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Performance Analysis of Steam Generators in Thermal Power Plant

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Abstract: Steam turbine convert a part of the energy of the steam evidenced by high temperature and pressure into mechanical power-in turn electrical power. The steam from the boiler is expanded in a nozzle, resulting in the emission of high velocity jet. This jet of steam impinges on the moving vanes or blades, mounted on a shaft. Here it undergoes a change of direction of motion which gives rise to a change in momentum and therefore a force. The motive power in a steam turbine is obtained by the rate of change.

INTRODUCTION

Thermal energy storage plays an important role in concentrating turbine. Power plants are where power is produced such as in the electricity generating station and jet engines. The working of these power plants are based on the turbine used. Steam has been a popular mode of conveying energy since the industrial revolution. Steam is used for generating power and also used in process industries such as sugar, paper, fertilizer, refineries, petro chemicals, chemical, synthetic fiber and textiles.

B.H. Salman et al. [1] laminar convective heat transfer in a two dimensional microtube (MT) with 50 lm diameter and 250 lm length with constant heat flux is numerically investigated. The governing (continuity, momentum and energy) equations were solved using the finite volume method (FVM) with the aid of simple algorithm. Different types of nano fluids Al2O3, CuO, SiO2 and ZnO, with different nanoparticle size 25, 45, 65 and 80 nm, and different volume fractions ranged from 1% to 4% using ethylene glycol as a base fluid were used. This investigation covers Reynolds number in the range of 10 to 1500. The results have shown that SiO2–EG nano fluid has the highest Nusselt number, followed by ZnO–EG, CuO–EG, Al2O3–EG, and lastly pure EG. The Nusselt number for all cases increases with the volume fraction but it decreases with the rise in the diameter of nanoparticles. In all configurations, the Nusselt number increases with Reynolds number

Then based on the type of exchanger the fluid may be in direct contact or separated. Some devices uses fired heater or nuclear fuel pins as energy sources, those devices are not considers as the normal heat exchanger. But these devices also may have the same principles and designs as the normal heat exchanger [2-3]. The heat exchanger has two types of approaches. The first approach is categorised based on the flow configuration in the exchanger [4]. The second type is categorised based on the construction equipment. In flow type approaches, four different flows are considered they are concurrent counter, cross and hybrid flow [5]. Then the construction type approaches are classified into two types they are Recuperative and Regenerative. But in general the heat exchangers are divided into two types,

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they are indirect and direct [6-7]. The steams in indirect heat exchangers are mostly separated by metal wall. The tube and shell exchanger is one of the most used indirect type of heat exchangers. In this type the tubes are mounted inside a cylindrical tube [8].

PROBLEM FORMATION

Analyze the turbo generator process function for it's efficiency the actual design of turbine efficiency is 30%, but now we are getting the efficiency 25.5%, There is an 4.5% of efficiency difference. So the present efficiency is increased and the power is also increased by this finally cost is save the company.

Details of Turbine

Turbine	Pressure	Temperature	Power	Max.TPH
TG#1	44	440	8mW	81
TG#2	44	440	18mW	120
TG#3	44	440	10.5mW	105
TG#4	64	480	24.62mW	90
TG#5	64	480	20mW	170
TG#6	105	570 ±5°C	41mW	220

Turbine Data

S.No	Description	Units	TA#4
1	Type	-	ENK 50/71-3(T 485)
2	Year of Installation	-	2001
3	Design Pressure(inlet)	kg/cm2	62+/-2
4	Design Temperature(inlet)	°C	480+/-10
5	Design Capacity	MW	24.62
6	Designed Steam Input	Tph	90
7	LP Extraction(Designed)		
	Controlled/Uncontrolled		
	Quantity	tph	30
	Pressure	kg/cm2	4.5+/-0.5
	Temperature	°C	200
8	RPM of turbine	-	5000
9	RPM of alternator	-	1500

Specification of turbine data

Turbine

Steam from live steam system is admitted into the turbine through Emergency Stop Valve and Governing Valves (valve block) which are mounted on the turbine. Balance Piston Leak off is connected to extraction piping. Pressure measurement is provided in the Wheel Chamber Zone which helps in knowing about the salts deposited on turbine blade during course of turbine running.

Live Steam System

Turbine is supplied with live steam from a steam source of 63 atm, 480°C. Motor Operated Gate Valve is provided in live steam line to isolate turbine during the shut down period. During start up steam is admitted steadily through the bypass Valve. During this period steam is vented to atmosphere. Any condensate formed shall be drained through gate valves.

Controlled Extraction

Extraction pressure is controlled by controlling the steam inputs through HP &LP Governing Valves for various process and power demands. Power Assisted Check Valve is provided to prevent back flow of process steam into the turbine. Extraction is led to process(5.5 atm). The extraction temperature is dependent on the inlet steam flow quantity.

Bleed Steam

A bleed is taken from the turbine Bleed steam is led to the LP Heater. During start up of the turbine entire bleed steam piping up to the Isolation Valve is to be drained. The Drain Valves are to be closed only after establishing extraction steam flow through the line.

