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Modification of Heating Method of HT Water in Standby Wartsila Diesel Engine

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ABSTRACT: Waste heat recovery from running engine HT water to stand by engine HT water is one of the advanced system. By this method we can transfer the heat from running engine HT water to standby engine HT water .In future waste heat recovery system of HFO based engine will be used instead of conventional method.The engine cooling water at high temperature contain more heat energy which is wasted on the cooling tower. To reduce the energy loss a shell and tube heat exchanger is used. By using this we can transfer the heat from running engine HT water to standby engine HT water.

KEYWORDS: HT water, Engine, Heat exchanger

I. INTRODUCTION

CPP is the diesel power generation station of DCW LTD SAHUPURAM. There are two generators installed in this plant and each has a captive of 6MW. Total captive is 12MW. Diesel engine is the prime mover of the alternator of 11KV. Thus the power generated from CPP is used all over the company such as in DCW are caustic soda, PVC, Trichloroethylene. Diesel engine plays a vital role in DCW LTD SAHUPURAM. Since the energy produced from this plant is utilized all over the plant. Thus the plant runs the engines to produce energy and remaining one engine as a stand by engine.

II. LITERATURE REVIEW

Computer program for economical design of shell and tube heat exchanger [M.M.El-Fawal, A.A.Fahmy and B.M.Taher (2015)]

In this paper a computer program for economical design of shell and tube heat exchanger using specified pressure drop is established to minimize the cost of the equipment. The design procedure depends on using the acceptable pressure drops in order to minimize the thermal surface area for a certain service, involving discrete decision variables. Also the proposed method takes into account several geometric and operational constraints typically recommended by design codes, and provides global optimum solutions as opposed to local optimum solutions that are typically obtained with many other optimization method.

Optimization of the design of shell and tube heat exchanger[Andre L.H. Costa, Eduardo M. Queiroz (2015)]

This paper approaches the optimization of the design of shell and tube heat exchangers. The formulation of the problem seeks the minimization of the thermal surface area of the equipment, for certain minimum excess area and minimum pressure drops, considering discrete decision variables. Important additional constraints, usually ignored in previous optimization schemes, are included in order to approximate the solution to the design practice.

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Turbocharging of IC engine [D.r.Manoj Kumar,IFTM University, Moradabad,2013]

Turbochargers are used throughout the automotive industry as they can enhance the output of an internal combustion engine without the need to increase its cylinder capacity. The application of such a mechanical device enables automotive manufacturers to adopt smaller displacement engines, commonly known as 'engine downsizing'. Historically, turbochargers were often used to increase the potential of an already powerful IC engine. The emphasis today is to provide a feasible engineering solution to manufacturing economics and 'greener' road vehicle. It is because of these reasons that turbochargers are now becoming more and more popular in automobile applications. The aim of this paper is to provide a review on the techniques used in turbocharging to increase the engine output and reduce the exhaust emission levels.

Improvement of efficiency of centrifugal pump through modifications in suction manifold[IJIERT (2015)]

The paper reviews the literature available on the improvement of efficiency of centrifugal pump through modification in suction manifolds. The paper discuss the available material of performance improvement through various parameters and mainly focuses on the research related to manifold modifications.

Vibha P.Pode, Shylesha Channapattanna [2014] have proposed a study to be done on the suction side of a centrifugal pump, the objective of the study was to improve the performance and provide the best alternative design for the suction side.

Sumit N.Gavande, Prashant D.Deshmukh, Swapnil S.Kulkarni[2014] have studied the various methodologies to increase the discharge of the pump. Some methodologies relate to the change in design of the suction side and some relate to change in design of pump.

Wand Fu-jun al [2007] have been successfully simulated the three-dimensional turbulent flows generated by an axial flow pump equipped with an inducer, using the multiple reference frame approach. The effects of angular alignment of inducer and impeller blades and the axial gap between inducer and impeller have been examined.

III. PROBLEM IDENTIFICATION & OBJECTIVES

Problem identification

1. Time required for heating the HT water before the starting of standby engine is high.
2. Energy consumption is high.
3. Cost is high.

Objectives

1. The objective of this project is to reduce the time required for heating the HT water before the starting of standby engine.
2. To eliminate the requirement of electric heater.
3. To reduce the power consumption.

IV. DIESEL ENGINE GENERATOR HALL

The DG hall house the entry prime mover alternator set. The prime mover used in CPP is 32E WARTSILA Diesel engine. It is a smoke turbocharged and intercooled engine with direct twin fuel injection. The engine fuel primary fuel is LSHS. Diesel is used for starting and stopping purposes.

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Diesel engine generator hall

V. COMPONENTS OF ENGINE

Following are the components of engine

1. Engine cylinder
2. Cylinder block
3. Crank case
4. Inlet valve and Exhaust valve
5. Connecting rod
6. Crank shaft
7. Flywheel
8. Turbocharger
9. Engine auxiliary system
10. Charging air system
11. Fuel system
12. Lubrication system
13. Starting air system
14. Cooling Water system
15. Speed governing system
16. Exhaust air system

VI. WORKING PRINCIPLE

The piston which is reciprocating in the cylinder has a stroke length of 35cm. Each cylinder has a set of valve and exhaust valve and a fuel injection system. A cam is mounted on a cam shaft these valve. The cam shaft coupled to the crankshaft these valves. This arrangement provided an economic method for replacement of individual cams during fault. The fuel injection system can be broadly into two parts pressurized and atomized unit.

Pressurized unit consists of a plunger which reciprocated in a cylinder called barrel. These together from pump which is pressurized the fuel to above 500 bars.

Atomizing units are nozzles which provided a fine spray of fuels into the cylinder. A cam provides the up & down motion of the plunger in the barrel.

