

STUDY OF WASTE HEAT RECOVERY FROM STEAM TURBINE XHAUST FOR VAPOUR ABSORPTION SYSTEM IN SUGAR INDUSTRY

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ABSTRACT

Most of the energies are utilized by the industries, due to depletion of fossile fuels and increasing the fuel price to utilize the maximum available energy from the waste heat source. The study is conducted in the turbine exhaust of the sugar cogeneration plant. From this study determine amount of heat energy is lost from turbine exhaust and it condensate in the condenser. The turbine exhaust heat energy is converted to cooling effect using vapour absorption refrigeration system and to replace the vapour compression refrigeration system. From the study, energy consumption and energy savings in terms of energy and fuel are analyzed.

Key words: steam energy; recovery; refrigerant; vapour absorption system.

INTRODUCTION

In India most of the industries are in the position of high power consumption and they are emitting more amount of heat energy to the atmosphere. The power crises plays a major role of the economy of our country day by day demand of the fossile fuels going on increasing. So we have to use the energy as much as efficient.

Steam Energy

The steam energy which is produced with the help of water tube boiler and the fuel as Bagasse sugar industry. The steam energy contains more amounts of pressure and temperature. Then it is utilized by the turbine for making the power. After generating the power some amount of energy going to be exhausted to the atmosphere.

Refrigeration and air conditioning system

India being a warm tropical country most of the refrigeration and HVAC applications involve cooling of air water and equipments. Refrigeration and air conditioning accounts for a significant position of the energy consumption in much industry like chemical, cement, sugar, food, dairy etc.

Due to an Industrial development the demand for the process related refrigeration and air condition is increasing however. modern life styles with the rising demand for comfort air conditioning in Industry and homes are a source of concern for an energy scare country like India.

The vapour absorption chiller is a machine, which produces chilled air by using of heat energy and it may be economically situated where the waste heat available.

In steam turbine exhaust contain the temperature more them 100^oc. By utilizing the waste heat, can able to operate the vapour absorption chiller and operating cost will be reduced and energy will be saved.

Table1
Operating performance of the vapour absorption refrigerant [A]

| Parameter | Li-br water | | | Ammonia |
|-------------------------------------|---------------|---------------|---------------|-------------|
| | Single effect | Double effect | Trible effect | |
| Temperature °C | 8 | 8 | 8 | 10 |
| Co efficient of performance | 0.5 to 0.6 | 1 to 1.2 | 1.6 | 0.55 |
| Specific fuel consumption (kg/h/TR) | 8.75 | 4.5 to 5.25 | 2.3 | 10.2 |
| Pressure in bar | Less than 3 | 8 to 8.5 | 10 to 11 | More than 3 |

Quality of steam in steam turbine exhaust:

Mass flow rate = 3.76 T/hr.
 Inlet temperature of water =109 °C.
 Inlet pressure of steam =0.6 kg/cm²

VAPOUR ABSORPTION REFRIGERATION SYSTEM

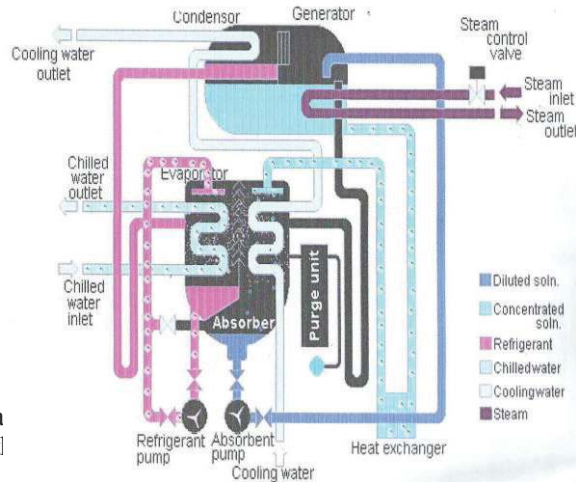
Vapour absorption refrigeration machine where in heat energy is consumed are being increasingly used. Absorption refrigeration and air conditioning temperature ranging from 25^oC to -70^oC.

