International Journal of Science and Research (IJSR)
ISSN (Online): 2319-7064
Impact Factor (2012): 3.358

Wastage Heat Energy Recovery System: A Technology Review

Vivek Kumar Jayswal[1], Hari Kumar Singh[2]

[1]Suresh Gyan Vihar University, Jagatpura, Jaipur, Rajasthan, India

[2]M. Tech (under dual degree) Electrical Engineering + Energy Engineering

Abstract: ***In any industrial sector the wastage heat energy is take place in almost all processes. In an industrial circumstances these wastage heat energy emission typically take place in the different form of hot water, steam or chimneypot gases. For this energy recovery process we use different types of heat exchangers and heat pump. The emission of this wastage heat energy is may be abundant and the losses in industries, both commercial and in terms of energy, can amount to significant value. Mostly the wastage heat energy recover system is used for economic and planning purpose at low level. Wastage heat at low temperature to the range (0-120°C) is applicable for the production of bio-fuel or also applicable in green house or eco-industrial parks. Wastage heat of medium range up to (120°C-650°C) and high range up to (> 650°C) temperature is used for electricity generation or mechanical work through different capturing process. This paper proposes the technical options for waste heat recovery and consider in greater depth through the real life example as case studies. This paper also help to decision makes to study the various techniques and technology involved in wastage heat energy process and its play an important role in the future energy recovery process.***

Keywords: Wastage heat energy recovery, Low and high temperature heat energy, Electricity generation, Energy recover and heat exchanger.

1. Introduction

In many industrial sector such as steel industries, cement industries, hydro power plant etc. they emits large amount wastage heat energy in the form of hot gas, hot water, hot streams etc. and other form of energy .When we recover this extra heat energy into useful form of energy by the help of energy recovery heat exchanger is called waste heat recovery unit (WHRU). An energy recovery heat exchanger is a waste heat recovery unit that recovers heat from hot streams with potential high energy content, such as hot flue gases from a diesel generator or steam from cooling tower or even waste water from different cooling processes such as in steel cooling. In many industries sector the heating processes produce waste energy that cannot expeditiously recovery. Generally, in an industry the low grade wasted energy has been discarded in environment, and become pollution in environment because of thermal pollution and fuel price. Recycle of wastage heat energy is one of the most important scopes to recover the efficiency of the energy sector, which is very important. Thus, this wastage heat recovery system is very important for industrial energy conversion system.
There are some important benefits of wastage heat energy recovery system in an industry:

1) Minimise energy cost: By the help of recovered waste heat energy is directly use in the place of purchased energy, so it can minimise the cost of energy.
2) Minimise cost of capital equipments: By the help of recycling of waste heat allows for the use of smaller energy conversion equipment capacity, so it can minimise cost of capital equipments.
3) Environmental impacts Minimise: Due to all waste heat recovery directly change purchased energy, it also minimise the environmental impact on air and water.
4) Minimise operating cost: Waste heat recovery minimise energy cost and generally also minimise capital cost, it minimise operating costs.
5) Minimise green house gas (GHG) emission: By the help of waste heat energy recovery by industry minimise GHG emission accomplice with industrial operation.

These are the some important benefit of waste heat energy recovery system in an industry.

There are some recent applications of waste heat energy recovery system:

1) **At low temperature (0-120°C)** waste heat: By the help of this Technology we can utilise the low temperature up to 0-120°C waste heat could be used for the production of bio-fuel by growing of algae farms or could be used in green house or even used in eco-industrial parks.
2) **At medium (120-650°C)** and high (> 650°C) temperature: By the help of this technology we can utilise the medium temperature up to (120-650°C) and high temperature up to (> 650°C) could be used for the electricity generation or mechanical work via different capturing processes.
3) **Waste heat recovery system** can also be used to fulfil refrigeration requirements of a trailer. The configuration is easy as only a waste heat recovery boiler and absorption cooler is required. Furthermore only low pressure and temperature needed to be handled.

1.1 Heat Recovery Equipment

There are mainly two types of heat recovery equipments used in industries: heat pumps and heat exchangers. The use of heat exchanger is more vulgar than the use of heat exchanger. Especially in retrofit situation. All the same, heat pump may be more economic option in some instances. The coefficient of performance (COP) for the heat pump must be considerably greater than 3 to be economically attractive.
There are four types of industrial heat pumps:

1) Closed –cycle mechanical heat pumps: This type of heat pump is used for mechanical compression of refrigerant. It is also used for lumber drying, space heating, and heating water/process liquids.
2) Open-cycle mechanical vapour compression heat pumps: This type of heat pump is used for mechanical compression to increase the pressure of waste water vapour. They are mainly used in the petroleum, chemicals, pulp and food and beverage industries.
3) Open –cycle thermo compression heat pumps:
4) This type of heat pump is mainly use high pressure steam high pressure steam to Increase the pressure of waste water vapour.