The speed of the engine is maintained constantly even when the load on the alternator varies. This is attained with the help of governor.

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A safety valve is provided at the top of the cylinder. It is set for a maximum pressure of 400 bars. To improve the efficiency of the engine a turbocharger is provided which is a turbine compressor system. Hence the air is compressed of about 3bars. The compressed air is cooled to maintain a particular temperature the turbo charger works at 1500 rpm for every 150 hours the turbine is washed.

VII. HEAT EXCHANGER

A heat exchanger is a device used to transfer heat between one or more fluids. The fluids may be separated by a solid valve prevent mixing or they may be in direct contact. They are widely used in space heating, refrigeration, air conditioning, power station, chemical plants, petrochemical plants, petroleum refiners, natural-gas processing and sewage treatment. The classic example of heat exchangers is found in the internal combustion engine in which fluid known as engine coolant flows through radiator coils and air plant gas the coils, which cools the coolant and heats the incoming air.

Classifications of heat exchanger

Based on physical states of fluids

1. Condenser
2. Evaporator

Flow based heat exchanger

1. Parallel flow
2. Counter flow
3. Cross flow

VIII. CALCULATION

Engine efficiency

Calorific value for furnace oil = 10500 kcal/kg

Specific fuel consumption of engine = 0.225 kg/ unit

For producing 5500 unit, fuel required

$$= 5500 \times 0.225 \\ = 1237.5\text{kg}$$

Energy input to the engine = 1237.5kg

$$= 1237.5 \times 10500 \\ = 12993750 \text{ kcal}$$

Actual work done = 5500 units

For 1 unit, output = 850 kcal

Therefore, 5500 units = 850 × 5500

$$= 4675000 \text{ kcal}$$

Efficiency of the engine = (output/input) × 100

$$= (4675000/12993750) \times 100 \\ = 36\%$$

Efficiency of the engine = 36%

Balance energy loss

Heat carried out in the flue gas = 24%

Heat carried out in the cooling water = 31%

Radiation loss =9%

So, W.K.T,

$$\text{Power generated} = 0.36 \times 12993750 \\ = 4677750 \text{ kcal}$$

$$\text{Heat losses in flue gases} = 0.24 \times 12993750 \\ = 4028062 \text{ kcal}$$

$$\text{Radiation loss} = 0.9 \times 12993750$$

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$$= 1169437 \text{ kcal}$$

Design of shell and tube heat exchanger

W.K.T,

$$\text{Pump capacity } m = 2.1 \text{ lit/s}$$

$$\text{Therefore, } c_p \text{ for water} = 4.186 \text{ KJ/kgK}$$

Cold side:

Here,

$$\text{Cold water inlet temperature, } t_1 = 40^\circ\text{C}$$

$$\text{Cold water outlet temperature, } t_2 = 60^\circ\text{C}$$

W.K.T,

$$Q = mc_p t$$

Where,

$$Q = \text{heat transfer coefficient, KW}$$

$$m = \text{mass transfer, kg/sec}$$

$$c_p = \text{coefficient of water, KJ/kg K}$$

$$\Delta t (t_2 - t_1) = \text{difference in temperature, } ^\circ\text{C}$$

$$Q = 2.1 \times 4.186 \times (60-40)$$

$$Q = 175.81 \text{ KW}$$

Hot side:

$$\text{Water required for heating is } Q = mc_p t$$

Here,

$$T_1 = 95^\circ\text{C}$$

$$T_2 = 80^\circ\text{C}$$

$$\text{Therefore, } 175.81 = m \times 4.186 \times (95-80)$$

$$m = 2.79 \text{ kg/sec}$$

Area calculation:

We know that,

$$Q = UA (\Delta T)_{lm}$$

Where,

$$Q = \text{coefficient of heat, KW}$$

$$U = \text{overall heat transfer coefficient, } \text{W/m}^2\text{k}$$

$$A = \text{area, } \text{m}^2$$

$$(\Delta T)_{lm} = \text{LMTD, } ^\circ\text{C}$$

So,

To find $(\Delta T)_{lm}$:

$$(\Delta T)_{lm} = \frac{(T_1 - t_2) - (T_2 - t_1)}{\ln \frac{(T_1 - t_2)}{(T_2 - t_1)}} \quad (\text{from HMT data book, for counter flow})$$

Where,

$$T_1, T_2 \text{ are hot side temperature, } ^\circ\text{C}$$

$$t_1, t_2 \text{ are cold side temperature, } ^\circ\text{C}$$

So,

$$(\Delta T)_{lm} = ((95 - 60) - (80 - 40)) / \ln (35/40)$$

$$(\Delta T)_{lm} = 37.44^\circ\text{C}$$

$$(\text{say } 37^\circ\text{C})$$

Now we know that,

$$Q = 175.81 \text{ KW}$$

$$U = 1100 \text{ W/m}^2\text{k}$$

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$$(\Delta T)_{lm} = 37.44 \text{ }^{\circ}\text{C}$$

To find area:

$$A = Q / U \times (\Delta T)_{lm}$$

$$A = 4.3 \text{ m}^2$$

IX. RESULT

1. Less time consumption to start ideal engine.
2. It does not require electrical heater.
3. To reduce power consumption.
4. Less area is required.
5. Excess heat energy is utilized for hot standing engine

X. CONCLUSION

By introducing a shell and tube heat exchanger instead of an electrical heater we are transferring the heat produced in running IC engine to the standby engine by passing the outlet of HT water from running engine to the shell & tube heat exchanger in order to maintain the temperature of the ideal engine by using thermostats. This ultimately reduces the fuel consumption, electricity consumed by electrical heater and hence the operating cost of the power plant.

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