Chimney Steam

Steam from turbine glands is evacuated to a Gland Steam Condenser. This shall prevent steam oozing out from the gland and heating the bearing pedestals. 2 Ejectors with steam or motive fluid, one main and other as standby mounted on the gland steam condenser are employed for evacuation.

Gland Sealing System

It is necessary to seal the glands of the condensing turbine to maintain the vacuum in turbine and condensing system. The vacuum in the system is maintained by supplying steam at 1.1 atm continuously at turbine glands. The Control Loop consists of pressure transmitter mounted on gland steam header, a pressure indicating controlling (in PLC) & control valves.

Operation of The System

For condensing turbines, vacuum is to be established in the condensing system before starting the turbine. The complete sealing of the inner compartments against the atm is done by admitting the steam to front and rear glands. Pressure controller is set at 1.1 kg/cm2 (abs) and the steam is supplied to gland steam header through the control valve at a constant pressure of 1.1 atm from auxiliary steam 14 atm 380°C.

Exhaust Hood Spray System

It may be necessary to run the turbine in no load condition for prolonged periods. Hence it is necessary to limit the exhaust hood temperature by cooling the exhaust steam by spraying condensate through spray nozzles fitted in the exhaust hood. Spray water is taken from Condensate Extraction Pump discharge. Spray water is supplied to spray nozzles through a Solenoid Operated Valve. Spray water is supplied to spray nozzles through a Solenoid Operated Valve. This valve opens automatically by means of a temperature switch mounted on exhaust hood, whenever the temperature exceeds the preset limit. Whenever the temperature returns to the safe limit, the solenoid valve closes automatically thus stopping the spray water supply.

Turbine sprays

Drains from all spaces of turbine which are under vacuum during start up are connected to the condenser. Drains are led to the condenser through Surge Pipe arranged adjacent to it. Top of the surge pipe is connected to steam space and bottom to the hot well of the condenser. The hot drains may thus flash out in the surge pipe without endangering the Condenser Tubes.

Vaccum Breaking System

In case of turbine trip, (for reasons lube oil pressure or high axial displacement) vacuum is broken in the condenser by admitting atmospheric air in to the condenser through a motor operated valve which opens in that case. This is provided to shorten the coasting down time. The valve is sealed with condensate water against ingress of air into the condenser during normal running of set.

PERFORMANCE EVALUATION

Heat Rate=[(m1*h1)+(A1*h2)]-[(c1*h3)+(e1*h3)]/p

Where
m1=inlet steam flow kg/hr
E1=extraction steam flow kg/hr
c1=condensate flow kg/hr
A1=steam to ejector kg/hr
h1=inlet steam enthalpy kcal/kg
h2=Ejector steam enthalpy kcal/kg
h3=condensate enthalpy after LPH kcal/kg
h4=Extraction steam enthalpy
p=Generator power kw

RESULT AND DISCUSSION

H1=Enthalpy @ 470°C, = 799.8 kCal/kg
H2=Enthalpy @ 350°C, = 752.5 kCal/kg
H3=Enthalpy @ 40°C = 40.07 kCal/kg
H4=Enthalpy @ 199.2°C, = 682 kCal/kg
P = 19020 kW
Heat Rate = [(85*1000*799.8) + (0.4*1000*752.5)] -[(75.4*1000*40.7) + (10*1000*682)]19020
= 69284000-9838262
= 19020
Heat Rate = 3072.75 kCal/kWhr
Actual turbine efficiency = 1kwh\ Actual turbine heat rate
= 860/3072.75
= 0.2798
Actual turbine efficiency = 27.98%
H1=Enthalpy @ 478°C, = 804.4 kCal/kg
H2=Enthalpy @ 350°C, = 762.3 kCal/kg
H3=Enthalpy @ 47°C = 47.07 kCal/kg
H4=Enthalpy @ 199.2°C, = 682 kCal/kg
P = 19020 kW

Heat Rate =

$$\frac{[(85*1000*804.4) + (0.4*1000*762.3)] - [(75.4*1000*47.07) + (10*1000*682)]}{19020}$$

$$= \frac{58309842}{19020}$$

Q = 3065.712 kCal/kWhr

Heat Rate = 3065.712 kCal/kWhr
Turbine efficiency = 1kwh\ Actual turbine heat rate
= 860/3065.712
= 0.2805
Turbine efficiency = 28.05%
Heat rate = 860/0.2805
= 3065.712 kcal/kw hr
Power = [(85*1000*804.4) + (0.4*1000*762.3)] -[(75.4*1000*47.07) + (10*1000*682)]

3065.712

= 19020.1 KW

CONCLUSION

To analysis the turbine power and to improve the reheated cycle. To generate the final report of the paper due to compare of actual turbine efficiency and design turbine efficiency, varying the inlet temperature of inlet steam. The velocity of steam flow can be increase. The variation of turbine efficiency in the research it increases the output power of 0.1 mw can be obtained. Finally, improve the efficiency of turbine, increase power and save the cost of company

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