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Fabrication of Water Portable Heat Exchanger by Using Waste Heat

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Abstract –
In this study, the waste heat of the heat exchanger was analyzed. A heat pipe prototype is made for the recovery of waste heat. This study experimentally investigated the effect of a heat pipe on the recovery of waste heat from gas combustion in cooking and hot water production in households. The highest hot water temperature at the outlet of the tank was approximately 58 C. Heat is a form of "energy" and energy conservation is one of the most important requirements in this scenario, so energy consumption in any form is important to conserve heat. global environment. This article actually proposes a model to recover waste heat from a standard gas stove used in homes and large-scale cooking by actually capturing a large amount of heat (radiation and convection) released during cooking (in the form of waste gases). and use it to heat water, which saves fuel for electrical appliances and domestic water heating.

Keywords: Solar Energy, Wind Energy, PV Cell, Renewable Energy, Hybrid Power System, Electricity.

1. Introduction

The most common application of heat transfer is the design of heat transfer devices that exchange heat from one fluid to another. Such efficient heat transfer devices are usually called heat exchangers. When cooking food, more waste heat is generated when gas is used, and it mixes directly with the environment, and the polluted environment with waste heat. We use this waste for heated water using a copper or aluminum pipe that runs through the waste. Between the water In this case, the water is heated and used for swimming and many other activities.

The disk collector was connected to a two-diameter impulse heat pipe. The pulsed heat pipe was made of copper. The obtained results showed that the maximum efficiency of the collector at 60% ling dose was approximately to. . The heat pipe with an inner diameter of 2 mm is made of copper. Water is used as an activity aid. Any increase in temperature has been shown to increase efficiency. The performance of the system is also improved when it is used instead of water. ratio was used as a workflow. An increase in hot air velocity and temperature would reduce efficiency.

This system also has the ability to reduce humidity. Another study investigated the performance of a so-called and vacuum tube oscillating heat pipe in a waste heat recovery application. The results showed that the average waste heat recovery of the oscillating heat pipe was about 80% higher than that of the empty tube oscillating heat pipe, while the waste heat recovery of the diesel generator using the pulse heat pipe was affected.

Benefits of Waste Heat Recovery Benefits of 'waste heat recovery' can be broadly classified in two categories:

- **Direct Benefits**: The efficiency of the process is directly impacted by the recovery of waste heat. Reductions in utility consumption, costs, and process costs are evidence of this.

- **Indirect Benefits:**

a) Reduction in pollution: When burned in incinerators, a variety of toxic combustible wastes, including carbon monoxide gas, sour gas, carbon black off gases, oil sludge, Acrylonitrile and other plastic chemicals, among others, release gases into the atmosphere that recover heat while lowering pollution levels.

b) Reduction in equipment sizes: Recovering waste heat lowers the amount of fuel needed, which lowers the amount of flue gas produced. This causes all flue gas handling equipment, including fans, stacks, ducts, and burners, to have smaller equipment sizes.

c**) Reduction in auxiliary energy consumption:** Reduced auxiliary energy usage, such as that used for fans, pumps, and other devices, results from smaller equipment.

2. Problem Identification

Heat pipes are an efficient means of heat transfer in various energy applications. The heat transfer coefficient in the evaporator and condenser is significantly high, and therefore the heat pipe is widely used in energy systems.

Because the thermal resistance of the heat pipes is too low, the heat exchanger has a smaller surface area and a smaller mass compared to other traditional types of heat exchangers.

improved freshwater production and evaluated the effect of a closed-loop pulsating heat pipe on the generation of wetting/dehumanizing water. Dehumanizer exhaust air was preheated and prehumidified by a closed-loop pulsed heat pipe before entering the desalination system humidifier. They found that the largest daily freshwater irrigation/dehumanization investigated the effects of ling dose, tilt angle and solar intensity on the performance of a novel closed-loop pulsed heat pipe.

3. Literature Review

Manshu Kapoor , Heat is a form of "Energy," and as energy conservation is currently a top priority, using energy in any form is crucial for safeguarding the environment worldwide. This paper will actually propose a design for recovering waste heat from a typical gas cooker used in homes and for large-scale cooking purposes, by encasing a significant amount of heat released during cooking in the form of (Radiation and Convection), i.e. (Remaining Emitted Gases), and using it to heat water. This will actually reduce the consumption of electrical units and fuel used to heat water for domestic purposes.

Hussam jouhare , Most of the energy needs of the industry are mainly used for operational purposes. recovery of waste heat can significantly reduce production costs and greenhouse gas emissions. In this paper, an innovative heat recovery system was designed, manufactured and tested. A flat heat pipe (FHP) is designed to recover heat by radiation from a hot steel rod during the manufacturing cooling process. The FHP system consists of a stainless steel heat pipe connected to a collector at the bottom and a jacket and tube at the top. The thermal efficiency of the FHP was investigated by testing the wire transport barrier of the system at two points. The amount of energy recovered and the operating temperature of the FHP are also reported. experimental result that FHP heatability is an innovative technology for high-efficiency waste heat recovery in industrial applications.

Lakshya Soni , Heat is energy, so energy saving is one of the key issues related to refrigerant use and global environmental protection. This waste heat affects environmental conditions because when the environment warms, it causes global warming and is also not good for our ozone layer. That is why it is necessary to invest significantly and concretely in saving energy also by recovering residual heat. An attempt was made to utilize the waste heat from the condenser of the refrigerator. This heat can be used for various domestic and industrial purposes. This system is very useful in the household with low costs of construction, maintenance and operation. This is a valuable opportunity to improve overall efficiency and recover waste. Tests have shown that such a system is technically feasible and economically feasible. This system pushed less heat into the environment, making it safer for the environment.

