International Journal of Technology Engineering Arts Mathematics Science
Special Issue 1, August 2023, pp. 56-59
ISSN: 2583-1224,

ENERGY EFFICIENT PROJECTS

Er. Arun Atre

S B Patil College of Architecture, Pune
Maharashtra, India

Email: arunatre69@gmail.com

Article Information

Article history:

Received Jun 15, 2023
Accepted Dec 10, 2023

ABSTRACT

Energy efficient projects have been the need of the hour since long in which Team work is very important. Engineers & Architects need collaborate & support in respect of understanding engineering design, statutory requirements, acts etc. Design phase thoughtfulness is very important. It is essential to understand & agree that we can save energy with a thoughtful approach. One must have Green Mission. I have presented the project of Waste Heat Recovery based Heat-exchange from flue gas from concept to commissioning. An Absorption system is useful with hot water as input. Regular site visits to assess the progress is much needed.

KEY WORDS: #Energy Efficient Projects # Team Work# Energy Saving# Flue gas heat recovery # absorption Heat exchange

1. INTRODUCTION

We are using diesel engines in industry for various purposes. The engine losses 33% in exhaust, 33% in jacket water & 33% is useful power. It will be beneficial to use the lost energy to advantage. The heat lost can be use d for savings, reduce lower atmospheric pollution as the flue gas is let out at lower temperature (150 deg C instead of 500 deg C)

I. Tapping of heat from exhaust gas was not pursued earlier. Difficulties in getting materials and difficulty in maintaining was the reasons behind. Tapping of heat from engine exhaust or flue gas to generate hot water or steam is called as Waste Heat Recovery (WHR) .In this we use heat energy (Thermal Energy) and make use of it to generate usefully.

II. Flue gas heat is generated due to fuel combustion. It is normally released into the immediate surroundings. Recovery of this flue gas heat or waste heat can be important from environmental, economic (Cost saving) point of view.

III. Advantages of WHR: The heat recovered will increase the efficiency as free energy is available. This will eliminate the need of prime mover energy.

IV. Indirect benefits of WHR

- Because of reduced pollution or less hot exhaust, ambient conditions do get affected to a lesser extent.
- Disadvantages of WHR
- Initial cost is high.
- If waste heat is of low quality (temperature) it is not much advantageous.
- Size of heat exchanger is large to manage the gains of heat tapped.
- Maintenance of equipment is an added job.

Co-generation: Cogeneration is generation of electricity or power & heat. It is also called Combined Heat and Power (CHP).

CHP is most efficient when heat can be used very near to the point of use. Losses are happening if the

viscidity is lost. A car engine becomes a CHP plant, as we heat up our car space in winter season. Trigeneration differs from cogeneration in that the waste heat is used for both heating and cooling, typically in an absorption refrigerator.

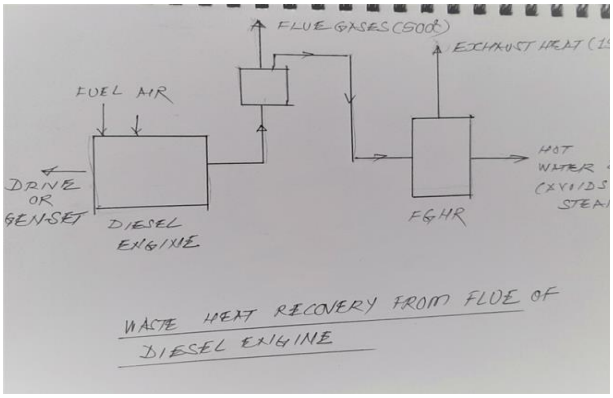

Figure 1. Cogeneration diagram

In this project we have used Flue Gas Waste Heat Recovery in Co-generation Based on Absorption Heat-exchange. We look in to sources for tapping Waste Heat as per Table 1.

Indicating quality of heat

2. METHDOLOGY

Vapour Absor: S. No.1. In above table was very near & dear for us. It was chosen to work on. This waste heat is of high quality (temperature) Vapour Absorption water fires chillers were employed wherein hot water available from WHR from flue gas. Each one has a capacity of 10 TR. There were 4 such chillers used. Input is 80 deg C (Water fired chiller eliminates the need for steam & boiler Act.). Output is 7 deg C chilled water. Lithium Bromide solution with changing concentrations provides water vapours of varying temperatures. The system comprises of components as FGHR & WATER FIRED CHILLER

FGHR (Flue Gas Heat recovery unit): FGHR exchanger is illustrated in Figure 2. We have used this in our project.

