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MECHANICAL ENGINEERING

Objective Practice Sets

Power Plant Engineering

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CHAPTER

Fuel and Combustion

Q.1 Which of the following grades of coal contains highest volatile matter?
(a) Lignite   (b) Bituminous
(c) Anthracite   (d) All

Q.2 Which of the following is steam coal?
(a) non-coking bituminous coal
(b) brown coal
(c) pulverised coal
(d) coking bituminous coal

Q.3 Incomplete combustion can be best judged by
(a) smoky chimney exit
(b) excess air in flue gases
(c) measuring carbon monoxide in flue gases
(d) measuring oxygen in the gases

Q.4 The fuel mostly used in boilers is
(a) anthracite   (b) peat
(c) lignite   (d) bituminous

Q.5 Match **List-I (Reagents in orsat analyzer)** with **List-II** (Gas absorbed) and select the correct answer:

List-I		List-II
A. KOH	1.	O_2
B. Pyrogallol	2.	CO
C. $CuCl_2$	3.	CO_2

Codes:

	A	B	C
(a)	1	2	3
(b)	3	2	1
(c)	3	1	2
(d)	2	3	1

Q.6 The higher calorific value of fuel is:
1. Calculated assuming that the water vapour formed by combustion leaves as vapour itself.
2. Also known as gross heating value.
3. Calculated by taking into account the latent heat of vaporisation of water vapour.
4. Measured experimentally in a bomb calorimeter.

Which of the above statements are correct?
(a) 1, 2, 3   (b) 2, 3
(c) 2, 3, 4   (d) 3, 4

Q.7 Sulphur content in a fuel
(a) aids in proper combustion
(b) has high corrosive effect
(c) facilitates ash removal
(d) lowers the ignition point

Q.8 Draught means a force required to
(a) maintain a flow of air through the fuel bed and aid in the proper combustion of fuel.
(b) draw the resulting hot gases through the system.
(c) force the spent up flue gases towards the chimney and then to atmosphere.
(d) all of the above

Q.9 Consider the following statements:
1. Pulverised fuel gives high and controlled burning rate.
2. Insufficient air causes excessive smoking of exhaust.
3. Excess air is provided to control the flue gas temperature.
4. Effect of sulphur in fuel is to give high heat transfer rate.

Which of the statements are WRONG?
(a) 3 and 4   (b) 2 and 3
(c) 1 and 2   (d) 1 and 4

Q.10 Which of the following statement is **not** true in the context of draught produced by chimney?
(a) Chimney needs no auxiliary power for its operation.
(b) Amount of draught produced increases with increase in outside air temperature.
(c) Lower the temperature of furnace gases, greater will be chimney draught.
(d) No flexibility in creating more draft to take peak loads.

Q.11 Calorific value of gaseous fuels can be found be
(a) bomb calorimeter   (b) junker calorimeter
(d) fire point apparatus (d) flash point apparatus

Q.12 In a coupled separating and throttling calorimeter, 0.9 is the dryness fraction of steam in the separating unit and 0.95 is the dryness fraction in the throttling unit. What is the approximate value of the dryness fraction of the steam sample?
(a) 0.855   (b) 0.925
(c) 0.947   (d) 0.950

Q.13 Which of the following statements are incorrect?
(a) Centrifugal fans with backward curved blades are normally used for FD (Forced Draught) fans.
(b) ID (Induced Draught) laden fans handle dust land flue gases
(c) Centrifugal fans having forward curved or flat blading are used for ID fans.
(d) FD fans handle small volume flow of air hence employ backward blading.

Q.14 Forced draught fan delivers air at 10 metres/sec against a draught of 25 mm water across the fuel bed on the grate.
The total draught developed by the force draught fan is
(a) 250 N/m^2 (b) 300 N/m^2
(c) 305 N/m^2 (d) 310 N/m^2

Q.15 A chimney of height 40 m has mean flue gas temperature of 327°C. The temperature of outside air is 30°C. The air fuel ratio is 14.3. Draught produced in mm of water column is
(a) 2026 mm H_2O (b) 21.42 mm H_2O
(c) 23.26 mm H_2O (d) 24.61 mm H_2O

Q.16 A thermal electric power plant produces 1000 MW of power. If the coal releases 900×10^7 kJ/h of energy, then what is the rate at which heat is rejected from the power plant?
(a) 500 MW   (b) 1000 MW
(c) 1500 MW   (d) 2000 MW

Q.17 Draught produced by stack 30 meters high for maximum rate of discharge of hot gases through it at 27°C is
(a) 17.65 mm H_2O (b) 35.5 mm H_2O
(c) 30 mm H_2O (d) data insufficient

Q.18 Consider the following statements:
1. The amount of volatile matter indicates whether the coal will burn with a short or long flame and whether it will tend to produce smoke.
2. Proximate Analysis gives the percentage of moisture, ash and volatile matter.
3. Ultimate Analysis gives the chemical elements that comprise the coal substance.
4. Higher rank coals are characterised by a greater oxygen content that aids ignition.
Which of these statements are correct?
(a) 1, 2, 3, 4   (b) 1, 2, 3
(c) 1, 2, 4   (d) 2, 3, 4