1.2 Closed- cycle absorption heat pump

This type of heat pump use a two component working fluid and the principle of boiling point elevation and heat of absorption.

2. Literature Review

This paper will extract the technical stages in achieve the capture and use of waste heat as a possible and good source of energy. It starts with an introduction to different engineering cycle that are used as the basis of waste heat recovery technology.

This paper gives a brief idea of various technology and technique to convert the un useful heat into useful form of energy. A range of criteria are recommended that might be useful in the selection of technology for energy recovery. In this paper there is various numbers of case studies are represented and implemented in decision making for the decision maker.

In this report it is also discuss the various criteria and technology which is very useful in the coming future. The work of heat energy recovery system is very simple. In this report the waste heat is recover by the waste water through a heat exchanger which is shown by the flow diagram. We use a various number of equipments for recovered heat like tubes, heat exchanger heat pump sewage storage capacity boiler and radiator. This method is very important at lower scale or in domestic and commercial application.

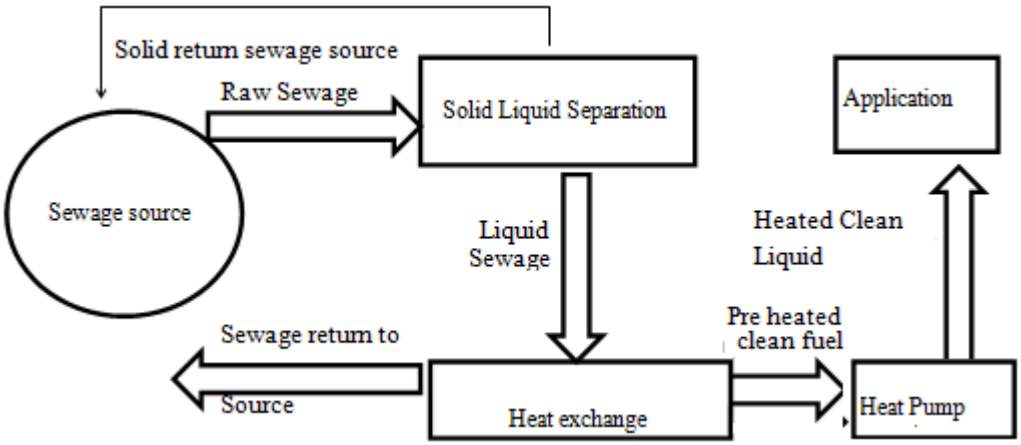

Figure 1: Waste water heat recovery system

The main aim of this research is minimising operational and energy cost and gives the brief idea about environmental and green house gas emission.

3. Technology Overview

In this portion, the different types of energy that can be release by waste heat energy recovery system will be considered. As well, towards all wastage heat recovery processes contain the application of heat exchange to recover energy and deliver it to a second working fluid for different approach. Some another types of heat exchanger and their uses are study. In this last port of this portion, the summary of heat pumps and electricity generation techniques are given.

a) Energy Delivered
By the help of different technologies, can produce various form of recovered energy for reprocess. The two main types of energy that can be made for further use are electrical energy and thermal energy.

b) Electrical Energy
Electrical energy is derived by the waste heat process. It is the most important form of energy. Electricity has flexibility in its applications and division, across thermal energy. Electricity has broad area of uses both at the local of the initial industrial process or it could be introduce into the local electricity grid. The electricity can also be generating by the help of thermoelectric effect, with peltier device.

c) Thermal Energy
Thermal energy is one of the important types of the recovered energy, normally in the form of heat.
The main problem of thermal energy is when it is in the condition of useless water or warm air, is that it can be complex to exchange the energy into other form usable energy. At small scal, it is only use for cooling and heating purpose.

d) Heat Exchanger
A heat exchanger is a device which is used for efficient heat energy transfer from one medium to another. It is

widely used in sewage treatment, natural gas processing, chemical plants, refrigeration, air conditioning etc. The ideal example of a heat exchange is predicate in an internal combustion engine.There are many different types of heat exchangers but these two are main:

e) Shell and Tube Heat Exchanger

The shell and tube heat exchanger is a extremely affect and extensively applicable device. It is applicable for liquid to liquid heat exchanger, but phase change can take place in the heat exchanger. The external part of heat exchanger is known as the shell. This part of the heat exchanger is create to allow for the working fluid to flow across the outside of the tubes. Another part of the shell and tube construction is the tube section. Mainly multiple thin walled pipes are connect to form the "tube", which allow for an accumulate in the surface area available for heat exchanger