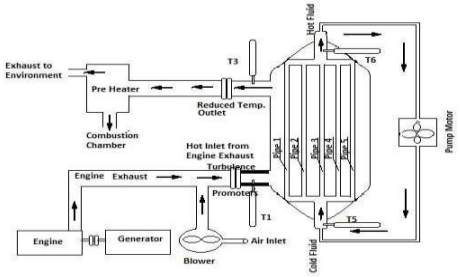

Figure 2. FGHR illustrated

Flue gas heat exchanger transfers exhaust gas heat to energy. Internal Combustion Engine can render usefulness in respect of using heat energy which will otherwise go waste. The hot exhaust pipe delivered by the engine is only thought of in this case.

The waste hot exhaust gases pass through the heat exchanger device and heats up the water on other side of heat exchanger.

As a result hot water (80 deg c) is available to feed the generator of a absorption machine.

So it is the Energy recovery from diesel engine exhaust gases for heating the water for input of a generator of absorption chiller.

Table 1: Sources for tapping Waste Heat

Sr. No.	Source	Quality
1.	Heat in flue gases	The higher the temperature, the greater the potential value for heat recovery
2.	Heat in vapor streams.	As above but when condensed, latent heat also recoverable
3.	Convective and radiant heat	Low grade – if collected may be used for space heating or air lost from exterior of preheats for equipment's.
4.	Heat losses in cooling water:	Low grade – useful gains if heat is exchanged with incoming fresh water
5.	Heat stored in products	Quality depends upon temperature leaving the process.
6.	Heat in gaseous and liquid	Poor in case of contaminated and thus requiring better materials.

Water Fired SINGLE-EFFECT Chiller produces chilled water for Air Conditioning. 4 Nos. 10 TR i.e. 40 TR chillers are employed.

The chiller is consisting of four main components mainly Condenser, Evaporator, Absorber & Generator.

The absorption cycle is energized by hot water at 80 deg C. In my project it was flue gas from a diesel generating engine.

The cooling tower is used for the condenser cooling. A dedicated cooling tower was installed. The cooling tower is 1.5 times larger than that for a vapor compression system. An absorption chiller uses a solution of lithium bromide and water, under a vacuum as the working fluid. Water is the refrigerant and lithium is the absorbent. Refrigerant is pressurized &

depressurized due to change in concentration of the solution.

a. Generator

When the water inlet is more than 68 deg C. The solution boils on the surface of the generator releasing refrigerant vapor which flows to the condenser. Condenser Refrigerant vapor condensation occurs. The liquid refrigerant is throttled in to the evaporator which has a large volume causing pressure drop thereby lowering the temp of refrigerant.

b. Evaporator

In the evaporator the refrigerant liquid gets converted to low temperature vapor. The evaporator lowers the temperature of chilled water in turn.

c. Absorber

The refrigerant vapor is absorbed by Li Br which is concentrated here. Lithium -Bromide solution flowing across the surface of the absorber coil.

In a vapor compression system compressor is used to pressure up refrigerant which makes the refrigerant flow through the refrigeration cycle.

In Vapor absorption system instead of compressor a combination of generator & absorber working in tandem resulting into change in concentration of the solution, (Lithium bromide –water), water here works as a refrigerant.

Vapor Compression system (VC System) is very common refrigeration & air conditioning system which has same parts like condenser, evaporator, throttling device and a compressor. It is a work operated system or cycle. Vapour absorption system or cycle (VA system) is a heat operated cycle. Compressor is replaced by absorber generator combination. VC system is a prime mover based while heat energy is requires for VA system.

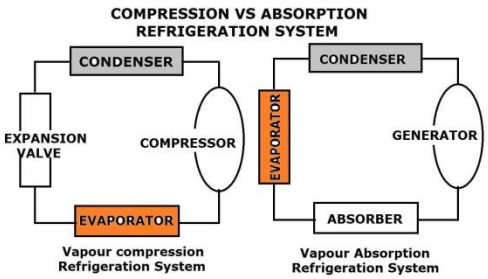

Figure 3. VCS and VAS

Coefficient of performance (COP = chiller load/heat input) is low. But absorption chillers can reduce operating costs because they are using waste heat.

As we went ahead in implementation of this project challenges faced were enormous namely-

It is very important to maintain the systems, especially condensing water temp should not go below 24 deg. C, and else crystallization of Li Br solution may take place, which is a very difficult preposition. You need to de crystallise the Li Br, if it happens. You have to heat up to de-crystallise. Only a person involved in the project will understand this phenomenon. Maintaining Cooling water temperature blow 24 deg c is task.

Water treatment of cooling water is an Important factor for the Vapor Absorption because water quality is much important so also for Vapor Compression system as scaling on tube surface is detrimental.

Another challenge was the excess heat tapped generated excess hot water. It was required to be drained off. Sites of gutters delivering hot water vapours were a very common & disturbing thing. We were blamed & lashed out, seniors not understanding that it was first attempt to do such a project.

