waste can be classified in different groups? Discuss in details about each group. [6]

Q.3a) Describe 'Sanitary land filling operation for disposal of solid waste' in details with help of flow diagram. [8]

b) With the help of flow diagram, explain 'Ethyl Amine Process' for removal of acidic pollutants from gaseous emissions form petroleum [8]

industries.

Q.4a) How the biological waste is treated? What are the side effects if it is not treated properly? [4]

b) Give at least four advantages of electrostatic preceptor [4]

c) A conventional cyclone with diameter 2 m handles 6 m^3/s of standard air carrying particles with a density of 2000 kg/m3. For effective number of turns (Ne) =6. Determine the cut size. What will be the cut size for a high efficiency cyclone? Take viscosity of gas (μg) as 1.81x 10^{-5} kg /(m.s.).Neglect the density of the gas. [8]

Q.5a) With respect to Solid waste discuss the following with neat diagram. [8]

1) Sanitary and filling operations.

2) Composting

3) Open dumping

b) Give detailed classification of medical waste. [4]

c) What are the methods to treat the Biomedical wastes? [4]

SECTION II

Q.6a) Show the interrelationship of solids found in wastewater with help of diagram. [4]

b) Discuss in details about 'Organic matter in a wastewater'. [8]

c) Discuss in details about recovery of materials from process effluent [6]

Q.7a) What are the different types of Secondary treatment available? Write in details about any two secondary treatment [6]

b) What is Chemical Oxygen demand? Can we determine tentative BOD of wastewater if its COD is known? HOW?. [10]

Q.8a) Discuss the activated sludge treatment with help of neat diagram. [8]

b) Discuss in detail about how liquid effluent from petrochemical Complex is treated. [8]

Q.9a) Determine the 12-day demand of a wastewater at 20^0C if its 5-day BOD at the same temperature is 250 mg/L. Also, calculate the 5-day BOD at 27^0 C as well as 30^0 C temperature. [8]

Data i) $\theta = 1.053$ ii) Reaction Rate constant (k) (base e, 20^0 C) =0.23 per day.

b) Discuss the new potential methods of disposal for solid wastes. [8]

Q.10a) Write Short note on following. (Any Four) [16]

a) Trickling filter Vs Activated sludge process

b) Sludge treatment & disposal

c) Sludge volume index (with formula)

d) Facultative pond system.

e) Origin of wastewater

[Total No. of Questions: 10] **[Total No. of Printed Pages: 2]**

UNIVERSITY OF PUNE
[4364]-261
B. E. (Petrochemical Engineering) Examination - 2013
CATALYSIS TECHNOLOGY AND FLUIDIZATION ENGINEERING
(2003 Course)

[Time: 3 Hours] **[Max. Marks: 100]**

Instructions:

1 *Answer three question from each section*
2 *Answers to the two sections should be written in separate answer-books.*
3 *Neat diagrams must be drawn wherever necessary.*
4 *Black figures to the right indicate full marks.*
5 *Use of logarithmic tables, slide rule, Mollier charts, electronic pocket calculator and steam tables is allowed.*
6 *Assume suitable data, if necessary.*

SECTION -I

Q.1	A	Discuss the importance of Catalysis in relation to modern day chemical and petrochemical industries.	8
	B	Define the following: Activation site, Turnover Number, Selectivity and Functionality	8
		OR	
Q.2	A	Differentiate between Chemisorption and Physical Adsorption – provide suitable examples as well.	8
	B	Differentiate between Riedel Model and Langmuir Hinshelwood Model for catalytic reaction.	8
Q. 3	A	With the help of neat sketch explain how catalyst changes reaction pathways.	6
	B	For the catalytic gas phase reaction: $X + Y \longrightarrow Z$, derive the rate expression considering Langmuir-Hinshelwood mechanisms in terms of partial pressure of the respective components. Note that all reactants and products are adsorbed appreciably. If some inert gas Helium is also present, this is also strongly adsorbed on the surface, write down the modified rate expression.	10
		OR	
Q. 4	A	A specially designed catalyst with mass of 362.3 gm displaces 231.4 cm^3 Helium. The same catalyst sample is reported to displace 254.6 cm^3 of Mercury in another study. Calculate pore volume of the sample and particle porosity.	8
	B	What is Sintering? Explain with help of neat sketch. How can it be reduced.	8
Q. 5	A	Write short notes on (any three) i) Dual functional catalysts ii) Promoters iii) Multiphase catalytic reactor iv) Characterization of catalysts	18

