

**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 **7** 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.	Excess air can be derived by measuring percentage of in flue gas a) CH ₄ b) O ₂ c) CO d) N ₂
2.	Which of the following fuel requires the largest amount of excess air for complete combustion? a) Furnace Oil b) LDO c) Coal d) Natural Gas
3.	LPG consists of one of the following a) Methane b) Iso-Octane c) Hexane d) Propane
4.	The limiting temperature to which the flue gases can be cooled is influenced by percentage of a) Carbon in fuel b) Hydrogen in fuel c) Sulphur in fuel d) Ash in fuel
5.	Stoichiometric air to fuel ratio for burning one kg of Carbon is a) 10.0 b) 11.6 c) 3.76 d) none of the above
6.	Which parameter of coal gives a rough estimate of Calorific Value a) Hydrogen b) Fixed Carbon c) Carbon d) none of the above.
7.	A system in which the boiler operates with a FD and ID fan is called a) Natural draft b) Forced draft c) Induced draft d) Balanced draft

Paper EA2 - Energy Auditor - Set A

8.	<p>Steam generation in a boiler is 26 tonnes in 2 hours. Fuel consumption in the same period is 1 ton per hour. Continuous blow down is 10% of feed water input. The evaporation ratio is</p> <p>a) 11.7 b) 12 c) 13 d) 26</p>
9.	<p>Suitable atomizing viscosity of fuel oil for use in LAP/MAP burners is</p> <p>a) 300 Redwood Seconds-1 b) 100 Redwood Seconds-1 c) 400 Redwood Seconds-1 d) 600 Redwood Seconds-1</p>
10.	<p>The evaporation ratio in a fuel oil fired boiler was found to be 20 . This was mainly due to</p> <p>a) more feed water fed in b) over capacity utilization of boiler c) low dryness of the generated steam d) none of the above</p>
11.	<p>The presence of silica in the boiler water causes</p> <p>a) steam carryover b) corrosion c) scale formation d) none of the above</p>
12.	<p>Removal of dissolved gases from the boiler feed water is called</p> <p>a) degasification b) deaeration c) deoxidation d) none of the above</p>
13.	<p>Enthalpy of evaporation of steam will be highest at</p> <p>a) 2 kgs/cm² b) 8 kgs/cm² c) 12 kgs/cm² d) 20 kgs/cm²</p>
14.	<p>Which of the following has the highest overall efficiency</p> <p>a) combined cycle b) stand alone gas turbine c) back pressure steam turbine d) extraction condensing turbine</p>
15.	<p>Steam mains should be run with a falling slope of ... in the direction of steam flow for effective line condensate drainage</p> <p>a) 50 mm in 30 meteres b) 125 mm in 30 metres c) 250 mm in 30 metres d) 350 mm in 30 metres</p>
16.	<p>Which of the following is not a property of ceramic fibre insulation?</p> <p>a) low thermal conductivity b) light weight c) high heat capacity d) thermal shock resistant</p>
17.	<p>Furnace wall heat loss does not depend on</p> <p>a) temperatures of external wall surfaces b) velocity of air around the furnace c) k-value d) stock to be heated.</p>
18.	<p>Which of the steam traps operates on the principle of difference in density between steam and condensate</p> <p>a) thermostatic b) inverted bucket c) bi-metallic d) none of the above</p>
19.	<p>Which property of ceramic coating influences energy savings in furnaces</p> <p>a) conductivity b) convective heat transfer coefficient c) emissivity d) coating thickness</p>

