15^{th} NATIONAL CERTIFICATION EXAMINATION FOR ENERGY AUDITORS – August, 2014

PAPER – 4: Energy Performance Assessment for Equipment and Utility Systems	
Date: 24.8.2013 Timings: 14:00-16:00 Hrs Duration: 2 Hrs	**Max. Marks: 100**

Section - I: BRIEF QUESTIONS — Marks: 10 x 1 = 10

(i) Answer all **Ten** questions
(ii) Each question carries **One** mark

S-1	Which loss is not considered while evaluating boiler efficiency by “Indirect Method”?
Ans	Blow down loss
S-2	What will be the synchronous speed of a VFD driven 4-pole induction motor operating at 60 Hz ?
Ans	Ns = 120 x f/P = 120 x 60/4= 1800 RPM
S-3	What is the refrigerant used in a vapour absorption system with lithium bromide as an absorbent?
Ans	Water
S-4	Other than rated kW of motor and the actual power drawn, what other parameter is required to determine the percentage loading of the motor ?
Ans	Motor Efficiency or rated motor efficiency
S-5	Inclined tube manometer is used for measuring gas flow in a duct when the air velocity is very high: True or False?
Ans	False.
S-6	A pump will cavitate if the $NPSH_{available}$. is __________ than the $NPSH_{required}$
Ans	Less
S-7	To determine the effectiveness of the cooling tower, it is required to measure cooling water inlet, outlet and _____temperatures.
Ans	Ambient Wet bulb
S-8	The ratio of actual heat transfer to the heat that could be transferred by heat exchanger of infinite size is termed as ………

Ans	Effectiveness
S-9	If the unit heat rate of a power plant is 2866 kcal/kWh ,what is the power plant efficiency ?
Ans	(860/2866) x 100 = 30 %
S-10	The difference between GCV and NCV of hydrogen fuel is Zero: True or False
Ans	False

………… End of Section - I …………

Section - II: SHORT NUMERICAL QUESTIONS Marks: 2 x 5 = 10

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

L-1	Hot water at 80 ^{O}C is used for room heating in a 5 Star hotel for 4 months in a year. About 200 litres per minute of hot water is maintained in circulation with the return temperature at 50 ^{O}C. The hot water is generated using a 'hot waste stream', through a Plate Heat Exchanger (PHE). The hot stream enters the PHE in counterflow direction at 95 ^{O}C and leaves at 60 ^{O}C. The area of the heat exchanger is 22 m^2. Calculate the LMTD and the overall heat transfer coefficient.
Ans	Heat load, Q = 200 * 60 * (80 – 50) = 360000 Kcals/hr (or) 418.7 kW LMTD (for counter flow) $= \dfrac{(95 - 80)/(60 - 50)}{\ln(15/10)} = 3.7\ ^{O}C$ Overall Heat Transfer Coefficient, U = Q/(AxLMTD) = 418.7/(22 x 3.7) = 5.14 kW/m^2.^{O}C (OR) = 4420.4 kcal/hr.m^2.^{O}C
L-2	A gas turbine generator is delivering an output of 20 MW in an open cycle with a heat rate of 3440 kcal/kWh. It is converted to combined cycle plant by adding heat recovery steam generator and a steam turbine raising the power generation output to 28 MW. However, with this retrofitting and increased auxiliary consumption, the fuel consumption increases by 3% in the gas turbine. Calculate the combined cycle gross heat rate and efficiency.

Ans	Gas turbine output = 20 MW Combined cycle output = 28 MW Heat rate in GT open cycle for 20 MW = 3440 kcal/kwh Increase in fuel consumption in combined cycle operation = 3% Combined cycle heat rate = (3440 X 1.03) X(20 / 28) = 2530.8 kcal/kwh Combined cycle plant efficiency = (860 / 2530.8) X 100 = 33.98%

…………. End of Section - II ………….

