Sustainable and Renewable Energy Development Authority (SREDA)

Power Division, Ministry of Power, Energy and Mineral Resources

Invigilator's Signature

2nd Energy Auditor Certification Examination-2022

Paper- 2

Candidate's Roll No. | 2 | 0 | 2 | 2 | 0 | 3 | | | |

Examinee's Name _____

A

Paper 2: Energy Efficiency in Thermal Systems

Total Marks- 150, Time- 3.00 Hours, Date: 5 March 2022

- **Important Instruction:**

1. This Paper has 50 MCQs + 8 Short Questions + 6 Long Questions = Total 64 Questions.
2. Mark indicated on the right side of each question.
3. Fill in correct circle with permanent ink ballpoint pen shown on the top sheet only corresponding to the MCQ given in Section A.
4. Answer in the blank space provided after each question (short/long).
5. Do not put any sign or write anything on the answer script except written answer.
6. Any unfair means, peer talking, keeping any communication device and misbehavior will lead to cancellation of examination.

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MCQ Answer (Section A):

1	18	35	
2	19	36	
3	20	37	
4	21	38	
5	22	39	
6	23	40	
7	24	41	
8	25	42	
9	26	43	
10	27	44	
11	28	45	
12	29	46	
13	30	47	
14	31	48	
15	32	49	
16	33	50	
17	34		

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MCQ	:	[ ]	
Short Question	:	[ ]	
Long Description Question	:	[ ]	
Total Marks	:	[ ]	Signature of Examiner

Do not write or mark anything in this page

Section A: MCQ

Fill the appropriate circle in the OMR answer sheet at the top page.

1 x 50 =50

1 Among which of the following fuels, the difference between the GCV and NCV is maximum

A) coal
C) natural gas
B) furnace Oil
D) hydrogen

2 Which of the following has the lowest energy content in terms of MJ/kg

A) LPG
C) Bagasse
B) Diesel
D) Furnace oil

3 The stoichiometric amount of air required to burn 1 kg of methane is

A) 69.57
C) 17.39
B) 4
D) 16

4 Temperature control in fuel oil storage tank is intended to control

A) viscosity
C) specific heat
B) density
D) caloric value

5 With increase in the percentage of excess air for combustion of coal, percentage of CO2 in flue gas

A) increases
C) remains same
B) decreases
D) none of the above

6 Desirable boiler water pH should be?

A)) 5-7
C) 9-11
B) 7-9
D) none of the above

7 In a boiler Air preheater is installed

A) before the economizer
C) after ESP
B) after economizer
D) before superheater

8 According to the Boiler Act, 1923 which is not true for boiler definition

A) volume of vessel must be over 22.76 liters
C) it must be a closed vessel
B) working pressure more than 1.0 MPa
D) it must generate steam for external use

9 Which of the component is common to supercritical boiler and sub critical boiler for power generation

A) economizer
C) re-heaters
B) water walls
D) all of the above

10 The material used to control SOx in the FBC boiler is

A) limestone
C) silica
B) alumina
D) fly ash

11 The TDS level in boiler water, in the context of boiler blow down, can be determined by measuring

A) alkalinity of water
C) electrical conductivity of water
B) thermal conductivity of water
D) turbidity of water

12 In an oil-fired steam boiler, the air to fuel ratio is 15:1 & evaporation ratio is 14:1. The flue gas to fuel ratio will be

A) 29:1
C) 14:1
B) 16:1
D) 15:1

13 Latent heat of steam increases

A) with increasing pressure
C) does not changes with pressure
B) with decreasing pressure
D) none of the above

14 If the diameter of the steam main is 280 mm what will be the pocket diameter of the drip leg?

A) 280 mm
C) 140 mm
B) 100 mm
D) 140 mm

15 Which is not the component of a PRV (Pressure Reducing Valve) station?

A) separator
C) safety Valve
B) strainer
D) temperature Gauge

16 Removal of dissolved gases from the boiler feed water is called

A) degasification
C) deoxidation
B) deaeration
D) none of the above

17 Large and irregular lumps of coal when fired in a boiler may lead to ____.

A) poor combustion
C) low unburnt fuel in the ash
B) low excess air
D) high thermal efficiency

18 High percentage of carbon monoxide presence in the flue gas of boiler is an indicator of

A) high excess air
C) good control of pollutants
B) complete combustion
D) low excess air

19 Heat transfer mode in a furnace -

A) radiation and convection
C) conduction and radiation
B) only radiation
D) only convection

20 What pressure should be maintained for optimum fuel consumption in furnace?

A) slight positive pressure
C) negative pressure
B) positive pressure
D) slight negative pressure

21 Which of the following is used as insulation in low temperature applications?

A) ceramic fiber
C) fiber glass
B) calcium silicate
D) polystyrene

22 The determination of economic thickness of insulation does not depend on

A) surface temperature
C) cost of insulation
B) pipe diameter
D) material of the surface

23 The coefficient of thermal expansion of refractory material should be

A) low
C) medium
B) high
D) very high

24 Low combustion temperature minimises___ in FBC boilers

A) NOx
C) CO
B) SOx
D) Suspended particulate matter

25 The difference between mean velocity of solid and gas in a FBC boiler is called

A) fluidization factor
C) settling velocity
B) slip velocity
D) none of the above