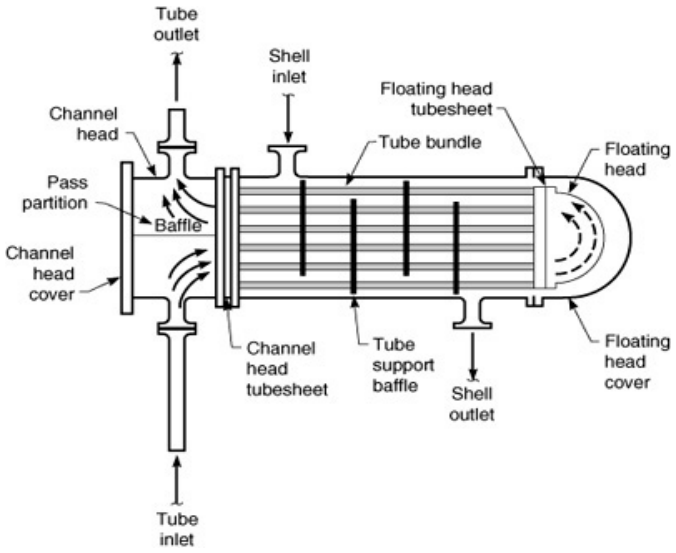

Figure 2: Schematic diagram of Shell and tube heat exchanger

f) Compact heat exchanger

Another area of heat exchanger technology is the compact heat exchanger. There are basically high density heat exchangers which have the effect of large surface area in a comparatively small overall volume.

g) Heat Pump

Heat pump performs using the equal cycle as represent in refrigeration cycle. The basic assumption of operation is that heat pump take utility of the properties of their functional fluid in a closed loop system. The closed loop set up has the capability for two different process of operation. The first process of operation is removing energy from a cooler place to a heated place and it is regular heat pump operation. The second process of operation is that the where heat energy is moved from a heated place to a cooler place. For heat pump equipment, this is known as air conditioning. The performance of heat pump is measured by the coefficient of performance or COP. It can be measure of the ratio between the energy passes for work to be carried out on the working fluid and the useful thermal energy that is delivered at the output of the heat pump.

$$COP(Heat\ pump) = \frac{Desired\ output}{Required\ Input} = \frac{Q}{w}$$

The cause of the heat energy for a heat pump can either be a fluid.

h) Electrical Generation

Electrical energy is the most important type of energy that can be accomplish from a waste heat source. One example of this transformation is possible the most high profile and in the another advice, This example is the combined cycle gas turbine power station and three reasons base for this advice.

1) Its extensive scale performance in combined cycle gas turbine (CCGT) electrical power station.
2) Second the increase in efficiency of this combined cycle gas turbine(CCGT) plant over stand alone gas turbine.
3) Third is the potential to use any high temperature source of waste heat and increased efficiency across a number of industries.

4. Result

The case study has been done by taking various situations and working condition. In this report it show that amount of energy recover by the system is less than the half the amount of producing heat. This report all show the various method to reduce the risk and insecurity of heat supply to the various plant and industries.

5. Conclusion

In this report chapter five briefly discuss thirteen selection criteria for wastage heat energy recovery system. In the final analysis the chapter six briefly discuss about testing and evaluation of waste heat recovery system. Based on study of water heat recovery system by using various data there various conclusions occur. Reprocess of waste heat energy will be the almost major process of energy generation in industries. Reprocess of heat, waste heat recovery, has major benefits with respect to minimise environmental impacts as compared to the usual basic energy generation.

Waste heat should be recovered from the various flue gases to increase the efficiency of the whole system. The temperature of water is generally about 600 to 700℃ so their is a large chances to wastage of heat so by the process of heat recovery we can increase the initial water temperature through which efficiency is increase and equipment is more reliable. These types of heat recovery system can be used at various place mainly on coal based and nuclear plant because there is large heat required in these plant.

6. Future Scope

Future scope of wastage heat energy recovery system is very brightly. Today in all most industrial process the wastage hear energy occur. If we develop the new technology for this wastage heat energy recovery system then we recover large amount of heat energy. This paper motivates the other

researchers who want to study in the field of waste heat energy recovery system.

Reference

[1] A. B. Etemoglu, "Thermodynamic investigation of low – temperature industrial waste heat recovery in combined heat and power generation system". ELSEVIER Dec 2012.
[2] Cecilia Arzbaecher, Ed Fouche and Kelly parmenter, "Industrial waste heat recovery: benefits and recent Advancements in technology and application". ACEEE summer study on energy efficiency in industry 2007.
[3] Peter Gent, "Industrial waste heat energy recovery system- technology overview and approaches for selection of system", 2010.
[4] Sarah Broberg viklund, Maria T. Johansson," Technologies for utilization excess heat: potentials for energy recovery and carbon dioxide emission reduction", ELSEVIER September 2013

Author Profile

Vivek Kumar Jayswal was born in Patna, Bihar on 6 Sept. 1992. He is currently pursing M. Tech under dual degree (B. Tech electrical engineering & M. Tech Energy engineering). Presently he works on wastage heat energy recovery system: A technology review. His research include the how to recover industrial wastage heat energy and technology analysis for this process and efficiency for future aspects.