Section - III: LONG NUMERICAL QUESTIONS **Marks: 4 x 20 = 80**

(i) Answer all **<u>Four</u>** questions

N-1	The steam requirement of an export oriented unit is met by a 6 TPH oil fired package boiler generating steam at 10 kg/cm^2. The monthly steam consumption of the unit is 3000 tonnes. Other data are given below: Fuel oil composition: Carbon = 86%; Hydrogen = 12%; Oxygen= 0.5%; Sulphur =1.5% Specific heat of flue gases, Cp = 0.27 kcal/kg^{o}C G.C.V. of fuel oil = 10,000 kcal/kg Sp.heat of super heated water vapour = 0.45 kcal/kg^{o}C Enthalpy of steam at 10 kg/cm^2 = 665kcal/kg Feed water temperature = 85 ^{o}C % O_2 in dry flue gas = 6% Flue gas temperature at boiler outlet = 240 ^{o}C Ambient temperature = 30^{o}C Cost of fuel oil = Rs.43 per kg. Radiation and other unaccounted losses = 2.45% The export oriented unit is costing its steam cost based on the fuel consumption cost with additional 10% to account for the auxiliary and consumables. A neighbouring continuous process plant now offers to supply the required steam at 10 kg/cm2 to the export oriented unit at a cost of Rs 3300 per tonne.with a condition that all the condensate will be returned back.

	Calculate the following: a) Boiler efficiency b) Cost advantage per tonne of availing steam from neighbouring plant in place of in-house generation and also monthly monetary saving.
Ans	<u>First calculate the efficiency of Boiler (in EOU)</u> Theoretical air required = = 11.6 C + 34.8 (H – O/8) + 4.35 S = [11.6 X 86 + 34.8 (12 – 0.5/8) + 4.35 X 1.5] x 1/100 = 14.195 = Say 14.2 % Excess Air = [% O_2 / (21 - % O_2)] X 100 = [6 / (21 – 6)] X 100 = 40% AAS = Actual amount of air supplied = 14.2 X 1.4 = **19.88 kg per kg. of fuel oil** Mass of dry flue gas m_{dfg} = Mass of combustion gases due to presence of C,H,S +Mass of N_2 supplied = (0.86 X 44/12) + (0.015 X 64 / 32) + [(19.88 – 14.2) X 23 / 100] + (19.88 X 77/100) = 19.797 Mass dry flue gas ,say = 19.8 Kg / kg fuel Or Alternatively mass of dry flue gas = (AAS + 1) – 9 H = (19.88 + 1) – 9 X 0.12 = 19.8 Kg./Kg. fuel L1 = % heat loss in dry flue gas = [m_{dfg} x Cp x (T_q – T_a) / GCV] x 100 $= \frac{19.8 \times 0.27 \times (240 - 30)}{10{,}000} \times 100$ L1 = **11.23%** L2 = Loss due to presence of hydrogen forming water vapour $= \frac{9 \times H\ [584 + Cps\ (T_g - T_a)]}{GCV} \times 100$ $= \frac{9 \times 0.12\ [584 + 0.45\ (240 - 30)]}{10000} \times 100$ L2 **= 7.33%** L3 = Radiation and other unaccounted losses **= 2.45%** Total losses = L1 + L2 + L3 = 11.23 + 7.33 + 2.45 = **21.05 %** Efficiency of the EOU boiler by indirect method = 100 – 21.05 =78.99 %

= **Say 79 %**

Secondly calculate the cost of steam in the EOU plant

Evaporation Ratio = [(n X GCV) / (h_g – h_f)] X 100
= [(0.79 X 10000) / (665 – 85)] X 100
= 13.62 kg Steam / kg. Fuel

Fuel oil consumption = 1000 / 13.62 kg. per tonne of steam
Fuel oil consumption = 73.42 kg./tonne of steam gen

Cost of fuel oil. = Rs. 43 per kg
Cost of steam in EOU = Fuel cost + 10% fuel cost
= 73.42 x 1.10 x 43
= Rs.3472.8 per tonne

Selling cost of steam from neighboring plant = Rs 3300 per tonne

Cost advantage = 3472.8 – 3300 = Rs.172.8 per tonne

Annual Savings = Rs.172.8 per tonne x 3000tonne/month X 12 month
= Rs.62.2 Lacs

N-2

a) The operating parameters of a Vapour Compression Refrigeration system are indicated below.