Paper EA2 - Energy Auditor - Set A

20.	Heat loss through openings in furnaces is directly proportional to a) fourth power of furnace temperature b) square of absolute furnace temperature c) absolute furnace temperature d) fourth power of absolute furnace temperature
21.	Fluidized bed temperature exceeding 950 °C in a FBC boiler may result in a) over heating b) ash fusion c) melting of lime stones d) ash carry over
22.	In coal fired FBC boilers the percentage of bottom ash to the total ash is in the range of a) 20% b) 60-70% c) 30-40% d) none of the above
23.	The difference between mean solid and mean gas velocity in FBC boiler is called a) fluidization factor b) slip velocity c) settling velocity d) none of the above
24.	A cycle which generates first electricity or mechanical power is called a) bottoming cycle b) topping cycle c) combined cycle d) cogeneration cycle
25.	Ceramic recuperators can withstand gas side temperature up to a) 400°C b) 1300°C c) 1000°C d) 1700°C
26.	Which among the following uses a working fluid for heat recovery a) heat pipe b) recuperator c) heat wheel d) regenerator
27.	The device that upgrades a low temperature heat source to a high temperature sink is called a) heat pipe b) heat pump c) plate heat exchanger d) economizer
28.	The waste heat recovery equipment in a combustion system will be more economical when the exit flue gases are at a temperature of a) 200°C b) 400°C c) 600°C d) 800°C
29.	Recovery of heat from dryer exhaust air is a typical application of a) waste heat recovery boiler b) heat pump c) heat wheel d) economizer
30.	A three mm thick soot deposit on the heat transfer surface of a fire tube boiler can cause an increase in fuel consumption of a) 0.5% b) 2.5% c) 4.5% d) none of the above
31.	The working media in a thermocompressor is a) electricity b) compressed air c) high temperature oil d) steam
32.	Which of the following boiler has lowest permissible boiler drum TDS concentration a) low pressure water tube boiler b) fire tube boiler c) lancashire boiler d) none of the above
33.	A power plant which uses first a gas turbine followed by steam turbine for power generation is called a) topping cycle b) combined cycle c) Brayton cycle d) bottoming cycle

Paper EA2 - Energy Auditor - Set A

34.	The Gross Calorific Value of furnace oil, LSHS and LDO is of the order of a) 30 MJ /kg. b) 32 MJ / kg. c) 40 MJ /kg. d) 36 MJ / kg.
35.	Co-generation system is also known as a) reversible system b) combined heat and power system c) re-generation system d) Brayton system
36.	Which of the following loss component is the main contributor to total energy losses in an oil fired reheating furnace a) sensible heat loss in flue gas b) loss due to evaporation of moisture in fuel c) skin losses d) heat loss through openings
37	Velocity of steam in a pipe does strongly depend on a) number of bends and valves in the pipe b) specific volume of steam c) length of the pipe d) none of the above
38.	The major limitation of a metallic recuperator is a) limitation of reduced life for handling high temperature b) manufacturing difficulty of the required design c) limitation of handling SO _x , NO _x gases. d) none of the above
39.	Which of the following will not conserve energy in a furnace a) preheating combustion air b) minimizing excess air c) charge preheating d) addition of more burners
40.	Alumina is a type of refractory. a) acid b) basic c) neutral d) none of the above
41.	The equipment having the highest efficiency in case of conventional power plant is a) electric generator b) cooling tower c) steam or gas turbine d) boiler
42.	Regenerators are widely used in a) glass melting furnaces b) reheating furnaces c) baking ovens d) heat treatment furnaces
43.	In a CFBC boiler the capture and recycling of bed materials is accomplished by a) bag filter b) settling chamber c) cyclone d) scrubber system
44.	High emissivity coatings are most effective on a) inner surface of furnace b) outer surface of furnace c) refrigeration pipings d) none of the above
45.	Which of the following does not contribute to steam savings a) insulation of steam pipe lines b) superheated steam for indirect process heating c) providing dry steam for process d) none of the above

Paper EA2 - Energy Auditor - Set A

46.	The efficiency of a typical FBC boiler would be around a) 90% b) 80% c) 60% d) 50%
47.	In FBC boiler the combustion is carried out at a temperature a) closer to steam temperature b) below ash fusion temperature of fuel used c) at adiabatic combustion temperature d) at and above ash fusion temperature
48.	The coefficient of thermal expansion of refractory material should be a) low b) medium c) high d) very high
49.	The purpose of venting air from steam systems is because air is a a) insulator b) good conductor c) inert substance d) dilutant
50.	Estimate the efficiency of a re-heating furnace, operating at 10 tonnes per hour and consuming furnace oil of 460 kg/hour for reheating the material from 40°C to 1100°C. Consider specific heat of material as 0.13 kCal/kg°C. a) 25% b) 30% c) 35% d) 40%