26 Which of the following is not measured in proximate analysis?

A) volatile matter
C) sulphur
B) fixed carbon
D) ash

27 In a counter-flow heat exchanger, cold fluid enters at 30°C and leaves at 50°C, whereas the hot fluid enters at 150°C and leaves at 130°C. The LMTD is

A) 100°C
C) 0°C
B) 280°C
D) 20

28 100 kg of a fuel contains 2% Sulphur. For complete combustion of Sulphur it will require _____kg of oxygen

A) 2
C) 50
B) 4
D) 200

29 In a CFBC boiler, the capture and recycling of bed material is accomplished by

A) bag filter
C) natural gas
B) settling chamber
D) scrubber system

30 In a steam turbine power plant, vacuum is generated at

A) turbine inlet
C) deaerator
B) condenser
D) all of the above

31 1 kg of wood contains 30% moisture and 5% hydrogen by weight. How much water is evaporated during complete combustion of 1 kg of wood?

A) 0.75 kg
C) 0.15 kg
B) 200 g
D) none of the above

32 Which of the Cogen system can offer a minimum range of heat to power ratios

A) back pressure steam turbine
C) gas turbine
B) combined Cycle
D) DG sets

33 A 2000 kg/hr flue gas is exhausted from DG set at 400oC. Specific heat is 0.25 kCal/kg. Ambient temperature is 30oC. What is the Heat available in the flue gas?

A) 2,00,000 kCal/hr
C) 8,00,000 kCal/hr
B) 1,85,000 kCal/hr
D) 1,00,000 kCal/hr

34 The exhaust from which of the following is not suitable for waste heat boiler application?

A) gas turbine
C) diesel engine
B) hot air dryer
D) furnace

35 Which is not the problem of undersized steam pipe works

A) a lower pressure might be available at the point of use
C) greater volume of condensate will be formed
B) there is a risk of steam starvation
D) there is a greater risk of erosion, water hammer and noise

36 For high temperature application which is the best insulation material?

A) asbestos
C) glass wool
B) rock wool
D) glass wool

37 For steam main pipeline which steam trap is best suited?

A) thermodynamic trap
C) inverted bucket trap
B) float trap
D) thermostatic trap

38 What happen to the furnace exhaust gas loss if the air/fuel ratio decreases?

A) increase
C) initially decrease and then start to increase
B) decrease
D) no change

39 Which is wrong for proper heat distribution in furnace?

A) the flame should impinge the stock
C) flame should not hit the roof
B) the axis of the burner is never placed parallel to the hearth
D) more burner of less capacity gives better heat distribution in the furnace

40 Which of the following is a synthetic refractory?

A) MgO
C) SiC
B) Al_2O_3
D) SiO_2

41 Which is not the features of cold insulation?

A) low thermal conductivity
C) durability at low temperature
B) high water resistance
D) high capillary absorption

42 In FBC boiler the combustion is carried out at a temperature

A) closer to steam temperature
C) at and above ash fusion temperature
B) at adiabatic combustion temperature
D) below ash fusion temperature of fuel used

43 The heat loss in a furnace depends on

A) emissivity of walls
C) wall thickness
B) conductivity of refractory
D) all of the above

44 ____ gives an estimate of heating value of coal

A) ash content
C) fixed carbon
B) moisture content
D) volatile matter

45 In a coke fired cupola, carbon monoxide is produced in the

A) melting zone
C) combustion zone
B) reducing zone
D) preheating zone

46 Dolomite is a _____ type of refractory

A) acidic
C) neutral
B) basic
D) none of the above

47 For transporting the steam to the long distance, the best quality of steam is

A) dry saturated steam
C) mildly wet steam
B) slightly superheated steam
D) very high pressure steam

48 An increase in bulk density of a refractory increases its

A) thermal conductivity
C) resistance to slag penetration
B) heat capacity
D) all of the above

49 An increase in the steam pressure from 3 bar to 10 bar, will result in a decrease of

A) sensible heat
C) saturation temperature
B) enthalpy of steam
D) specific volume

50 The amount of CO_2 produced in complete combustion of 18 Kg of carbon is

A) 50
C) 66
B) 44
D) 792

Section B: Short Question

		Marks
01	Explain the difference between Flash Point and Pour Point of a liquid fuel?	5
02	Calculate the savings in heat loss due to reduction in blow down by using auto blow-down controller, from 2.5% to 1% for 10 T/hr boiler, which operates 8000 hrs/year. The temperature of boiler blow down water is 180^{o}C, boiler efficiency is 80% and GCV of Furnace oil is 10,000 kCal/kg. Feed water temperature = 30^{o}C	5

03	The efficiency of a billet heating furnace with an output of 15 ton/hr was 32%. Find out the specific fuel consumption in litre/ton of billet heating and total fuel consumption per hour as per data given below: Billet heating furnace: Initial temp. = $50^{o}C$ Final temp. = $1150^{o}C$ Specific heat of billet = 0.12 kCal/kg^{o}C Density of fuel oil = 0.95 kg/litre GCV of fuel oil = 10,000 kCal/kg Determine the specific fuel consumption in litre/ton and total fuel consumption in litre/hr.	5