Parameter	Chiller side	Condenser side
Water Flow (m^3/hr)	89	87
Inlet Temperature (^OC)	12.2	33.3
Outlet Temperature (^OC)	8.9	37.6
Density (kg/m^3)	1000	990

Find the COP of the Refrigeration system ignoring heat losses.

b) A 6 pole, 415 volt, 3 Φ, 50 Hz induction motor delivers 22 kW power at rotor shaft at a speed of 950 rpm with PF of 0.9. The total loss in the stator including core, copper and other losses, is 2 kW. Calculate the following.

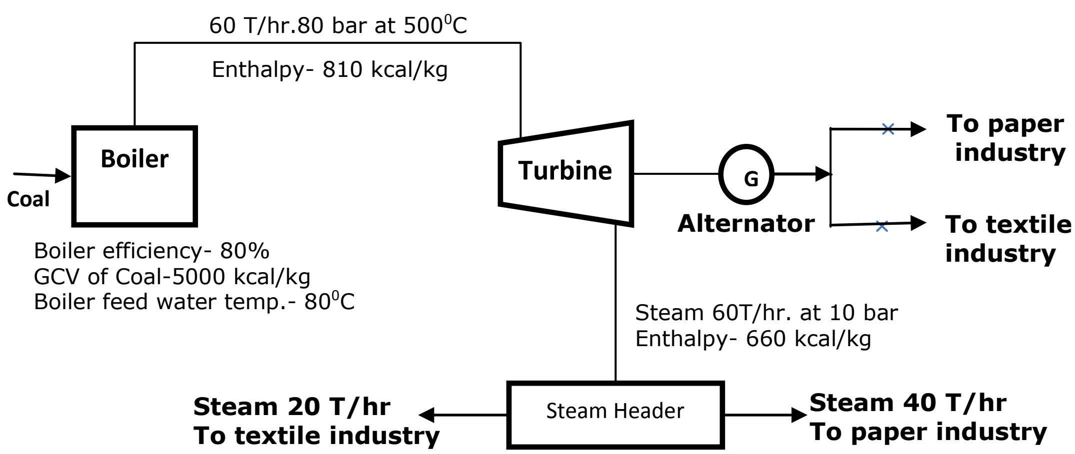
i) Slip
ii) Rotor Copper Loss
iii) Total Input to motor
ivi) Line current at 415 V and motor pf of 0.9
v) Motor operating efficiency

Ans

a) Refrigeration Effect = 89 x 1000 x (12.2 – 8.9)
= 293700 kcal/hr

Condenser load = 87 x 990 x (37.6 – 33.3)
= **370359 kcal/hr**

	Compressor work = Condenser load – Refrigeration effect = 370359 – 293700 = **76659 Kcal/hr** C.O.P. = Refrigeration Effect/ Compressor work = 293700/76659 = **3.83** b) Synchronous Speed = (120 x 50 / 6) = 1000 rpm Motor Speed = 950 rpm (i) Slip = (1000 – 950) / 1000 = **5%** Power input to rotor = { (22 / (1 – 0.05) } = 23.16 kW (ii) Rotor Copper Loss = (0.05 x 23.16) = **1.158kW** **Or** = 23.16-22 =1.16 kW (iii) Total Input to motor = (23.16 + 2) = **25.16 kW** (iv) Line Current = (25.16 x 1000) /(√3 x 415 x0.9) = **38.86 Amps** (v) Motor Efficiency = (22 / 25.16) = **87.44 %**
N-3	A common plant facility is installed to provide steam and power to textile and paper plant with a co-generation system. The details and operating parameters are given below:



Other data:

- Turbine, alternator and other losses = 8%
- Specific steam consumption in paper industry= 5 Tons/Ton of paper
- Specific power consumption in paper industry= 550 kWh/Ton of paper

