

Roll No: -----

**UNIVERSITY OF PETROLEUM
AND ENERGY STUDIES**



End Semester Examination – December, 2017

Program/course: M.Tech ES & REE

Subject: Fuels & Combustion

Code : EPEC7002

No. of page/s:3

Semester – I

Max. Marks : 100

Duration : 3 Hrs

Section A (5Qx4= 20 Marks)

Q1. Theoretical Air/ Stoichiometric air is physically unachievable. Find out the amount of excess air that has to be supplied, when Actual Air supplied is 18 % and Theoretical Air 16%.

Q2. Explain “TTT” for combustion taking in consideration an Fuel fired Furnace, also discuss about the impact of Air/Fuel Mixture.

Q3. For a typical coal washery near, Raniganj Coal Mines, the given data of coal sample found was:

Ash content in Feed Coal 20.9 %, Theoretical recovery coal 77.5%, % Ash in Clean coal 7.9, Recovery of clean coal 67.2%. Calculate the efficiency of the washery.

Q4. In a modulating furnace used in a ceramic industry, estimate the time taken by a 3mm coal particle to complete its devolatilization and volatile combustion in an Fluidized Bed Boiler operating at 850 Deg C. The value for ($a = 3.5$ at 775 Deg C)

Q5. Explain the various complications in essentially utilizing a pneumatic table, for drying process under the envelope of coal cleaning.

Section B (4Qx10= 40 Marks)

Q6. In a medium Scale Industry, fuel used is paddy husk with a GCV of 3568 Kcal/Kg. For complete combustion the actual air is 290 m³/Hr. The Stoichiometric Air required is 238 m³/Hr. The theoretical air required for combustion is 4.27 kg/kg of paddy husk. The flue gas has a temperature of 190 degree C, and has a mass of 5 kg/kg of Husk. The ambient temperature recorded is 32 degree C. (Cp-0.23)

Calculate the following

1. Stoichiometric Ratio
2. % of Excess Air
3. Actual Mass of Air supplied
4. % of loss due to dry flue gas
5. Overall Efficiency of biomass fired boiler (Other losses accounts for 28%)

Q7. Classify Biomass as a potential source of Renewable Fuel. Also, Given :

The gasification of Biomass yield 15 Kg/s product gas, with the products of its individual constituents in Kg/s : H- 1.1, CO- 0.3, CO₂-0.5, CH₄- 6, C₃H₈- 1.3, N- 0.8, Moisture- 0.4. Calculate the composition of product gas in 1) Mass Fraction, 2) Mole Fraction.

Q8. An electric furnace in an Iron Melting shop at Nagpur, the working is at 30 Kwh operating load. The intention is to switch the operation from electric to oil fired furnace.

The specification given are CV of Fuel Oil 9200 Kcal/Kg, Density of oil 0.9 Kg/l, Efficiency of Electric arc furnace 70, Efficiency of Fuel Fired furnace 55. Calculate the fuel oil required to meet the heat demand and the estimated quantity in liters

Q9. Burners designs are extremely crucial in proper exhausting of coal particles. Calculate the 1) rate of gas flow through orifice of burner, 2) Heat Rate, and also calculate the 3) Wobble Index. The given conditions are : Co – efficient of Discharge 0.9, Orifice area 0.1 m sq, Pressure drop 0.06 cm of water, Initial gas pressure 4 cm of Hg, temperature 140 Deg C, and Specific gravity of Gas (air) is 1. The Coefficient of Efficiency is 0.75, Net CV of Gas is 2500 Kcal/Nm cube

Section C (2Qx20= 40 Marks)

Q10. As an Energy consultant you have to do a relative study of Boiler systems in:

System in a Cement Industry	System in a Sugar Industry
Steam Flow rate 8 TPH	Steam Flow Rate 7.5 TPH
Fuel firing rate 1 TPH	Fuel firing rate 1 TPH
GCV of Fuel at 5% moisture 4500	GCV of Fuel at 5 % moisture 4900
Steam enthalpy 600 Kcal/Kg	Steam Enthalpy 680 Kcal/Kg
Feed Water Enthalpy 110 Kcal/Kg	Feed Water Enthalpy 90 Kcal/Kg
Cost Of Coal Rs 100/ Kg	Cost of Coal Rs 90/Kg

1. Cement Industry : Total cost involved, annual cost of steam is 400 lacs, proposed cost of steam 300 lacs, Investment cost 50 lacs

2. Sugar Industry: Total cost Involved, annual cost of steam is 500lacs, proposed cost of steam 240 lacs, Investment cost 60 lacs.

As a consultant, find out the following

1. Determine efficiency levels in two different industries and probable measures to enhance
2. Provide the customer with a simple Payback Period for both industries with given data above.
3. As a consultant, Suggests 3 Energy Efficiency Measures for the Boiler separately keeping in mind the production processes and fuel properties in Cement and Sugar Industry

Q11. In furnace operations in a MSME industry, coal is used as primary fuel. The actual CO₂ supplies are 18% and the excess air supplied is 16.6%. The mass of the stock heated in furnace is 5Kg. The value for Cp is recorded is 1.4. The temperature during combustion is recorded as 700 Deg C, and the temperature at the entry of the furnace is 45 Deg C. The GCV of the fuel is 7800 Kcal/Kg. Calculate the theoretical air and the furnace efficiency.