04	How can you select refractories for any application?	5
05	Two identical FBC boilers of capacity 10 TPH are operated in a chemical industry. They each have a full load efficiency of 80%. The part load efficiencies at 70% and 40% load are 75% and 68% respectively. For meeting 14 TPH requirement of steam, would you prefer to run both the boilers at 7 TPH capacity or one at full load capacity and other at 40% capacity. Estimate the % savings in the preferred case.	5

06	Milk is flowing in a pipe cooler at a rate of 0.95 kg/sec. Initial temperature of the milk is 55°C and it is cooled to 18°C using a stirred water bath with the constant temperature of 10°C around the pipe. Specific heat of milk is 3.86 KJ/kg°C. Calculate the heat transfer rate (kCal/hr) and also LMTD of the exchanger.	5
07	What are the parameters required to estimate the boiler efficiency by 'direct method'?	5

08	The following are the parameters obtained from a steam audit of a cylindrical dryer used for drying cloth: Cloth Throughput = 25 m/minute Cloth Density = 10 m/kg Measured Condensate Rate = 150 kg/hour Calculate the specific steam consumption per kg of cloth.	5

Section C: Long Question

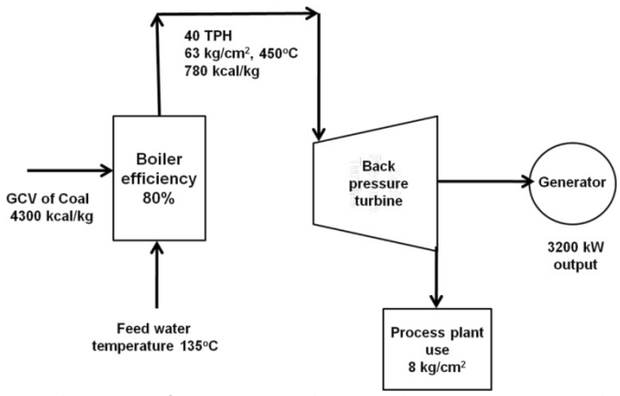
		Marks
01	Paddy husk is being used as a fuel in a water tube boiler. The ultimate analysis of fuel is given below. Calculate the theoretical quantity of air required for complete combustion and compute the quantity of CO_2, H_2O and SO_2 generated per 100 kg of fuel. The ultimate analysis of paddy husk is given below. **Ultimate analysis of paddy husk** **%** Moisture 10.8 Mineral Matter 16.7 Carbon 34.0 Hydrogen 5.0 Nitrogen 0.9 Sulphur 0.1 Oxygen 32.5 GCV (kCal/kg) 3570	10

02	What are the common mistakes in steam trap installation? State their corrective measures.	10

03	In an engineering industry, an electrically heated furnace of efficiency 80%, is used for annealing of the components. The annealing cycle and corresponding energy consumption as follows. The electrical energy drawn in each sub-cycle is uniform and plant operates 50 batches per month. The cost of electricity is Tk.8/kWh. The management has decided to replace the electric furnace with Furnace oil fired furnace with efficiency of 50%. The cost of Furnace Oil is Tk.30/kg. Calculate cost savings and payback period of converting from electric to oil fired furnace. Investment for Furnace Oil fired furnace is Tk.25 lakhs. The GCV of Furnace Oil is 10,000 kCal/kg.	10

S.No	Heat treatment cycle	Temperature ^{0}C	Time hrs	Power drawn in kW
1	Heat -Up	30 - 850	4	500
2	Holding at	850	4	100
3	Cooling	850 - 60	4	20

04	a) List the advantages of CFBC boilers over AFBC boilers. b) What are the advantages of plate heat exchanger over shell and tube heat exchanger?	5+5

05	The schematic of a back pressure steam turbine cogeneration system of process plant operating round the clock with operating data is depicted below.  If the steam requirement of the process is to be increased to 45 TPH which can be met by the existing boiler through the back pressure turbine, a) Find out the reduction in cost of electrical energy drawn from the grid per day due to additional power generation, assuming the same steam to power recovery as in the existing case and at a grid electricity cost of BDT 6/kWh, aux. power remains the same. b) Estimate the cost of coal per day, if the coal price is BDT 12,500/Ton. c) Comment on the findings.	10

06	In a crude distillation unit of a refinery, furnace is operated to heat 500 m^3/hr of crude oil from 260°C to 360°C by firing 3.4 tons/hr of fuel oil having GCV of 10000 kCal/kg. As an energy conservation measure, the management has installed an air preheater (APH) to reduce the flue gas heat loss. The APH is designed to pre-heat 57 tons/hr of combustion air to 200°C. Calculate the efficiency of the furnace before & after the installation of APH. Consider the following data: Specific heat of crude oil = 0.6 kCal/kg°C Specific heat of air = 0.24 kCal/kg°C Specific gravity of Crude oil = 0.85 Ambient temperature = 30°C.	10