..... **End of Section – I**

Section – II: SHORT DESCRIPTIVE QUESTIONS

Marks: 10 x 5 = 50

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

- S-1. List all the elements of an Ultimate Chemical Analysis of coal. Which additional coal information is necessary for the calculation of boiler efficiency.
- S-2. A boiler operator is trying to reduce excess air level from 30% to 10% in a coal fired boiler. Describe what will most likely happen to the CO, CO₂ concentration as well as amount of unburnt carbon in the flue gas. Explain your answer!
- S-3. Explain why “blow down” is done in a boiler. List a disadvantage of blow down.
- S-4. What is the need for boiler feed water treatment?
- S-5. What happens to steam properties such as saturation temperature, enthalpy of evaporation, latent heat of steam, enthalpy of steam and specific volume of steam if the steam pressure is increased?
- S-6. How are SO₂ emissions controlled in a FBC boiler and describe the method.

Paper EA2 - Energy Auditor - Set A

S-7. Match the following:

<u>Cogeneration system</u>	<u>Typical range of heat to power ratio</u>
a) Back pressure steam turbine	1) 4.0 - 14.3
b) Extraction-condensing steam turbine	2) 1.1 – 2.5
c) Gas turbine	3) 1.0 – 1.7
d) Combined cycle	4) 1.3 – 2.0
e) Reciprocating engine	5) 2.0 – 10.0

S-8. Define the efficiency of a furnace and explain why furnace efficiencies are lower than boiler efficiencies. State measures to improve the efficiency of furnaces.

S-9. Draw the appropriate curves and mark the point of most economical insulation thickness in a X – Y coordinate system where the Y-axis represents annual costs and X-axis represents the insulation thickness of a furnace.

S-10. In a heat exchanger 90°C hot water flows inside the tube. Hot combustion gas at 600°C passes at the outside of the water tube. What is your best judgement about the surface temperature of the tube at the gas side? Explain!

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

Section – III: LONG DESCRIPTIVE QUESTIONS

Marks: 5 x 10 = 50

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

L-1. Calculate

- i) The stoichiometric amount of combustion air required for the fuel whose composition is given below.
- ii) Calculate the NCV of the fuel based on the GCV of the fuel of 10,880 kcal/kg.

Fuel composition data

<u>Constituents</u>	<u>% by weight</u>
Carbon	85.9
Hydrogen	12
Oxygen	0.7
Nitrogen	0.5
Sulphur	0.5
H ₂ O	0.35
Ash	0.05

Paper EA2 - Energy Auditor - Set A

- L-2. Explain the concept of a FBC boiler with a sketch. What are the major benefits of using a FBC boiler.
- L-3. Calculate the annual financial loss from an opening in a reheating furnace which is 1m x 1m, assuming a factor for total radiation of 0.70. The furnace radiates at 1200 °C, and is operated for 12 hours a day, 200 days per year. Fuel oil costs are Rs.14,000/- per tonne and the oil has a Calorific Value of 10,000 kcal/kg. Ignore ambient temperature.
- L-4. 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 7000 hours/year of operation.
- Given:
- | | |
|--|-----------------|
| Boiler efficiency – | 90% |
| Fuel Oil cost – | Rs.13,000/tonne |
| Calorific Value of fuel oil - | 10,300 kcal/kg |
| Surface temperature without insulation – | 180°C |
| Surface temperature after insulation – | 75°C |
| Ambient temperature – | 30°C |
- L-5. Why is it advantageous to use steam at the lowest acceptable pressure in a process?

..... **End of Section – III**