SECTION II

Q. 6	A	Based on First Principle obtain Ergun's Equation for Fluidized Bed.	8
	B	With help of neat diagram explain pneumatic conveying. Discuss its industrial applications.	8
		OR	
Q. 7	A	With the help of rough sketch discuss various types of gas distributor for fluidized bed-Compare their performances.	8
	B	Differentiate between group of particles as classified by Geldart. Provide appropriate examples of each group.	8
Q. 8	A	In a fluidized bed, mixing is combined effort of plug flow and mixed flow mode – Explain with help of neat diagram.	8
	B	Write down important assumptions of Kuni-Levenspiel model and discuss the model qualitatively.	8
		OR	
Q. 9	A	Fluidized Catalytic Cracker comprises of two fluidized bed unit-discuss with help of neat diagram. Explain its operation along with operating conditions.	8
	B	With help of schematic diagram explain operations of various types of fluidized bed drivers.	8
Q. 10	A	Write short notes on (any three) i) Fluidized bed Heat transfer ii) Disadvantages of fluidized bed iii) Sintering and Agglomeration iv) Fluidized bed HDPE Reactor	18

[Total No. of Questions: 9] **[Total No. of Printed Pages: 2]**

UNIVERSITY OF PUNE
[4364]-728/263
B. E. (Petrochemical Engineering) Examination - 2013
PETROLEUM EXPLORATION AND PRODUCTION OPERATIONS (2003 and2008 Course)

[Time: 3 Hours] **[Max. Marks: 100]**

Instructions:

1 *Answers to two sections should be written in separate answer-books.*
2 *Draw neat diagrams must be drawn wherever necessary.*
3 *All questions are compulsory*

SECTION -I

Q.1		Describe important physical and chemical properties of crude oil and natural gas.	15
		OR	
Q.2	A	How is original oil and gas in place calculated? What is a difference between recoverable reserves and original oil and gas in place?	10
	B	What happens to each barrel of oil produced in terms of approximate percentage usage in each important application?	5
Q. 3	A	Explain important reservoir rock properties?	15
		OR	
Q. 4	A	What is a Petroleum Geosystem? Explain different components of Petroleum Geosystems	15
Q. 5		Write short notes any four of the following: a) Reservoir drive mechanisms b) Reserves estimation c) Geophysical methods used in oil exploration d) Comparison of NYMEX, Brent crude, Middle East and Mumbai High crudes. e) Geological risk analysis. f) Formation evaluation g) Porosity logs.	20

SECTION II

Q. 6	A	With the help of neat sketches, describe important components of a land rig.	15
Q. 7	A	What is well completion? Explain with the help of neat sketches various methods of oil well completion.	15
		OR	
Q. 8	A	Explain important EOR methods.	10
	B	What are different artificial lift methods?	5
Q. 9	A	Write short notes on any four of the following: a) Factors that balance demand and supply of petroleum. b) India's hydrocarbon potential. c) Importance of natural gas for India industry. d) Environmental impact of produced water. e) Applications of microbiology in oil industry, and f) Deepwater resources.	20

[Total No. of Questions: 12] **[Total No. of Printed Pages: 5]**

UNIVERSITY OF PUNE
[4364]-722-258
B. E. (Petrochemical) Examination - 2013
REFINERY PROCESS DESIGN
(2008/2003 Course)

[Time: 3 Hours] **[Max. Marks: 100]**

Instructions:

1 *Answers to the two sections should be written in separate answer-books.*

2 *Black figures to the right indicate full marks.*

4 *Make use of K Charts, LMTD correction factor curves and Gilliland Curve given in the end wherever appropriate.*

5 *Assume suitable data, if necessary.*

6 *Answer three question from each section*

7 *Use of steam tables and electronic calculator is allowed.*

SECTION -I

Q.1 The feed to a fractionating tower consists of equimolar mixture of n-butane, n-pentane , n-hexane , and n-heptane. If feed enters as 40% vaporized liquid at 5 bar pressure, calculate the feed temperature. This feed is distilled so that 97% of the n-pentane is recovered in the distillate and 98% of the n-hexane in the bottoms. Calculate molar flow rate and composition of distillate and bottom products. 16

