Sustainable and Renewable Energy Development Authority
(SREDA)
Power Division, Ministry of Power, Energy and Mineral Resources

3rd Energy Auditor Certification Examination-2022

Paper- 2

Candidate's Roll No. | 2 | 0 | 2 | 2 | 1 | 1 | | | |

Examinee's Name _____

Invigilator's Signature

Invigilator's Signature

B

Paper 2: Energy Efficiency in Thermal Systems

Total Marks- 150, Time- 3.00 Hours, Date: 26 November 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.

MCQ Answer (Section A):

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

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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 When liquid LPG evaporates it produces about _____ times volume of gas

A) 4
C) 40
B) 150
D) 250

2 Typical excess air to achieve the highest possible efficiency for natural gas is

A) 10-20%
C) 5-10%
B) 15-45%
D) 3-5%

3 The type of firing used for a pulverized coal fired boiler is

A) over firing
C) tangential firing
B) vertical firing
D) mixed firing for effective heat transfer

4 The circulation ratios of once through boiler can vary from

A) 30-50
C) 20-30
B) 1-3
D) 3-20

5 Which boiler is not suitable for high pressure application

A) water tube
C) super critical
B) fire tube
D) None of the above

6 Effect of air in steam system is

A) a lower pressure might be available at the point of use
C) reduced steam temperature
B) a risk of steam starvation
D) risk of erosion, water hammer and noise

7 Which is not the heat transfer barrier to a heat transfer surface

A) condensate film
C) scale
B) air film
D) steam

8 Approximately 1% fuel can be saved by raising the temperature of feed water by

A) 1^0C
C) 4^0C
B) 10^0C
D) 6^0C

9 What percentage of flash steam will be generated if the 7 bar (g) hot condensate is released to atmosphere? (Sensible heat of condensate at 7 bar (g) is 721 kJ/kg and at atmospheric pressure is 419 kJ/kg, enthalpy of evaporation at atmospheric pressure is 2258 kJ/kg)

A) 13.4%
C) 23.4%
B) 50.48%
D) 5.48%

10 The frequency of the alternating current used in induction furnaces may vary

A) 50 Hz-60 Hz
C) 50 Hz-1000 Hz
B) 50 Hz-10000 Hz
D) 50 Hz – 100 Hz

11 The axis of the burner in a furnace should be kept

A) slightly inclined towards the roof
C) more inclined towards the stock
B) slightly inclined towards the stock
D) parallel to stock

12 'Ceramic fiber insulation' is suitable up to temperature of

A) 540 °C
C) 1430 °C
B) 1050 °C
D) 1850 °C

13 Refractories with higher thermal conductivity are preferred in

A) regenerators
C) boilers
B) kiln
D) furnaces

14 The component required to reduce shrinkage levels in alumino silicate fibre is ___.

A) Al_2O_3
C) ZrO_2
B) SiO_2
D) all of the above

15 The insulation material suitable for low temperature application is

A) mineral fiber
C) silica
B) fiber glass
D) polyurethane

16 Which is not the component of FBC boiler?

A) air mover
C) solid withdrawal system
B) plenum Chamber
D) expansion valve

17 In FBC boilers the percentage of bottom ash to the total ash is about

A) 80-90%
C) 60-70%
B) 30-40%
D) 0%

18 FBC boiler has an advantage of

A) burning high quality coal
C) burning wide variety of coal
B) burning variety liquid fuels
D) None of the above

19 A waste heat recovery system (Shell and Tube heat exchanger) receives hot fluid at 180°C and leaves at 70°C, cold medium enters at 30°C and leaves at 80°C, the type of flow involved in this is

A) cross-flow
C) counter-current flow
B) co- current flow
D) none of the above

20 Rankine cycle is related to

A) boiler
C) condenser
B) steam turbine
D) all of the above

21 The cogeneration system which has high overall system efficiency is

A) back pressure steam turbine
C) extraction condensing steam turbine
B) combined cycle
D) reciprocating engine

22 The turbine heat rate is expressed as

A) kWh/kcal
C) kcal/kWh
B) kg/kcal
D) none of the above

23 Tube in tube heat exchanger cannot be used for

A) generating power
C) generating process steam
B) heating and ventilation
D) pre-heating combustion air