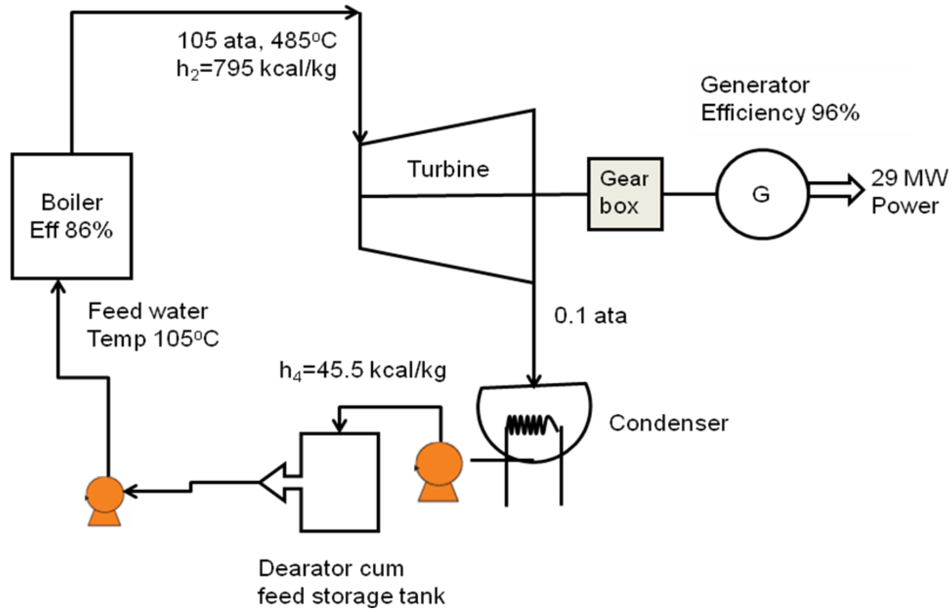
Calculate:

i. Coal consumption in boiler per hour or per day.

ii. Power generation from co-generation plant

iii. If 10% is auxiliary power consumption in co-generation plant, how much power

	is consumed by the textile industry per hour? iv. What is the gross heat rate of turbine?
Ans	i) Boiler efficiency = Steam production (steam enthalpy- Feed water enthalpy) / Quantity of coal x G.C.V. of coal Quantity of coal = 60,000 (810-80)/ 0.8 x 5000 **= 10.95 tons/hr**. ii) Gross power generation from co-generation plant Total enthalpy input to turbine = 60,000 x 810 = 48.6 Million kcal. Total enthalpy out put through back pressure= 60,000* 660 = 39.6 Million kcal Enthalpy difference = 48.6- 39.6 = 9 Million kcal/hr Turbine,alternator and other losses =8% or 9x0.08 = 0.72 Million kcal/hr Useful energy for power generation = 9- 0.72 = 8.28 Million kcal/hr Power generation from co-generation plant = 8.28 x 10^6/860 = **9628kWh** iii) If 10% is auxiliary power consumption in co-generation plant, power consumed by textile industry 10% of total power generation = 9628 x 0.10 = 962.8kWh Total power consumed by industries = 9628 – 962.8 = 8665.2kWh Total steam consumption in paper plant 40 tons/hr. and specific steam consumption 5 ton/ton of paper. So Paper production per hour is 8 tons. Specific power consumption = 550 kWh/ton. Total power consumption in paper industry = 8 x 550 = 4400kWh Total power consumption in textile industry = 8665.2- 4400 = **4265.2 kWh** iv) Gross heat rate= Input enthalpy – output enthalpy/ gross generation =(48.6- 39.6) 10^6/ 9628 = **934.7 kCal/kWh**
N-4	To attempt **ANY ONE OF THE FOLLOWING** among A, B, C and D
A	A captive thermal plant is delivering an output of 29 MW at the generator terminal. The generator efficiency is 96%. The steam generated in a utility boiler with an efficiency of 86% at 105 ata and 485^{o}C is fed to the turbine. The turbine exhausts steam to condenser maintained at 0.1 ata and 45.5^{o}C. The feed water temperature at inlet to the boiler is 105^{o}C.



The other data pertaining to captive power plant are,

Enthalpy of steam at 105 ata 485°C = 795 kcal/kg.
Dryness fraction of steam at inlet to condenser = 0.9
Enthalpy of dry saturated steam at 0.1ata =618 kcal/Kg.
Enthalpy of water at 0.1 ata & at 45.5°C = 45.5 kcal/Kg.
Loss in the gear box connecting turbine and generator = 1100 kW
Enthalpy of feed water at inlet to the boiler , = 105 kcal/Kg.

