MINIMIZATION OF PROCESS HEAT DISSIPATION TO COOLING TOWER

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Abstract: Cooling towers are hidden profits for energy conservation and cost effective when properly engineered and maintained. The savings accrued in energy conservation and additional product manufactured can be an important factor of an industries profits. In industry there are many waste heat sources are available. Existing technology for this is used cooling tower and modern technology are using heat pump, VAM,ORC(organic rankine cycle). In this research paper waste heat from compression is recovered by adding split type heat exchanger from which it is passed to VAM (vapor absorption machine). VAM is used for obtaining chilled water. This chilled water can be used to decrease the temperature of the gas at suction of compressor. In result we get less shaft power requirement for compression. Thus from waste heat we can make profit for industry.

Keywords: Cooling tower, VAM, ORC.

1. Introduction

In chemical plant there are various sources of waste heat generation .we are doing this research in ammonia plant with compression cycle as waste heat source. In compression cycle there is interstage cooler which is used for cooling down the incoming gas with temperature upto 200oc. We take three interstage cooler with temperature upto 100oc as temperature of waste water. now this waste heat water source is used either in VAM for chilled water generation or in ORC for electricity generation or in heat pump. Among all which gives more energy efficient, economic one is our final aim.

Split type exchanger; we can replace this interstage cooler as split type heat exchanger. In first half part is used for waste heat source generation and other part with ΔT is $10^{O}C$ We have 100OC as waste heat water .this is used in VAM for chilled water generation. The design of VAM is given below. The total water requirement before heat recovery must be less than installing VAM for heat recovery for economy purpose

Now this chilled water produced from waste heat is used for either chilling purpose or for decreasing shaft power requirement for compression process. For compression there is turbine for rotating shaft and In turbine because of shaft power decreases steam requirement is also get reduce so, there is less utility requirement and energy savings.

The payback period is also less.