Q.2 Using FUG method, calculate number of theoretical and actual plates required for separation of ethylene from ethane. Feed is saturated liquid having 50% ethylene and 50% ethane by weight. The column operates at 20 bar pressure. Recoveries of both ethylene and ethane should be 99% Also report the approximate height of the tower based on your calculations. 18

Q. 3 A Discuss how tower mass balances ca be set up form crude characterization curves. 8

B Calculations have determined that at the minimum pressure and maximum temperature conditions allowable at the tower inlet, a feed flash vaporization of 40 vol % will occur. Using 20vol % 8

of feed as over-flash and a steam-to-bottom ratio of 10 lb/bbl, calculate the volume of total distillate products for 100 bbl of feed. Assume strip-off ration fo 0.2 for the given steam-to-bottom ratio.

Q. 4	A	Hydrocarbon distillation tower having 100 actual plates reports a pressure drop of 1 bar between top and bottom. Average density of hydrocarbon liquid being handled is 700 Kg/m^3. Weir height over an individual sieve tray is 5 cm. comment on the hydraulic condition of the column.	7
	B	Discuss in detail important column internals used in packed and tray towers.	9

SECTION II

Q. 5	A	It is desired to design a 2-4 shell and tube heat exchanger to cool 20 kg/s of solution using 20 kg/s of cooling water. The solution is to be cooled from 67 C to 37 by employing cooling water available at 17 C. For cleaning considerations, the solution must circulate into the tubes. To achieve a reasonable value of the heat transfer coefficient when cooling a solution, a minimum fluid velocity of 1 m/s is to be ensured. The overall heat transfer coefficient is expected to be ensured. The overall heat exchanger must be constructed with ¾-in BWG 16 tubes that have an internal diameter of 0.0157 m and an external diameter of 0.019 m. comment on the appropriateness of the 2-4 configuration. Also suggest tube length and number of tubes to be employed.	8
	B	Discuss how appropriateness of an already installed heat exchanger for a newly specified duty is judged.	8
Q. 6	A	What do you mean by fuel efficiency of a furnace? Desired fuel efficiency of a furnace heater is 65% Flue gases are expected to leave the stack at 700C. Roughly 2% of the heat produced is lost to atmosphere through refractory walls. Advice on the % excess of air that should be maintained in steady state operation of the furnace. Use the data given in Fig 5 for your calculation.	8
	B	Draw a neat schematic of a process fired heater labeling its parts. Show process and utility streams clearly. With reference to this labeled sketch, write heat balance equation for the furnace.	8

Q. 7 With reference to centrifugal pump operation, discuss the following: 18

a. Pump Operating Point
b. NPSHR and NPSHA
c. Energy conservation

OR

Q. 8 A Discuss

a) Surge and Anti-surge in Compressor operation 5
b) Rating vs. design problem 5
c) Refining operations needing furnace heaters (State flux density if possible) 6