Based on the above data determine:

i. Output of the steam turbine in kW
ii. Steam flow through the turbine
iii. Turbine heat rate
iv. Unit heat rate

Ans

Enthalpy of steam at turbine exhaust = 45.5 +0.9 (618 – 45.5)
i.e. h_3 = 560.75 Kcal/Kg.

Generator electric output = 29000 KW
Generator input = 29000 / 0.96 = 30208.33 KW

Loss in gear box = 1100 KW
Output of steam turbine = Generator input + Gear box loss
= 30208.33 + 1100
= 31308.33 KW

i) Output of the steam turbine **Say = 31308 KW**

ms = Steam flow through turbine

	$= \frac{\text{(Turbine output x 860)}}{(h_2 - h_3) \text{ Turbine enthalpy drop}}$ h_2 = Enthalpy at turbine inlet = 795 kcal/kg h_3 = Enthalpy at turbine exhaust = 560.75 kcal/Kg. m_s = 31308 x 860 / 795 – 560.75) = 114940.78 kg/Hr. = 114.94 TPH ii) Steam flow through the turbine **Say = 115 TPH** iii) Turbine heat rate = Heat input to turbine / Generator output = $[m_s (h_2 - h_1)]$ / 29000 = 115000 (795 – 105) / 29000 = 2736.2 kcal/ kWh iv)Unit heat rate = Turbine heat rate / Efficiency of boiler Unit heat rate = 2736.2 / 0.86 = **3181.63 kcal/ kWh**
	Or
B	In a textile unit a stenter is delivering 80 meters/min of dried cloth at 5% moisture. The moisture of wet cloth at inlet is 50%. The stenter is heated by steam at 7 kg/cm^2 with inlet enthalpy of 660 kcal/kg. and condensate exits the stenter at 105 kcal/kg. Other data • Latent heat of water evaporated from the wet cloth = 540 kcal/kg • Weight of 10 meters of dried cloth = 1 kg • Inlet temperature of wet cloth = 27^{o}C • Outlet temperature of dried cloth at stenter outlet = 80^{o}C. i) Estimate the steam consumption in the stenter considering a dryer efficiency of 48%. ii) Determine the specific steam consumption kg/kg of dried cloth
Ans	Output of stenter = 80 mts/min. = 80 x 60 /10 = 480 Kg/hr. Moisture in the dried output cloth = 5% Wt of bone dry cloth = 480 X (1 – 0.05) i.e. W = 456 Kg/hr. m_o =moisture in outlet cloth =(480 – 456)/456 =0.0526 Kg./Kg. of bone dried cloth Inlet moisture = 50% Wt of inlet cloth = 456 / (1 – 0.50) = 912 Kg./hr. m_i = moisture in inlet cloth = 912 X 0.5 / 456 = 1.00 Kg./Kg. bone dried cloth Inlet temperature of cloth = 27^{o}C Final temperature of cloth = 80^{o}C

	Heat load on the dryer = $w \times (m_i - m_o) \times [(T_{out} - T_{in}) + 540]$ Kcal/hr. . Heat load on the dryer = 456 (1 – 0.0526) X [(80 – 27) + 540] = 2,56,184.5 Kcal/hr Efficiency of the dryer = 48% Heat input to the stenter = 2,56,184.5 / 0.48 = 5,33,717.71 Kcal/hr Steam consumption in the stenter = 5,33,717.71 / (660 – 105) = 961.7 Kg/hr Steam consumption per Kg. of dried cloth at stenter outlet cloth = 961.7 / 480 = 2 Kg./Kg. dried cloth
	Or
C	Determine the **cooling load** of a commercial building for the following given data. Outdoor conditions : DBT = 35°C ; WBT = 25°C; Humidity = 18 g of water / kg of dry air Desired indoor conditions : DBT = 25.6°C ; RH = 50 %; Humidity = 10 g of water / kg of dry air Total area of wall = 40 m^2 Total area of window = 20m^2 U – Factor (Wall) = 0.33 W / m^2K U – Factor (Roof) = 0.323 W / m^2K U – factor [fixed windows with aluminum frames and a thermal break] = 3.56 W / m^2K • 15 m x 25 m roof constructed of 100 mm concrete with 90 mm insulation & steel decking. • CLTD at 17:00 h :Details : Wall = 12°C Roof = 44°C Glass Window = 7°C • SCL at 17 : 00 h :Details : Glass Window = 605 W/ m^2 • Shading coefficient of Window = 0.74 • Space is occupied from 8:00 to 17:00 h by 25 people doing moderately active work. • Sensible heat gain / person = 75 W ; Latent heat gain / person = 55 W ; CLF for people = 0.9 • Fluorescent light in space = 21.5 W/m^2 FLF for lighting = 0.9