24 In an industry, exhaust gas from the furnace is used for power generation by installing waste heat recovery steam boiler and a steam turbine. This type of co-generation is termed as

A) combined cycle
C) topping cycle
B) brayton cycle
D) bottoming cycle

25 The heat recovery device in which high conductivity bricks are used for storing heat is

A) heat pipe
C) thermo compressor
B) heat pump
D) regenerator

26 100 tons of coal with a GCV of 4200 kcal/kg can be expressed in 'tonnes of oil equivalent' as

A) 42
C) 420
B) 50
D) 125

27 Chemical used for dozing in boiler drum to reduce dissolved gases is

A) hydrazine
C) alum
B) chlorine
D) all of the above

28 Higher excess air in an oil fired furnace would result in

A) increased furnace temperature
C) reduced flame temperature
B) increase in CO_2 presence in flue gas
D) increased flame length

29 Deaerator is a _____ heat exchanger.

A) Shell and tube type
C) Direct contact type
B) Plate type
D) Run Around Coil type

30 Which trap is preferred in discharge of condensate recovery from process equipment?

A) Float trap
C) Thermostatic trap
B) Thermodynamic trap
D) All of the above

31 Desirable boiler water pH should be?

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

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

A) 50 C) 66

B) 44 D) 792

33 Removal of condensate from main steam line is done to prevent

A) steam locking C) water hammer

B) air locking D) all of the above

34 The heat loss in a furnace depends on

A) emissivity of walls C) wall thickness

B) conductivity of refractory D) all of the above

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

A) Degasification C) Deoxidation

B) Deaeration D) None of the above

36 The highest % of sulphur is present in

A) LPG C) Natural gas

B) Furnace oil D) Kerosene

37 LPG is predominantly the mixture of Propane and ___ .

A) methane C) butane

B) ethane D) Isopropane

38 To improve the boiler efficiency, which of the following needs to be done

A) maximize O_2 in flue gas C) minimize CO_2 in flue gas

B) maximize CO_2 in flue gas D) maximize CO in flue gas

39 Which of the following is used for controlling pressure in a natural draft furnace?

A) Forced draft fan C) Dampers

B) Induced draft fan D) Both (A) & (B)

40 Steam at 6 bar has a sensible heat of 159.33 kcal/kg and latent heat of 498.59 kcal/kg. If the steam is 95 % dry then the total enthalpy is

A) 625 kcal/kg C) 553 kcal/kg

B) 649.95 kcal/kg D) 633 kcal/kg

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

A) LPG C) Bagasse

B) Diesel D) Furnace oil

42 Coal size of 75% below 75 micron is required for use in

A) spreader stoker boiler C) fluidized bed boiler

B) chain grate stoker boiler D) pulverized fuel boiler

43 Electrical energy consumption for coal sizing will be maximum for

A) stoker fired boiler C) CFBC boiler

B) AFBC boiler D) pulverised coal boiler

44 Steam generated in a boiler is 36 tonnes in 3 hours. Fuel consumption in the same period is 1 tonne per hour. Continuous blow down is 8% of feed water input. The boiler evaporation ratio is

A) 12
C) 36
B) 11.7
D) 24

45 Correction factor for LMTD is commonly applicable for

A) parallel flow type
C) cross flow type
B) counter flow type
D) both (a) and (b)

46 The working media in a thermo-compressor is

A) electricity
C) high temperature oil
B) compressed air
D) steam

47 The coefficient of thermal expansion of refractory material should be

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

48 Water flows at a rate of 30 m^3/hr. at 15^oC in a 150 mm bore pipe horizontally. What is the velocity of water flow in the pipe?

A) 0.47 m/s
C) 1.88 m/s
B) 0.94 m/s
D) none of the above

49 The head loss due to friction in a pipe is

A) directly proportional to the diameter
C) inversely proportional to the velocity
B) directly proportional to the gravitational constant
D) directly proportional to the square of velocity

50 The unit of overall heat transfer coefficient is

A) W/m^2 K
C) W^2/m^3 K
B) W^2/m^2 K
D) W/m^3 K

Section B: Short Question

		Marks
01	What are the advantages & disadvantages of calculating Boiler efficiency by direct method? Calculate the boiler efficiency if the evaporation ratio is 6 for a coal fired boiler? Steam enthalpy – 650 kcal/kg & GCV of coal – 5000 kcal/kg, feed water temperature 40^{o}C.	5