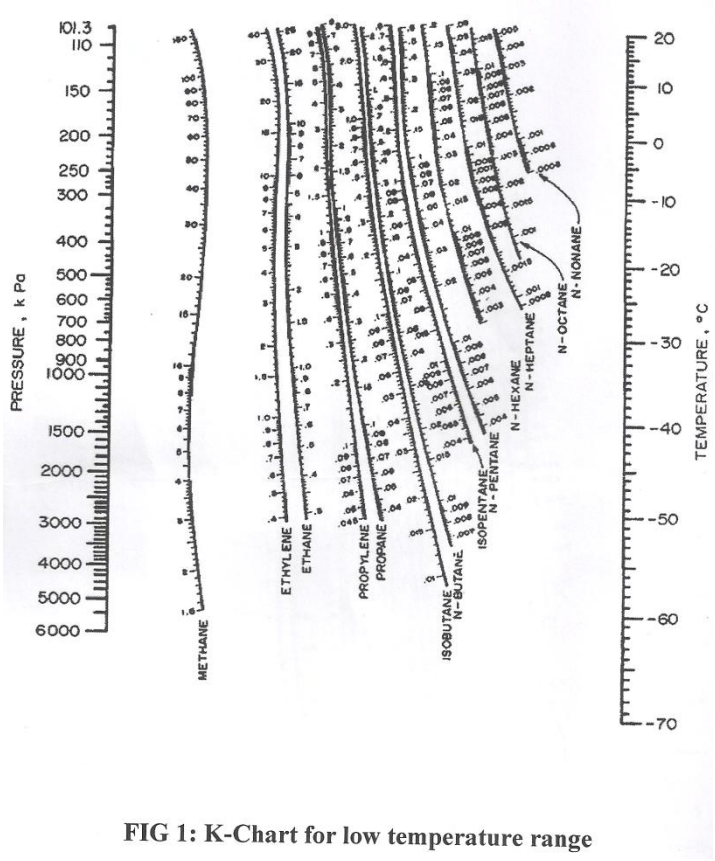


FIG 1: K-Chart for low temperature range

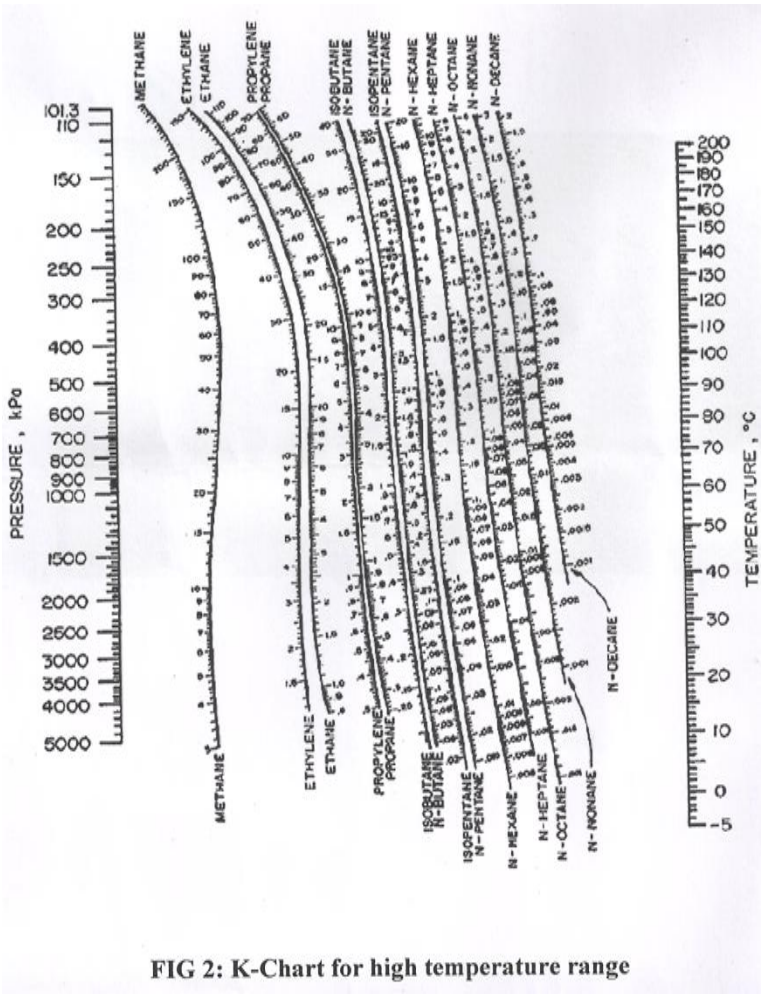


FIG 2: K-Chart for high temperature range

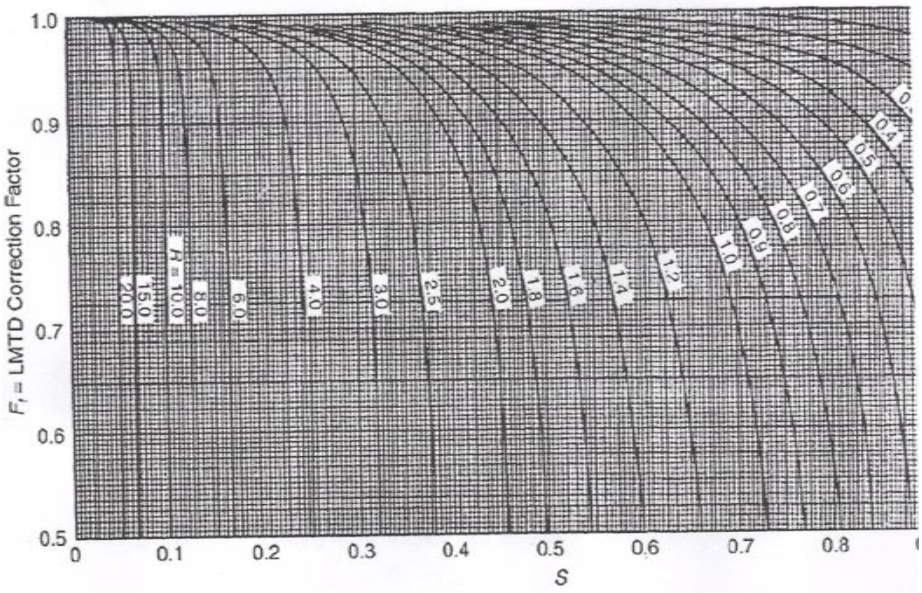


