

**NATIONAL CERTIFICATION EXAMINATION 2004
FOR
ENERGY AUDITORS**

PAPER – EA2: Energy Efficiency in Thermal Utilities

Date: 22.05.2004 Timings: 1400 - 1700 HRS Duration: 3 HRS Max. Marks: 150

General instructions:

- Please check that this question paper contains **6** printed pages
- Please check that this question paper contains **65** questions
- The question paper is divided into three sections
- All questions in all three sections are compulsory
- All parts of a question should be answered at one place

Section – I: OBJECTIVE TYPE

Marks: 50 x 1 = 50

- (i) Answer all **50** questions
- (ii) Each question carries **one** mark
- (iii) Put a (✓) tick mark in the appropriate box in the answer book

1.	Stoichiometric amount of Oxygen needed for complete combustion of 1kg of Methane is a) 17.39 kg b) 4 kg c) 6 kg d) none of the above
2.	In case of fuel oils, fuel density and specific heat are correlated as follows a) lighter oils have higher specific heat b) heavier oils have lower specific heat c) lighter oils have lower specific heat d) none of the above
3.	Identify the fuel among the four which has the highest specific gravity. a) Kerosene b) LSHS c) LDO d) HSD
4.	Proximate analysis of coal determines the weight percentage of the following a) Fixed carbon, volatile matter, moisture, ash b) All solid and gaseous components c) All solid and gaseous components except volatile matter d) Fixed carbon and volatile matter only
5.	For complete combustion of 1 kg of furnace oil, the approximate theoretical amount of air required is a) 14 kg b) 15.5 kg c) 21 kg d) 10 kg

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6.	Increased percentage of Carbon Monoxide and low percentage of Carbon Dioxide in the flue gas of boiler is an indicator of a) low excess air c) good control of pollutants	b) very high excess air d) stoichiometric combustion
7.	Oxygen Percentage measurement in the flue gas by volume basis involves the use of a) ultrasonic probe c) pitot tube	b) potassium oxide probe d) zirconium oxide probe
8.	An IBR steam boiler means any closed vessel exceeding ... litres in capacity and which is expressively used for generating steam under pressure. a) 18.75 b) 20.75 c) 22.75 d) 24.75	
9.	Which of the following data is not required in a boiler efficiency evaluation by direct method a) steam flow b) fuel flow c) feed water temperature d) O ₂ % in flue gas	
10.	The recommended maximum TDS level in the boiler drum, that should be maintained for a high pressure water tube boiler with super heater is a) 3000 – 3500 ppm b) 2000 ppm c) 5000 ppm d) It can be anything	
11.	An oil fired boiler is operating at 5% O ₂ in the flue gas. The percentage excess air supplied to the boiler is approximately a) 15 % b) 25 % c) 31 % d) 42 %	
12.	A rise in the conductivity of boiler feed water indicates a) decrease in level of dissolved solids b) greater purity of feed water c) increase in level of dissolved solids d) none of the above	
13.	Removal of dissolved gases from boiler feed water is called a) Degasification b) Deaeration c) De-oxidation d) None of the above	
14.	Which type of steam will be ideal for indirect heat transfer in a heat exchanger? a) super heated steam b) dry saturated steam c) wet steam d) none of the above	
15.	What type of steam is generally used for electrical power generation? a) high pressure steam with super heat b) dry saturated steam c) dry saturated steam with high pressure d) wet steam with very high pressure	
16.	The inverted bucket steam trap operates on the principle of a) temperature difference b) density difference c) pressure difference d) None of the above	
17.	The normal velocities encountered in pipes for superheated steam is a) 50-70 m/sec b) 30-40 m/sec c) 20-25 m/sec d) 15-20 m/sec	

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18.	A steam trap is a device, which discharges a) steam b) dry steam c) condensate d) effluent
19.	Which of the following is used as insulation in low temperature applications a) ceramic fibre b) calcium silicate c) fibre glass d) polystyrene
20.	The equipment used to remove dirt from steam lines before steam trap is a) vent b) drain c) strainer d) by pass line
21.	Proper sizing of steam pipeline helps reducing a) steam pressure b) steam temperature drop c) dryness fraction of steam d) steam pressure drop
22.	What happens if steam pipe insulation gets wet? a) emissivity increases b) convection losses decrease c) thermal conductivity of insulation increases d) none of the above
23.	For the same amount of excess air, the heat loss of a furnace will be a) higher at higher furnace temperatures b) same at higher furnace temperatures c) lower at higher furnace temperatures d) none of the above
24.	In a large glass industry, the equipment connected with glass melting furnace for preheating the combustion air is a) recuperator b) regenerator c) shell & tube heat exchanger d) heat wheel
25.	Putting insulation at the outside of the wall of a batch type furnace will always a) decrease furnace efficiency b) increase furnace efficiency c) increase wall temperatures d) none of the above
26.	The furnace pressure at hearth in the heating zone should be a) slightly negative pressure b) slightly positive pressure c) highly negative pressure d) highly positive pressure
27.	Increasing excess air level in an oil fired furnace will have the following effect a) increased furnace temperature b) increase of % CO ₂ in flue gas c) reduced furnace temperature d) reduced flue gas loss
28.	The difference between mean solid velocity and mean gas velocity in a FBC boiler is called a) fluidization b) slip velocity c) settling velocity d) none of the above
29.	The function of lime stone used as bed material FBC boiler is to remove a) ash b) sulphur and NOx c) un-burnts d) sulphur
30.	The coal particle size most suitable for CFBC boilers is in the range of a) 5 – 6 mm b) 6 – 12 mm c) 12 – 15 mm d) 15 – 25 mm