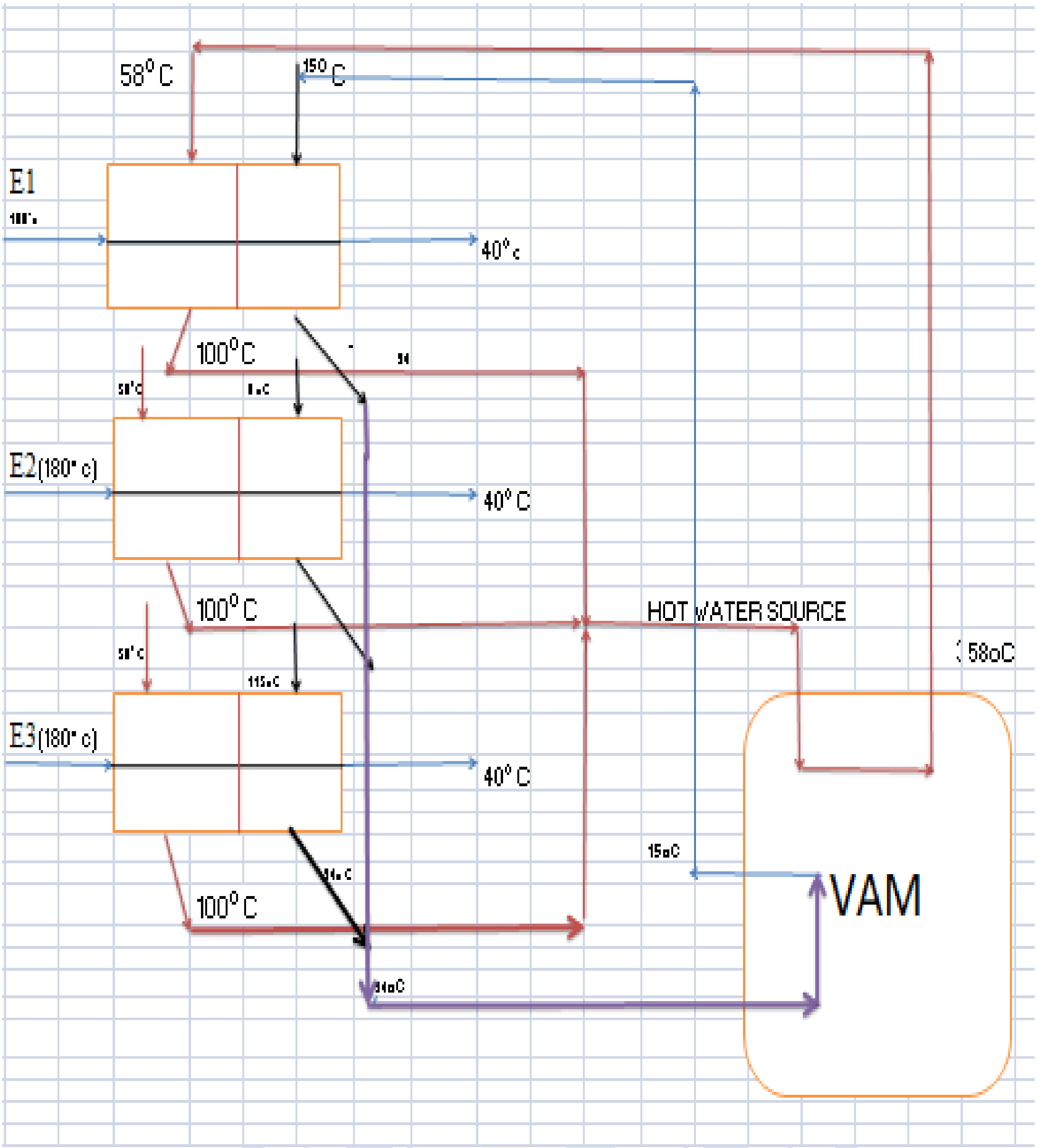
Modern technology for heat recovery

- Heat Pump
- Vapour Absorption Machine (VAM)
- Organic Rankine Cycle (ORC)

2. Arrangement of heat exchanger for heat recovery-

In this diagram, arrangement of heat exchanger from compression is shown. So, there are three exchanger from which we have to waste heat recover. The exchanger are split in two parts one part is for generating hot water source and other part we keep ΔT of 10OC

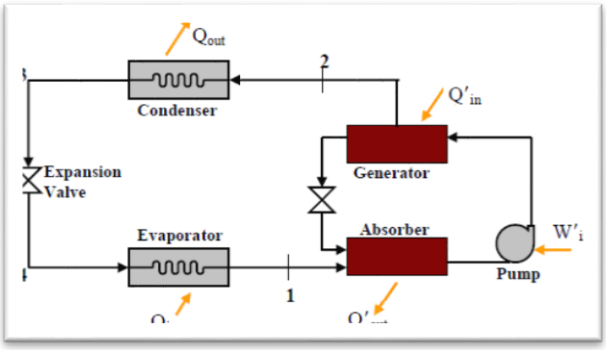
Gas after compression temperature rises up to 180o C, this we have to cooled to ambient temperature. so from this we can generate waste hot water temperature upto 100oC.



3. Method Description :

➢ Vapour absorption machine (VAM)

In the vapor-compression refrigeration cycle, refrigerant enters the evaporator in the form of low-pressure mixture of liquid and vapor. Heat is transferred from the relatively warm air or water to the refrigerant, causing refrigerant to boil. The resulting vapor is then pumped from the evaporator by the compressor, which increases the pressure and temperature of the refrigerant vapor. The hot, high- pressure refrigerant vapor leaving the compressor enters the condenser where heat is transferred to ambient air or water at a lower temperature. Inside the condenser, the refrigerant vapor condenses into a liquid. This liquid refrigerant, which creates a pressure drop that reduces the pressure of the refrigerant to that of the evaporator. At this low pressure, a small portion of the refrigerant boils cooling the remaining liquid refrigerant to the desired evaporator temperature. The cool mixture of liquid Much like in the vapor compression cycle, refrigerant in the absorption cycle flows through a condenser, expansion valve, and an evaporator. However, the absorption cycle uses different refrigerants and a different method of compression than the vapor compression cycle. vapor absorption cycle is more economic than vapor compression cycle because, compressor is not used in absorption cycle.



