Kafr El-Sheikh University
Faculty of Engineering
Mechanical Power Eng. Dept.
March 7, 2021 – 3rd Year

First Semester Exam
Theory of Combustion
Time: 3 hours – Full Mark: [75]

Answer the following questions. Assume any necessary assumptions.

1- **Choose the correct answer. (45 marks)(a1, a8,b5,b7,b11)**

1- The enthalpy of the combustion reactants is _____ compared to that of products.
a. More b. less c. equal

2- During combustion of gaseous fuels, deficiency of air_____
a. tends to slower the reaction b. tends to faster the reaction c. increases the reaction temperature

3- maximum adiabatic flame temperature is attained, when the fuel is burnt with_____
a. more than theoretically required amount of air.
b. theoretically required amount of oxygen.
c. theoretically required amount of air.

4- If the specific heat of gaseous products of combustion of a fuel is high, the abiabatic flame temperature will be_____
a.High b. low c. very high, if the fuel is of low calorific value

5- What is the percentage of excess air, if 10 moles of air entered the process and 10 moles of that are required?
a. 0% b. 50% c. 100%

6- The optimum percentage of excess air for combustion depends upon the _____of the fuel.
a. Calorific value b. Ignition temperature c. Type (solid, liquid or gaseous)

7- It is the temperature of a fuel at which a material self-ignites without any obvious sources of ignition, such as a spark or flame.
a.Flashpoint b. Auto-ignition c. Fire point

8- Combustion of most fuels releases
a. O2 b. CO c. CO2

9- Use of _____in vehicle reduces pollution
a. Gasoline b. Diesel c. CNG

10- Yellow colour in the flame denotes
a. Outermost part b. Middle zone c. Innermost zone

11- with the presence of water in fuels, heating value is-
a. Decrease b. Increase c. Remain constant

12- pure carbon completely burnt in oxygen, the flue gas analysis is 70% CO_2 , 20% CO and 10% O_2 . the percent excess oxygen used is _____.

a. 0 b.10 c. 20

13- With increase in H/C ratio of a fuel, the dew point of flue gases

a- Increases b- decreases c- increase or decrease depend on fuel type

14- A mixture of gases CO2, O2 and 4 g of N2 and total mass of mixture is 10 g, what is the sum of mass fraction of CO2 and O2?

a. 0.25 b. 0.6 c. 0.75

15- The equivalence ratio, $\Phi = 1$ is

a . chemically correct mixture b. lean mixture c. rich mixture

16- For hydrocarbon fuels, number of species _____ with the total number of carbon elements in fuels

a- Increases b. decreases c. constant

17- The pool of radicals increase rapidly by

a. chain initiation b. chain branching c. chain propagating.

18- the net change in the number of radicals is zero in _____ reaction

a. chain branching b. chain terminating or recombination c. chain propagating

19- When sufficient radicals are present, radicals can react among themselves in _____reaction

a. chain branching b. chain terminating or recombination c. chain propagating

20- can combuster is an example of a/an _____ burner.

a. premix flame b. diffusion flame c. Nonpremixed flame

21- in Bunsen burners ,If the equivalence ratio of mixture is greater than one the flame is _____

a. premix flame b. diffusion flame c. both premixed and nonpremixed

22- a reddish orange colour in the flame is due to radiation from

a. CH radicals b. CO_2 c. C_2 molecules

23- The heat released by 1 mol of sugar in a bomb calorimeter experiment is 5,648 kJ/mol. the enthalpy of combustion per mole of sugar is_____ .

a. - 5,65 kJ/mol b. 5,648 kJ/mol c. -5,648 kJ/mol

24- A methane fired industrial boiler operates with an oxygen concentration of 1 mole in the flue gases . the equivalence ratio is

a. 0.5 b. 0.67 c. 1.5

25- **The reactor temperature increases, the reaction rate is_____**

a.Increases **b. decreases** **c. constant**

26- **Which the following fuels have the highest heating value (kJ/L)**
a. gasoline **b- ethanol** **c- hydrogen**

27- **What is the heat of reaction if the heat of combustion of products is 40 J and heat of combustion of reactants is 25 J?**
a- 10J **b- 15 J** **c- -15 J**

28- **Bomb calorimeter is used to determine the _____calorific value**
a- lower **b- higher** **c- both lower and higher**

29- **_____is a combination of carbon monoxide, carbon dioxide, and hydrogen.**
a. Biogas **b. syngas** **c. bioethanol**

30- **_____have the lowest C/H ratio.**
a. Gaseous fuels **b. Liquid fuels** **c.Solid fuels**

2- (10 marks)(a8,c7)

isooctane C_8H_{18} burn with 20% excess air, determine:

(a) the mole fraction of fuel **(b) the fuel-air ratio**

(c) the mole fraction of H_2O in the products

(d) the temperature of products below which H_2O starts to condense into liquid at 101.3 kPa

3- (10 marks)(a8,c7)

If the adiabatic flame temperature of a constant-pressure reactor burning a stoichiometric mixture of H_2 and air at 101.3 kPa and 25°C at the inlet is 2400K. Estimate
.Take $\Delta\hat{h}^{o}_{H2O}$ = -241.88 kJ/mol

4-(10 marks)(b7,c1,c7)

Consider combustion of stoichiometric methane-air at a constant temperature of 1,800 K and 101.3 kPa. Using a one-step reaction formulation for the rate constant, estimate the amount of time required to completely consume the fuel. The consumption is assumed constant. Take

$$A_0 = 1.3\cdot10^9,\ E_a = 48.4\ \text{kcal/mol},\ a = -0.3,\ b = 1.3$$

Good luck, Dr. M. K. El-Fakharany