02	Calculate pressure drop in meters when pipe diameter is increased from 250 mm to 350 mm for a length of 500 meters. Water velocity is 2 m/s in the 250 mm diameter pipe and friction factor is 0.005.	5
03	What are the parameters required to evaluate economic thickness of insulation.	5

04	List the advantages of CFBC boilers over AFBC boilers.	5
05	Estimate the stoichiometric A/F ratio of Methane (CH_4).	5

06	The specification of a given oil sample is as follows: C = 72%, H_2 = 4%, O_2 = 18%, N_2 = 2.8% & S = 3.2% Estimate the stoichiometric A/F ratio required to burn the oil sample.	5
07	What are the parameters required to estimate the boiler efficiency by 'direct method'?	5

08	If one 1.5 kW diesel generator consumes 1 liter/hr diesel, estimate the thermal efficiency of the engine. Diesel has the following properties: S.G. = 0.84, LHV = 44 MJ/kg.	5

Section C: Long Question

		Marks
01	An uninsulated 100 mm pipe of 200m length carries steam at 10 kg/cm^2. The surface temperature measured is 165^{0}C. Find out the annual cost saving achieved by insulating it with 50 mm insulating material, which will bring the surface temperature down to 60^{0}C. The boiler efficiency is 85%, the fuel oil (with GCV of 10000 kcal/kg) cost is Tk.20,000 / tonne and ambient air temperature is 30^{0}C and annual operating hour is 8000 hours.	10

02	An open cycle gas turbine was running with naphtha as fuel. The following are the data collected during the gas turbine operation: Fuel (Naphtha) consumption = 300 kg/hr GCV of naphtha fuel = 11,500 kcal/kg Overall Efficiency of gas turbine = 22% (Which includes air compressor and alternator) Cost of naphtha fuel = Tk.40,000/Tonne a) Find out the output power and cost of fuel for generating one unit of electricity. b) The management has decided to install a waste heat boiler, to generate 2 TPH of saturated steam, at 4 kg/cm^2(g), with an enthalpy of 656 kcal/kg. Assuming that, 50% of the input heat is available in the turbine exhaust gases, how much steam can be generated if the feed water temperature is 30^{o}C.	10

03	A paddy drier requires 80 m^3/min of air at 92^0C, which is heated by rice husk fired thermic fluid heater. The density of air is 1.2 kg/m^3 and specific heat of air is 0.24 kcal/kg ^{0}C. The inlet air temperature to the drier is 32 ^{0}C and the drier is operating for 8 hrs per day. The efficiency of the husk fired heater and its distribution piping system is 50 %. The gross calorific value and the cost of purchased husk are 2000 kcal/kg and Tk. 5000 per ton. The auxiliary power consumption for operating the thermic fluid heater is 10 kW. The energy auditor recommended replacing the existing drying system with a 40-kW infrared electric heater drier. The kW loading of the proposed drier will be 70% over an 8-hour plant-operating period. The investment for the new drier is Tk. 10 Lakhs. If the cost of electricity is Tk. 7/kWh, calculate the following: a) Find out the annual energy cost savings of replacement of thermic fluid system with infra-red heater? b) Find out the payback period.	10

04	A process requires 7.5 TPH of dry saturated steam at 7 atm. pressure. a. Estimate the pipe size if the maximum allowable flow velocity is 20 m/s, assuming density of steam as 4 kg/m^3. b. Estimate pressure loss between two points 100 m apart if the friction factor of the pipe is taken as 0.005.	5+5

05	Mention some of the key characteristics of the following boiler types: a) Fire-tube boiler b) Water-tube boiler c) Once-through boiler d) Package boiler	10

06	A counter-flow double pipe heat exchanger using hot process liquid is used to heat water flowing at 10 m^3/hr. The process liquid enters the heat exchanger at 180°C and leaves at 130°C. The inlet and exit temperature of water are 25°C and 95°C respectively. Specific heat of water is 4.18 kJ/kg°C. a) Calculate the heat transfer area, if overall heat transfer coefficient is 750 W/m^2 °C. b) What would be the percentage increase in area, if the fluid flows were parallel?	10