	• Ballast factor details = 1.2 for fluorescent lights & 1.0 for incandescent lights • Computers and office equipment in space produces 5.4 W/m^2 of sensible heat • One coffee maker produces 1050 W of sensible heat and 450 W of latent heat. • Air changes / hr of infiltration = 0.3 • Height of building = 3.6 m
Ans	**I External Heat Gain** (i) Conduction heat gain through the wall =U – factor x net area of wall x CLTD =[0.33 x 40 x 12] = 158.4 W (ii) Conduction heat gain through the roof =U – factor x net area of roof x CLTD =0.323 x (15 x 25) x 44 = 5 329.5 W (iii) Conduction heat gain through the windows =U – factor x net area of windows x CLTD = (3.56 x 20 x 7) = 498.4 W (i) Solar radiation through glass = Surface area c Shading coefficient x SCL =(20 x 0.74 x 605) = 8 954 W **II Internal Heat Gain** (i) Heat gain from people =Sensible heat gain + Latent heat gain Sensible heat gain =(No.of people x Sensible heat gain / person x CLF) =(25 x 75 x 0.9) = 1 687.5 W Latent heat gain =No.of people x Latent heat gain / person =(25 x 55) = 1 375 W Therefore, Heat gain from people=(1687.5 + 1375) = 3 062.5 W (ii) Heat gain from lighting =(Energy input x Ballast factor x CLF) Energy input =(Amount of lighting in space / unit area) x Floor area =21.5 x (15 x 25) =8 062.5 W Therefore, heat gain from lighting =(8062.5 x 1.2 x 0.9) =8 707.5 W (iii) Heat generated by equipment : Sensible heat generated by coffee maker =1050 W Latent heat generated by coffee maker =450 W

	Sensible heat gain by computers and office equipment = 5.4 x 375 = 2025 W Therefore, Heat generated by equipment = **3 525 h** (iv) Heat gain through air infiltration=(Sensible heat gain + Latent heat gain) Sensible heat gain =(1210 x airflow x ΔT) Airflow =(Volume of space x air change rate) / 3600 ={ (15 x 25 x 3.6) x 0.3 } / 3600 =0.1125 m^3 / s Therefore, sensible heat gain =1210 x 0.1125 x (35 – 25.6) =1 279.58 W Latent heat gain =3010 x 0.1125 x (18 – 10) = 2 709 W

No	Space Load Components	Sensible Heat Load (W)	Latent Heat Load (W)
1	Conduction through exterior wall	158.4	------
2	Conduction through roof	5 329.5	------
3	Conduction through windows	498.4	------
4	Solar radiation through windows	8954	------
5	Heat gained from people	1 687.5	1 375
6	Heat gained from lighting	8 707.5	------
7	Heat gained from equipment	3 075	450
8	Heat gained by air infiltration	1 279.58	2 709
Total space cooling load		**29 689.88**	**4 534**

Or

D During heat balance of a 5 stage preheater Kiln in a cement plant, the following data was measured at Preheater (PH) Fan Inlet and clinker cooler vent air fan inlet:

Parameter measured	Temperature	Static Pressure	Avg. Dynamic Pressure	Specific heat	Gas Density at STP	Duct Area
Unit	^oC	(P_s) mm WC	(P_d) mm WC	kcal/kg ^oC	kg/m^3	m^2
PH Exit Gas at PH fan Inlet	316	-650	28.6	0.248	1.4	2.27
Clinker cooler vent air at cooler Stack Fan Inlet	268	-56	9.7	0.24	1.29	2.01

Note: take Pitot tube constant as 0.85, reference temperature 20 ^oC and atmospheric pressure 9908 mm WC.