The electrical power consumption of the vapor absorption machine is only about 2% of a comparable vapor compression machine, including the power consumption of cooling water System. It may also be noted that for the same heat load, the heat rejected in absorption machine is about 60% more than in a vapour compression machine; hence the cooling water pumping power consumption is likely to be significantly higher. It may be noted that electricity savings are large. However, the economics would depend on the cost of heat energy used in the absorption system.

Working of Lithium Bromide Absorption Refrigeration Chiller

Evaporator: Water as the refrigerant enters the evaporator at very low pressure and temperature. Since very low pressure is maintained inside the evaporator the water exists in the partial liquid state and partial vapor state. This water refrigerant absorbs the heat from the substance to be chilled and gets fully evaporated. It then enters the absorber.

Absorber: In the absorber concentrated solution of lithium bromide is already available. Since water is highly soluble in lithium bromide, solution of water-lithium bromide is formed. This solution is pumped by the pump to the generator.



Generator: The heat from the generator from the condenser, where it goes to the generator. The generator moves the refrigerant through nozzles, its pressure reduces and so also the temperature. This water refrigerant then enters the evaporator where it produces the cooling effect.

ENERGY RECOVERY

Available energy in the condenser:

$$Q = m_s \times C_{p_s} \times (t_{out} - t_{in}).$$

Where, $h = C_{p_s} \times (t_{out} - t_{in}).$

$$h_{sup} = [h_s + C_{p_s} \times (t_{sup} - t_{sat})].$$

$$h_{sup} = 2699.3 \text{ kJ/kg.}$$

$$\text{Total heat energy available} = m_s \times h_{sup}.$$

$$= 2811.81 \text{ kJ/sec.}$$

vapour compression system for producing the cooling effect to the thyrist DC motor drives.

Specification of air conditioned room

- Area of the space to be cooled : 15 m².
- Volume of the room : 152 m³
- Total number of machine : 3TR/each.
- Compressor input power : 4kW.
- Company : blue star.
- Total refrigeration capacity : 12TR.

Energy required for operating the vapour compression system

$$P = 4 \text{ kW/machine.}$$

$$= 4 \times 2/3 \times 24$$

= 64 kW/day/machine.

Total number of machine is 4 so $= 4 \times 64$

P= 256 kW/day.

256 kW of energy required for operating the vapour compression system for producing the cooling effect to thyrist DC motor drive for a day. The plant operated 180 days for the year.

Energy required for vapour compression System.

= 46080 units/year.

Energy required for operating vapour absorption System.

= 2% of VCR

Energy required for vapour absorption system = 921.6 units/year.

Energy recovery = (Energy required for vapour Compression system) – (Energy required for vapour absorption system)

= 46080 - 921.6

= 45158.4 units/year.

Energy saving in terms of fuel:

Calorific value of bagasse = 10465 kJ/kg.

Total energy recovery = 45158.4 kJ/kg.

Mass of fuel saved

Total amount of electricity saved per year = 45158.4 Kw/year.

Mass of steam required = 45158.4 × 5.5

= 251671.2 kg of steam.

Enthalpy of super heated steam = $h_s + C_{p_s} (t_{out} - t_{in})$.
= 2634.25 kJ/kg.

$$\begin{aligned} \text{Efficiency} &= \frac{\text{Energy available}}{\text{Energy supplied by the coal.}} \\ \text{Of the boiler} &= \frac{m_s \times h_{sup}}{m_f \times \text{calorific value.}} \\ &= \frac{(251671.2 \times 2634.25)}{(0.65 \times 10465)}. \end{aligned}$$

$m_f = 74.53021$ tons of fuel.

CONCLUSION:

From this analysis, the amount of fuel saved nearly 75 tons/year using the vapour absorption refrigeration system and also power required for vapour compression system eliminated.

Total energy recovery = 45158.4 units/year.

ABBRIATION

m_s = Mass f of steam Kg.
 C_{p_w} = Specific heat of water KJ/Kg k.
 C_{p_s} = Specific heat of steam KJ/Kg k.
 h_s = Enthalpy of steam KJ/Kg .
 h_{sup} = Enthalpy of super heated steam KJ/Kg.
 T_{out} = Outlet temperature.
 T_{in} = Inlet temperature.
 P = Power.

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