Also suggest suitable measures to improve furnace efficiency thereby ensuring proper combustion.

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Section A (5Qx4= 20 Marks)

Q1.

Explain in Brief Combustion Control Methods. Also

Calculate the inflammability limits for a gas burner having the given composition. L1 denotes the Lower Inflammability limit and L2 denoted Upper Inflammability limit.

Elements	% Composition	L1	L2
CO	40	14	75
H ₂	50	5	80
CH ₄	30	6	15

Q2.

Calculate the total amount of oxygen required for complete combustion of 1 Kg of Fuel. Given composition

Elements	Percentage Composition
C	9
H	5
S	6
O (In fuel)	44

Q3

Explain the requirement for Excess Air in combustion.

Theoretical Air/ Stoichiometric air is physically unachievable. Find out the amount of excess air that has to be supplied, when Actual Air supplied is 20 % and Theoretical Air 18%.

Q4.

The gasification of Biomass yield 15 Kg/s product gas, with the products of its individual constituents in Kg/s : H- 1.1, CO- 0.3, CO₂-0.5, CH₄- 6, C₃H₈- 1.3, N- 0.8, Moisture- 0.4. Calculate the composition of product gas in 1) Mass Fraction, 2) Mole Fraction.

Q5.

- a. If the temperature of exhaust is less from a furnace, what does it imply on its efficiency?
- b. Controlled Wetting of coal during coal preparation increases fineness of coal/ decreases efficiency of unburned C.
- c. LPG is a mixture of two constituents?
- d. Percentage excess air required for complete combustion for burning coal is less than natural gas, true or false?

Section B (4Qx10= 40 Marks)

Q6. The given conditions are : Co-efficient of Discharge 0.9, Orifice area 0.1 m², Pressure drop 0.06 cm of water, Initial gas pressure 4 cm of Hg, temperature 140 Deg C, and Specific gravity of Gas (air) is 1. The Coefficient of Efficiency is 0.75, Net CV of Gas is 2400 Kcal/Nm³

Calculate: 1) rate of gas flow through orifice of burner, 2) Heat Rate, and also calculate the 3) Wobble Index

Q7. In furnace operations in a MSME industry, Blend of Biomass is used as primary fuel. The actual CO₂ supplies are 18% and the excess air supplied is 16.6%. The mass of the stock heated in furnace is 5Kg. The value for Cp is recorded is 1.4. The temperature during combustion is recorded as 700 Deg C, and the temperature at the entry of the furnace is 45 Deg C. The GCV of the fuel is 7800 Kcal/Kg. Calculate the theoretical air and the furnace efficiency

Q8. An electric furnace used in a Steel Melting shop in an Iron & Steel Plant, is working at 30 Kwh operating load. The intention is to switch the operation from electric to oil fired furnace.

The specification given are CV of Fuel Oil 9200 Kcal/Kg, Density of oil 0.9 Kg/l, Efficiency of Electric arc furnace 70, Efficiency of Fuel Fired furnace 55. Calculate the fuel oil required to meet the heat demand and the estimated quantity in liters.

Q9. Explain the Problems that are encountered for coal washing in India.

Section C (2Qx20= 40 Marks)

Q10. Coal has been used as a fuel in a furnace to heat water and convert into steam. The steam pipelines are having 100 mm diameter and are not insulated for 100m length supplying steam at 10 Kg/cm sq, to the required equipment. Find out the Fuel usage savings if it is properly insulated with 65mm insulating material.

Given Conditions:

Efficiency of Boiler : 80 , Fuel Oil Cost : Rs 15000/ Tonne , Surface Temp without Insulation 170 Deg C, Surface Temp after Insulation 65 Deg C, Ambient Temp 25 Deg C.

Q11. As an Energy consultant you have to do a relative study of Boiler systems in:

System in a Pig Iron Industry	System in a Forging Unit
Steam Flow rate 7.5 TPH	Steam Flow Rate 8 TPH
Fuel firing rate 1 TPH	Fuel firing rate 1 TPH
GCV of Fuel at 5% moisture 4900	GCV of Fuel at 5 % moisture 4500
Steam enthalpy 680 Kcal/Kg	Steam Enthalpy 600 Kcal/Kg
Feed Water Enthalpy 90 Kcal/Kg	Feed Water Enthalpy 110 Kcal/Kg
Cost Of Coal Rs 90/ Kg	Cost of Coal Rs 110/Kg

As a consultant, find out the following

1. Determine efficiency levels in two different industries and probable measures to enhance
- 2.. As a consultant, Suggests 3 Energy Efficiency Measures for the Boiler separately keeping in mind the production processes and fuel properties.