Other Data

Clinker Production	Designed specific volume of PH gas	NCV of Coal	Cost of coal	Annual Operation
TPH	Nm^3/kg clinker	kcal/kg	Rs./ton	hrs
45.16	1.75	5500	5500	8000

Calculate the following:

i. Specific volume of PH gas as well as cooler vent air (Nm^3/kg clinker)

ii. Heat loss in pre-heater exit gas (kcal/kg clinker)

iii. Heat loss in cooler vent air (kcal/kg clinker)

iv. If the measured specific volume of PH gas (Nm^3/kg clinker) exceeds the design value, calculate the heat loss (kcal/kg clinker) and annual monetary loss due to excessive specific volume of PH gas.

Ans

i. Density of Pre-heater gas at PH Fan Inlet at prevailing temp., pressure conditions:

$$\rho_{T,P} = \rho_{STP} \, X \frac{273 \, X \, (9908 + P_S)}{(273 + T) \, X 10334}$$

$$\rho_{T,P} = 1.40 \, X \frac{273 \, X \, (9908 - 650)}{(273 + 316) \, X 10334} = 0.581 \text{ kg/m}^3$$

Velocity of PH gas

$$v = P_t \sqrt{\frac{2 \, g \, P_d}{\rho_{T,P}}}$$

$$v = 0.85 \sqrt{\frac{2 \, X 9.8 \, X 28.6}{0.581}} = 26.4 \text{ m/sec}$$

Volumetric flow rate of PH gas = velocity X duct cross-sectional area
= 26.4 X 2.27
= 59.9 m^3/sec
= 59.9 X 3600
= 215640 m^3/hr

Specific volume of PH gas = 215640 X 0.58/1.4
= 89491 Nm^3/hr
= 89491/45160 = **1.98 Nm^3/kg clinker**

Similarly density of cooler vent air at cooler vent air fan Inlet at prevailing temp., pressure conditions:

$$\rho_{T,P} = \rho_{STP} \, X \frac{273 \, X \, (9908 + P_S)}{(273 + T) \, X 10334}$$

$$\rho_{T,P} = 1.29 \, X \frac{273 \, X \, (9908 - 56)}{(273 + 268) \, X 10334} = 0.62 \text{ kg/m}^3$$

Velocity of cooler vent air in the fan inlet duct

$$v = P_t \sqrt{\frac{2 g P_d}{\rho_{T,P}}}$$

$$v = 0.85 \sqrt{\frac{2 X 9.8 X 9.7}{0.62}} = 14.88 \text{ m/sec}$$

Volumetric flow rate of PH gas = velocity X duct cross-sectional area
= 14.88 X 2.01
= 29.9 m^3/sec
= 29.9 X 3600
= 107640 m^3/hr

Specific volume of cooler vent air = 107640 X 0.62/1.29
= 51734 Nm^3/hr
= 51734/45160 = **1.15 Nm^3/kg clinker**

ii)Heat loss in PH exit gas

Q1 = $m_{ph} \, c_p \, \Delta T$ (C_p of PH gas = 0.248 kcal/kg ^oC)

Q1= 1.98 X 1.4 X 0.248 x (316-20)
= 203.5 kcal/kg clinker

iii) Heat loss in cooler vent air

Q2 = $m_{CA} \, c_p \, \Delta T$ (C_p of cooler vent air = 0.24 kcal/kg ^oC)

Q2= 1.15 x 1.29 x 0.24 x (268-20)
= 88.3 kcal/kg clinker

iv) Heat Loss due to excess specific volume of PH gas

V_{excess} =1.98 – 1.75 = 0.23 **Nm^3/kg clinker**

Heat loss Q = 0.23 x 1.4 x 0.248 x (316-20) = 23.6 **kcal/kg clinker**

Equivalent coal saving = 23.6/5500 = 0.0043 kg coal/kg clinker or ton of coal/ton of clinker

Coal saving in one hour = 0.0043 x 45.16 = 0.194 TPH

Annual Coal Saving = 0.194 x 8000= 1552 tons of coal per annum

Annual Monitory Saving = 1552 x 5500 = Rs. 85.36 lakhs

-------- End of Section - III ---------