Q.19 Consider the following statements with respect to draught system in a thermal power plant:
1. It is used to supply to the furnace the required quantity of air for complete combustion of fuel.
2. The term 'draught' is used to define the static pressure in the furnace.
3. Natural draught is provided by the use of induced draught fans
4. Forced draught fans are normally located at the foot of the stack and handle hot combustion gases.
5. Forced draught fans maintain the entire system up to stack entrance under positive gauge pressure.
Which of these statements are correct?
(a) 1, 2, 3, 4   (b) 1, 2, 5
(c) 3, 4, 5   (d) 1, 3, 4

Q.20 If x_1 and x_2 be the dryness fractions obtained in separating calorimeter and throttling calorimeter respectively, then the actual dryness fraction of steam will be
(a) $x_1 + x_2$ (b) $\dfrac{1}{x_1} + \dfrac{1}{x_2}$

(c) $x_1 x_2$ (d) $\dfrac{x_1 + x_2}{2}$

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Answers   Fuel and Combustion

1. (a)	2. (a)	3. (c)	4. (d)	5. (c)	6. (c)	7. (b)	8. (d)	9. (a)
10. (b)	11. (b)	12. (a)	13. (d)	14. (d)	15. (b)	16. (c)	17. (a)	18. (b)
19. (b)	20. (c)							

Explanations   Fuel and Combustion

1. (a)
- Anthracite has less volatile matter hence difficult to burn.
- Lignite is the lowest grade of coal containing moisture as high as 30% and high volatile matter.

2. (a)
Steam coal is the coal with relatively high sulphur content, suited for generating steam but not for coking. Non-coking bituminous coal is used as steam coal.

3. (c)
Incomplete combustion leads to formation of carbon monoxide instead of carbon dioxide, hence incomplete combustion can be best judged by measuring carbon monoxide in flue gases.

4. (d)
Non-coking bituminous coal is the fuel mostly used in boiler.

5. (c)
In Orsat gas analyser, the reagents normally used are a KOH solution to absorb the CO_2 gas, Pyrogallol solution to absorb the O_2 gas and a cuprous chloride mixture ($CuCl_2$) to absorb the CO gas.

6. (c)
Higher calorific value assumes that the water vapour in the product condenses and thus includes the latent heat of vaporization of the water vapour formed by combustion.

7. (b)
Sulphur content in a fuel has high corrosive effect, as sulphur may form SO_2 or SO_3.

8. (d)
Small pressure difference causing flow of air and gases (in and out) through the boiler is called draught (or draft). The function of draught system is basically two-fold:

- To supply the furnace the required quantity of air for complete combustion of air.
- To remove the gaseous products of combustion from the furnace and throw these via chimney or stack to the atmosphere.

9. (a)
(i) Excess air is provided for completing the combustion.
(ii) Effect of sulphur is corrosion.

10. (b)
Chimney produced draught, is caused by the density difference between the atmospheric air and the hot gas in the stack, so amount of draught produced will decrease with increase in outside air temperature.

$$\Delta P = \frac{gHP_a}{R_a}\left[\frac{1}{T_a} - \frac{1}{T_g}\right]$$

11. (b)
Bomb calorimeter is used for determining the higher calorific value of solid fuels.

12. (a)
$$x = x_1 x_2 = 0.9 \times 0.95 = 0.855$$

13. (d)
FD rotate at high speed and handle large volume flow of air.

14. (d)
Draught across the fuel bed
$$= 25 \text{ mm of water}$$
$$= g \times 25 \text{ N/m}^2$$
Draught to impart the velocity head
$$= \frac{v^2}{2g} = \frac{10 \times 10}{2g} = 5.1 \text{ m}$$
$$= 5.1 \times 1.293 \text{ kg N/m}^2 = 6.6 \times g \text{ N/m}^2$$
Total draught developed by the force fan
$$= g(25 + 6.6) = 310 \text{ N/m}^2$$

15. (b)

$$h = 353H\left[\frac{1}{T_1} - \left(\frac{m+1}{m}\right)\frac{1}{T}\right]$$

$$= 353 \times 40\left[\frac{1}{303} - \frac{14.3+1}{14.3} \times \frac{1}{600}\right]$$

$$= 21.42 \text{ mm } H_2O$$

16. (c)

Energy released by the coal
$$= 900 \times 10^7 \text{ kJ/hr}$$
$$= 2500 \text{ MW}$$
Heat rejected from the power plant
$$2500 - 1000 = 1500 \text{ MW}$$

17. (a)

Draught, $\quad h = 176.5 \times \dfrac{30}{300}$

$$= 17.65 \text{ mm } H_2O$$

18. (b)

Lower rank coals are characterised by a greater oxygen content which aids ignition

$\therefore$ statement 4 is incorrect.

19. (b)

Natural draught is provided by the use of chimney or stack. Induced draught fans are located at the foot of stack. Forced draught fans are installed at the inlet of air pre-heater.

20. (c)

For the combined throttling separating calorimeter, if x_1 is the dryness fraction obtained in separating calorimeter and x_2 is the dryness fraction obtained in throttling calorimeter then the actual dryness fraction

$$x = x_1 x_2$$

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