

**Total Pages—4**

**(Set-P)**

**B.Tech - 4th(Chem. Engg)**  
**Fuel and Combustion**

*Full Marks : 70*

*Time : 3 hours*

**Answer any six questions including Q. No. 1  
which is compulsory**

*The figures in the right-hand margin indicate marks*

*Symbols carry usual meaning*

1. Answer *all* questions : 2 × 10
- (a) Define the term fuel with its classification.
  - (b) Define calorific value.
  - (c) Explain higher and lower calorific value.
  - (d) What is the significance of pre-heating furnace oil before burning ?
  - (e) Name two liquid fuels, solid fuels and gaseous fuels used in boilers.

*( Turn Over )*

( 2 )

- (f) How the gaseous fuels are superior to all other fuels ?
  - (g) What is the typical stoichiometric air fuel ratio for furnace oil ?
  - (h) What is knocking ? How is it rectified ?
  - (i) Mention the significance of flue gas analysis.
  - (j) What is octane number ? How is it improved ?
2. (a) Explain proximate analysis. Give its significance. 5
- (b) What do you mean by the term coke ? How Metallurgical coke is manufactured ? 5
3. (a) Explain producer gas with a neat diagram. 5
- (b) Explain why natural gas requires least amount of excess air ? 5
4. (a) Explain Water gas with manufacture process reactions. 5



- (b) Explain the following : 5
- (i) Compressed natural gas(CNG)
  - (ii) Liquid petroleum gas.(LPG)
5. (a) The measured  $\text{CO}_2$  is 8% in an oil fired boiler flue gas. Theoretical  $\text{CO}_2$  content for the fuel fired is 16%. Estimate the % excess air level ? 6
- (b) What is crude oil ? What are the various fractions obtained by the fractional distillation of crude oil ? Mention the composition and uses ? 4
6. (a) The proximate analysis of coal is : Moisture 2.4%, Volatile Matter 29.4%, Fixed Carbon 58%, Ash 9.7% and sulphur 0.5%. Its gross calorific value is 7650 Kcal/kg. Calculate proximate analysis and calorific value on
- (i) Moisture free basis
  - (ii) Dry ash free basis. 6
- (b) With a neat diagram, describe the manufacture of water gas. 4

( 4 )

7. (a) Calculate the percentage excess air for methane burning. The flow rate of methane and air are 25 and 290 m<sup>3</sup>/h respectively. 6
- (b) Explain ultimate analysis. Give its significance. 4
8. (a) In combustion of pure methane gas with 5% of excess air, determine the gas composition of flue gas in volume%. 5
- (b) How synthetic petrol is obtained by Bergius and fischer-Tropsche method ? 5
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**B.Tech-4<sup>th</sup> Semester (Chemical Engineering)**

**FUEL AND COMBUSTION**

*Full Marks: 70*

*Time: 3 hours*

Answer SIX questions including Q No. 1 which is compulsory.

The figures in the right hand margin indicate marks. *Symbols carry usual meaning.*

Q1. Answer all questions.

[2×10]

- a) What are the different theories involved in the formation of coal?
- b) What do you mean by Proximate analysis and Ultimate analysis?
- c) Differentiate between GCV and NCV?
- d) Define Octane number and Cetane number and write its importance.
- e) Differentiate between Dry washing and Wet washing?
- f) What do you mean by calorific value and its unit? What are the different types of calorific value?
- g) Differentiate between HTT and LTT?
- h) Define Cloud point and Pour point.
- i) What is the effect of temperature on viscosity for liquid and gas?
- j) What are the by products recovered in a coal carbonisation plant?

Q2. a) Differentiate between HTC and LTC? [5]

b) Describe the tar distillation plant with a neat flow diagram. [5]

Q3. a) What is reforming & its type? Write down the chemical reactions. [5]

b) Explain the Dubbs Thermal cracking process with a neat flow diagram. [5]

Q4. a) Explain the Thermofer Catalytic cracking moving bed process with a neat flow diagram. [5]

b) What do you mean by Visbreaking of crude oil? Describe briefly. [5]

Q5. a) How the by products are recovered from coke oven gas? Describe briefly with a typical flow sheet. [5]

b) Describe the manufacture of metallurgical coke by HTC method. [5]

Q6. a) A coal containing C-67.9%, H-4.4%, S-0.8%, N-16%, O-79%, ash-4.5% and water 12.9% is burnt in the furnace. The product of the combustion dry gas analysis is CO<sub>2</sub>-14.5%, O<sub>2</sub>-4.7% and N<sub>2</sub> rest. Calculate

i) Theoretical volume of air used for the complete combustion of 100kg of coal

ii) % excess air used.

b) Write down the production of carburetted Water gas.

Q7. a) A producer gas with the composition by volume, 27.3% CO, 5.4% CO<sub>2</sub>, 0.6% O<sub>2</sub>, 66.7% N<sub>2</sub> is burnt with 20% excess air. If the combustion is 98% complete, calculate the composition by volume of the flue gases. [5]

b) Write short notes on blast furnace gas. [5]

Q8. Write short notes on any two. [5×2]

a) Wilfley table

b) Low temperature oxidation and spontaneous combustion

c) Pyrolysis



## FUEL & COMBUSTION

Full Marks: 70

Time: 3 hours

**B.Tech 4**  
**F&C**

Answer SIX questions including Q No. 1 which is compulsory.  
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Q1. Answer all questions.

- What is fossil fuel and how are they formed?
- What do you mean by GCV and NCV? Under what condition  $GCV = NCV$ ?
- Differentiate between caking coals and non-caking coals?
- What do you mean by spontaneous and low oxidation of coal?
- What is reforming of fuel?
- Differentiate between octane number and cetane number.
- Calculate the weight volume of air required for combustion of 5 kg of carbon.
- What is blast furnace gas? What are the uses of blast furnace gas?
- What is knocking? What are factors on which knocking depends?
- What is petrography of coal?

[2×10]

Q2. a) What are the characteristics of a good fuel?

b) Describe the manufacture of metallurgical coke by high temperature carbonisation method.

[5]

[5]

Q3. a) Describe tar distillation plant with a neat flow diagram.

b) Explain ultimate analysis of coal and its significance.

[5]

[5]

Q4. a) Discuss the manufacture of liquid fuel by Fischer-Tropsch method with a flow diagram.

b) Describe the manufacture of coal gas with a neat diagram.

[5]

[5]

Q5. a) Discuss about Catalytic Cracking.

b) Compare between primary and vacuum distillation of crude oil.

[5]

[5]

Q6. a) The percentage composition of weight of a sample of coal gas found to be C = 80%, O = 9%, N = 1% and rest ash. Calculate the minimum amount of  $O_2$  and air required for complete combustion of 100 kg of coal.

[5]

b) Write a note on Natural gas.

[5]

Q7. a) The composition of a producer gas was found to be  $H_2 = 15\%$ ,  $CH_4 = 2\%$ ,  $CO = 22\%$ ,  $CO_2 = 4\%$ ,  $N_2 = 54\%$ ,  $O_2 = 3\%$  by volume. Find the air required for complete combustion of  $1m^3$  of this gas. If 50% excess air is used, find the volume analysis of dry products of combustion.

[5]

b) Distinguish between

[5]

(i) Producer gas and Water gas

(ii) Dry and Wet washing of coal.

Q8. a) Calculate GCV and NCV of a coal sample having the following composition;

C = 80%, H = 8%, O = 2%, S = 3%, N = 2.5% and rest ash.

[5]

b) Discuss about principle and working of bomb calorimeter.

[5]