Three- way diverting valve for flue gas line to control the heat tapped can be used to for this purpose. In absence of the three-way diverting valve excess hot water was required to be drained off.

There was much more deposition of carbon suite in the heat exchanger. Weekly suite removal & cleaning was a very tough & bothersome task. Some cool down period was also needed for the heat Exchanger. We were not able to manage it on weekly off Sunday. Overtime labour deployment was necessary.

The system employed is explained with the help of some schematic diagrams:

1. Water Fired Chiller Diagram
2. Chilled Water piping to & fro AHU Schematic
3. AHU & Ducting with false ceiling Schematic.

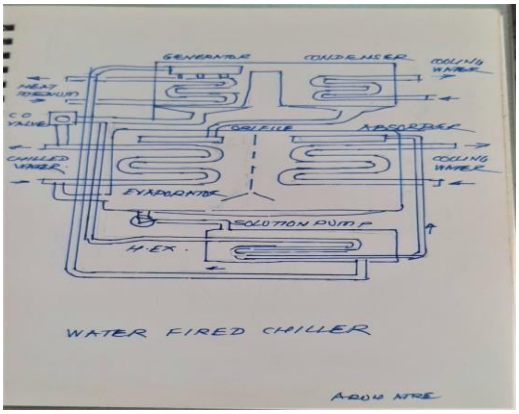

Figure 4. Water Fired Chiller diagram

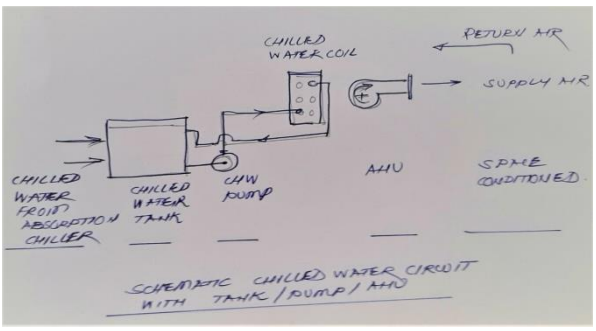

Figure 5. Chilled Water piping to & fro AHU Schematic

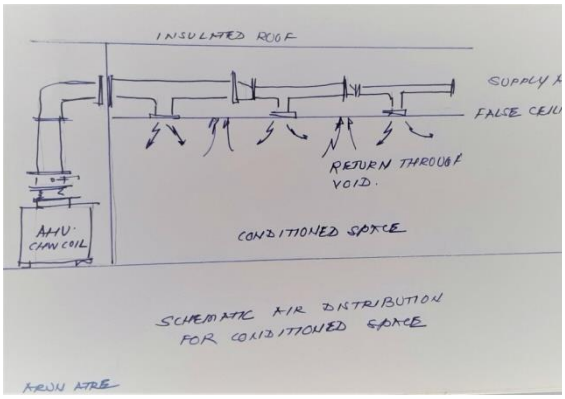

Figure 6. AHU & Ducting with false ceiling Schematic

3. ARCHITECTS ROLE

a. Understand the process requirements.

Visit site & discuss with engineers & project team

b. Pipe system, Insulation, supporting structure to be planned & make layouts.

c. Do not start unless drawings finalized for execution.

d. Modify as per site situation, small changes accepted. Make final drawings as per execution for future reference to run & maintain the system.

e. Be present at time of commissioning .Witness performance & success.

4. RESULTS AND DISCUSSION

Waste Heat recovery from exhaust of diesel engine flue was successfully tapped to generate chilled water which was used to producing air conditioning of corridor in the close vicinity of the tapping point.

Air Conditioning System:

Inside Design Conditions: 24+/-2 deg C, 50% +/- 5% RH

Outside Design Conditions: 41 deg. C, 75% RH PUNE

Air conditioning cost estimated at

Rs.50, 000/- per TR

Total Saving 50,000 x 40 = Rs.2, 000,000/-

Estimated cost of Chillers, Cooling Tower, Heat exchanger etc. = 3,000,000/-

Payback period is estimated as 18 months.

Electricity required for 40 TR is about 44 KW. We can understand savings depending on hours of operations.

5. CONCLUSION

Achievement: 40 TR air conditioning available for free. The prospect of the development of research results and application of further strategies are greater. The author was involved in this project from concept to commissioning in the year 1983-84.

6. REFERENCES

[1] https://www.researchgate.net/figure/Waste-Heat-Recovery-Waste-heat-recovery-represents-the-amount-of-waste-heat-of-the_fig1_333185514

[2] https://en.wikipedia.org/wiki/Water_chiller

[3] https://en.wikipedia.org/wiki/Chiller

[4] https://themechanicalengineering.com/difference-between-vapour-compression-and-absorption-refrigeration-system/