FIG 3: LMTD Correction factor for 2-4 Shell and Tube Heat Exchanger.

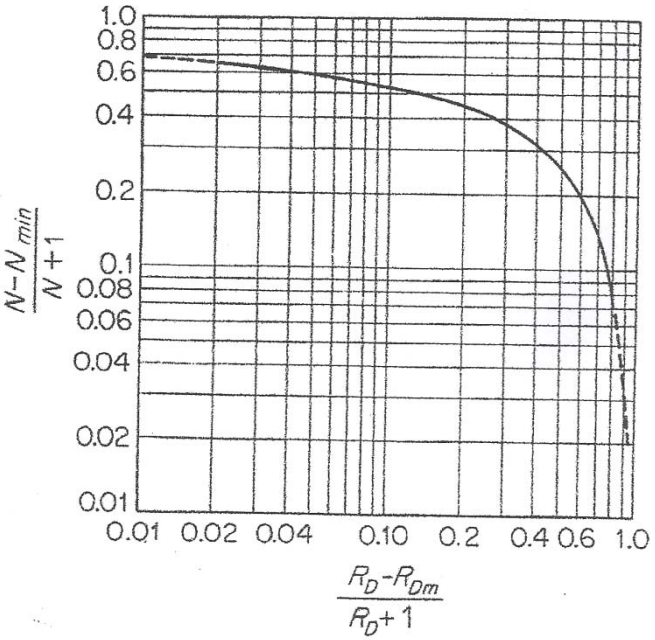


FIG 4: Gilliland Curve

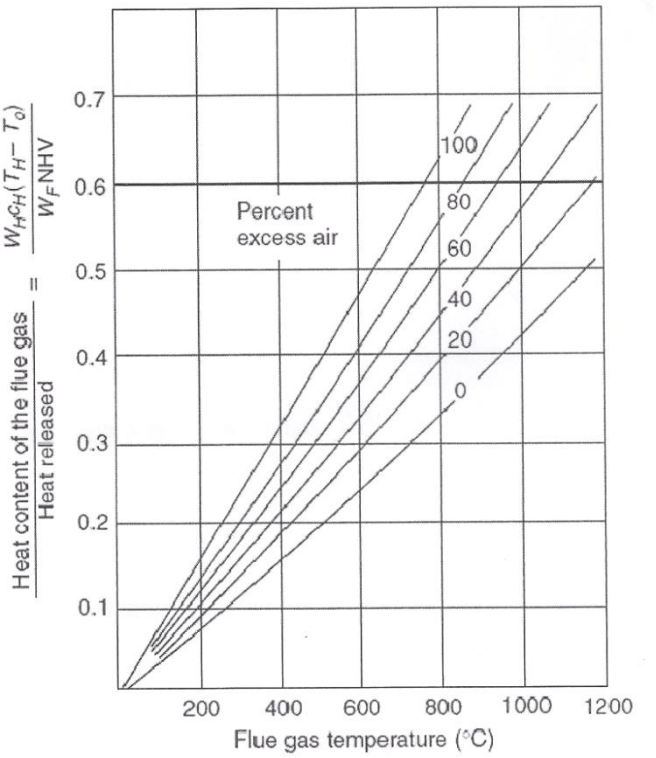


FIG 5: Heat carried by flue gas in furnace operation