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31.	Which of the following when added to alumino silicate helps to reduce shrinkage a) ZrO ₂ b) SiO ₂ c) Al ₂ O ₃ d) CaSO ₄
32.	What improves heat transfer in FBC? a) low temperature b) little turbulence c) maximum slip velocity d) none of the above
33.	For efficient sulphur retention, the temperature of the fluidized bed should be in the range of a) 950°C -1000°C b) 1050°C -1100°C c) 800°C - 850°C d) none of the above
34.	Which type of fluidized bed combustion boiler would be a good choice for more efficient combined cycle power generation a) CFBC b) AFBC c) PFBC d) all of the above
35.	CFBC is a good choice if a) medium to large boiler capacity is required b) SO _x emission and NO _x control is important c) low grade fuel or fuel with high fluctuating fuel quality is fired d) all of the above
36.	Find the thermodynamic cycle not related to cogeneration. a) Brayton cycle b) Rankine cycle c) Otto cycle d) Bell-Coleman cycle
37.	Which among the following steam turbines has the highest efficiency a) condensing turbine b) back pressure turbine c) extraction condensing d) double extraction condensing
38.	A cycle which generates first electricity or mechanical power is called a) bottoming cycle b) topping cycle c) combined cycle d) cogeneration cycle
39.	Energy consumed by the air compressor of a gas turbine plant is approximately..... % of generation a) 10 b) 22 c) 55 d) 80
40.	Efficiency of cogeneration plants fall within the following range a) 50% - 90% b) 60% – 90% c) 70% – 90% d) 80% – 90%
41.	A power plant which uses first a gas turbine followed by steam turbine for power generation is called a) Topping cycle b) Bottoming cycle c) Brayton cycle d) Combined cycle
42.	Typical heat to power ratio range in pulp and paper industry is a) 1.1 – 4.5 b) 2.5 – 4.0 c) 0.8 – 3.0 d) 1.5 – 2.5
43.	Which industry does not normally use the concept of cogeneration? a) sugar b) pulp & paper c) refinery d) refractory

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44.	The overall efficiency of sensible heat transfer in heat wheels can be as high as a) 60% b) 70% c) 85% d) 95%
45.	The temperature of waste gases coming out from a gas turbine exhaust are in the range of a) 450°C – 550°C b) 450°C – 700°C c) 700°C - 800°C d) 250°C - 440°C
46.	The device used to upgrade a low pressure steam to a higher pressure steam is called a) heat pump b) thermocompressor c) heat pipe d) heat wheel
47.	Generally for every 6° C rise in feed water temperature by an economizer, the fuel savings in an oil fired boiler is of the order of a) 1% b) 2% c) 3% d) 4%
48.	In a low temperature waste heat recovery system, which of the following devices is the most suitable a) economiser b) heat wheels c) regenerator d) ceramic recuperator
49.	The temperature range of exhaust gases of a turbo charged reciprocating engine is a) 230°C - 370°C b) 450°C - 540°C c) 540°C - 620 °C d) 620°C - 700 °C
50.	Magnesite, chrome-magnesite, dolomite are examples of ... type of refractory a) acidic b) basic c) neutral d) none of the above

..... End of Section – I

Section – II: SHORT DESCRIPTIVE TYPE

Marks: 10 x 5 = 50

- (i) Answer all **Ten** questions
- (ii) Each question carries **Five** marks

- S-1. Mention a few agro residues used as fuel, and compare the Calorific Value of one kg of dry agro residue with that of one kg of furnace oil.
- S-2. Define sensible heat, latent heat, enthalpy of evaporation and super heat of steam.
- S-3. What is the need for boiler feed water treatment? Which boiler property influences most the required quality of boiler feed water ?
- S-4. Which are the two most attractive and economical measures of energy conservation in furnaces in India?
- S-5. Define the term 'emissivity' of a refractory material. What does high emissivity ceramic coating achieve in furnaces?

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- S-6. What is the advantage of PFBC system over AFBC?
- S-7. Define the heat-to-power ratio of a cogeneration plant. State its importance. What does a heat to power ratio of ZERO mean?
- S-8. How does a direct contact heat exchanger work? State a typical application.
- S-9. What is the unit of viscosity? Name the instrument used for measuring the viscosity of fuel oil.
- S-10. Draw the enthalpy versus temperature curve of steam in a y-x coordinate system. Label and indicate at least one important point or area of this curve in that system.

..... **End of Section - II**

Section – III: LONG DESCRIPTIVE TYPE

Marks: 5 x 10 = 50

- (i) Answer all **Five** questions
(ii) Each question carries **Ten** marks

- L-1. Discuss four energy efficiency improvement opportunities in a boiler system.
- L-2. Explain the concept of a FBC boiler by a sketch. What are the major benefits of using an FBC boiler?
- L-3. Initial Oxygen level in the furnace exhaust is 11%. The level was brought down to 4%. Find out the percentage reduction in heat loss. For simplicity, assume flue gas temperature remains the same.
- L-4. Why is it advantageous to use steam at the lowest acceptable pressure in an indirect heating application?
- L-5. A steam pipeline of 100 mm outer diameter is not insulated for 100 meters and supplying steam at 10 kg/cm². Find out the annual fuel savings if the line is properly insulated with 65 mm insulating material. Assume 6000 hours/year of operation.

Given:

Boiler efficiency –	80%
Fuel oil cost –	Rs.15,000/tonne
Calorific Value of fuel oil –	10,300 Kcal/kg
Surface temperature without insulation –	190°C
Surface temperature after insulation –	65°C
Ambient temperature –	25°C

..... **End of Section - III**