➢ HEAT BALANCE IN VAPOUR ABSORBTION MACHINE:

Case =1) If hot water inlet temperature is 100oc and outlet temperature case is 33^{O}C

Total water as heat source = 32082 kg/hr with inlet temperature 100o c and
outlet temperature 33o c

Total water as cooling source = 22421.69 kg/hr with inlet temperature 22o c

○ HEAT BALANCE IN GENRATOR:

rate of heat in by hot water = rate of heat out by vaporization

m (kg/hr)* cp(kj/kg k)* ΔT(k)=m(kg/hr)* ƛ
32082 * 4.187* 67 = m * 2392.87

MASS FLOW RATE OF VAPOUR =3761.378 Kg/hr

○ HEAT BALANCE IN CONDENSOR:

Rate of heat out by vapor = rate of heat out by cooling water
m (kg/hr)* ƛ = m(kg/hr)* cp(kj/kg k) *ΔT(k)

3761.5 *2392.87 = 2242.4 *4.187 *(T2-295)

The outlet cooling water temperature=390.87 K

○ HEAT BALANCE IN EVAPORATOR:

Heat removed by chilled water = heat gained by refrigerant vapor

m (kg/hr)* ƛ = m(kg/hr)* cp(kj/kg k)* ΔT(k) 3761.5*2492.1 = m * 4.187* (T-295)

mass flow rate of chilled water =86101.3 kg/hr

○ HEAT BALANCE IN ABSORBER:

m (kg/hr)* ƛ = m(kg/hr)* cp(kj/kg k)* ΔT(k) 3761.5*2492.1 = 22421.6 *4.187* (T2-295)

The outlet cooling water temperature= 394 k

So, in this way we get chilled water from VAM with mass flow rate of 86101.3 kg/hr. This chilled water can be used in compression cycle to decrease the temperature of compress gas. Because, of reduce in temperature of gas shaft power requirement for compression also get reduced and there is saving in energy. This retrofit can be implement in plant for energy saving and also increase profit

4. Compressor shaft power calculation:

Case 1 – Before using VAM

Exchanger number	Shaft power requirement in KWh
1	930
2	1386
3	1510
4	1332

Total shaft power – 5352KWh

Case 2 – After using VAM

Exchanger number	Shaft power requirement in KWh
1	920
2	1145
3	1574
4	1511

Total shaft power – 5352KWh

5. RESULT

Total shaft power requirement without using VAM -5352.7 KWH

Total shaft power requirement after using VAM - 5140.5 KWH

SAVING IN SHAFT POWER- **212.2 KWH**

Steam is required for turbine to compress gas, because of shaft power reduces steam requirement is also get reduced

1 KWH = 859.84 Kcal

COST OF STEAM = 3300RS/Ton

Saving in shaft power – 212.2*859.84= 181983.4 Kcal/hr

100 ata steam enthalpy = 850Kcal/Kg 214.09Kg/hr = 5138.54Kg/day
= 1695654 Kg/year - 330 days
= 1695.65 MT/year
Total cost of steam = 5595680 Rs/year

Cost of VAM = 2.5 CR

Simple payback period= total investment/annual saving
=25000000/5595680
=4.46 yrs

Conclusion:

- The result of this study is that we can retrofit existing condition to reduce the energy and to increase the profit.
- The Vapour absorption machine is very helpful to produce chilled water by using our waste source heat.
- The shaft power of turbine also reduce. We can use this technology to increase the profits and to reduce the energy in plant.

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