A.J, Adam , Heat exchanger H.X.s is the equipment used to transfer the thermal energy between two or more fluids at varying temperatures. The nature of this paper is an experimental study of the optimum design for shell and tube heat exchanger as a condenser with high productivity of drinking water for portable solar water distiller. The elaboration covers the aspects of considerations, design, fabrication, and test of the shell and tube H.X. as a portable condenser for solar water distiller system. The system consists of a portable stainless steel condenser, which is able to be dismantled and assembled without tools.

Matlaq Al Qahtani, Heat pipe heat exchangers are proved to be a very efficient way to recover waste heat. For this purpose this project aims to design heat pipe in modern heat exchanger in form of thermosyphon heat exchanger. Project tends to show the applications and advantages of the uses of thermosyphon heat exchangers as heat recovery and cooling device either on small or large scale especially in industrial zones. Heat pipe heat exchangers in thermal conductivity are highly effective. Heat pipes requires no other source of energy like electricity, it simply function with a working fluid in the heat pipe and heat is absorbed in the evaporator region and is then transferred to the condenser where the vaporized liquid is then condensed discharging the heat to the cooling area. There are immense applications of the heat pipe heat exchanger and worldwide it has been receiving acceptance as it is cheap and effective and efficient way of recovery of waste heat.

Tanmay Patil , To review the energy savings associated with improved utilization of waste heat from a domestic refrigerator. Domestic refrigerators may be operating continuously to maintain proper food storage condition. The continuous operation of this equipment accounts more electrical energy consumption. So it is that a significant and concrete effort should be made for conserving energy through waste heat recovery. A cabin was installed on a domestic refrigerator with condenser coils of refrigerator serving as heating coils inside the cabin. Known quantity of water was heated by the condenser coils (due to convection currents) thereby increasing the overall COP of the refrigerator. Besides, the refrigerator may be used as conventional refrigerator by keeping the cabin door open in case of absence of heat sink.

S. Vijayakumar , Nowadays, the refrigeration system is commonly used in most of the places. Especially in the bakery shops, hotels and other food processing industries, where they use refrigerator to cool the food items at the same time they had to use heater to maintain hot conditioned preservation for some bakery or food items. In order to

eliminate the dual energy consumption devices being available separately, Our idea is used for both heating and cooling with the single refrigeration unit. The main aim of the research is to recover the waste heat generated in the refrigeration unit. The heat is rejected to the atmosphere through the condenser. This heat is utilized to maintain the chamber located at the top of the refrigerator unit in hot condition. The waste heat recovered will give you the result in terms of the reduction in energy consumption as implies reduction in the CO emission to the environment.

Shahin Shoeibi , Many studies have been done on the Pulsating heat pipes (PHP) using energy applications system. In this study a heat exchanger PHP is analyzed. A heat pipe prototype is manufactured for waste heat recovery. The present study experimentally investigated the effect of pulsating heat pipe on the waste heat recovery of the chimney and produce hot water for household consumption. The evaporator is placed in a smoke exhaust duct and the condenser is located in a water chamber in which the smoke heat is transferred through.

Hassam Jaber, The energy crisis we are facing today has several aspects. Indeed, it not only concerns the fuel cost and reserve but also the level of pollution. That is why the last three decades had shown a tremendous effort to come up with new adequate solutions allowing to overcome the negative impact of this crisis. The anatomy of the overall situation shows that most of the solutions fall within the frame of renewable resources. That said, another approach is attracting increasing interests that is heat recovery. From energy strategy stand point, recovering waste heat could be considered as a complementary solution with renewable systems. In this frame, the present paper aims at highlighting the concept of heat recovery applied to domestic systems. The paper is a short review that essentially investigates four main applications, heat recovery from exhaust gas of chimneys, heat recovery from cook stove, heat recovery from electric generators and heat recovery from drain water.

Uprety Dependra , In Nepal, drinking unsafe water is attributed for the mortality of 13,000 children. The prevalence of this cause of morbidity and mortality in many poor rural regions has created a need for water quality intervention. These days various household drinking water treatment options are currently available in Nepal. Almost 85% of Nepalese population use cooking stove and more than 70% of the heat energy is wasted through chimney of cooking stove. Three different heat exchangers with different efficiencies were designed for Water Pasteurization by utilizing waste heat of flue gas.

Abhimanyu Anil Kshirsagar, Generally in cooking devices three modes of heat transfer takes place (conduction, convection and radiation). Heat is transferred to the utensils mainly due to conduction and convection. A considerable amount of heat in the form of radiation is dissipated to the surroundings. The purpose of this project is to recover this waste heat. Surface radiation without participating media is considered in this study. Hence, copper coil is used to absorb the radiant heat and transfer it to water which run through the coil. This low temperature recovery water can be used for cooking or to keep the food hot packed or other similar low grade heat applications.

4. Proposed Methodology

The waste heat water heater is simple in construction and mainly it consists f primary arts which may be considered as a working elements and various auxiliary parts for its proper functioning and providing stability. Each units (Parts) have its own importance in the assembly of this equipment. The working of these units is to heat water by using waste heat.
Water heat equipment consist of following units.

- Cooking gas cylinder
- Copper tube
- Hot water collecting insulating tank
- Control valve
- Digital Thermocouple
- Input cold water storage tank
- Frame (Stand)
- Pipe

5. Working Of the Machine

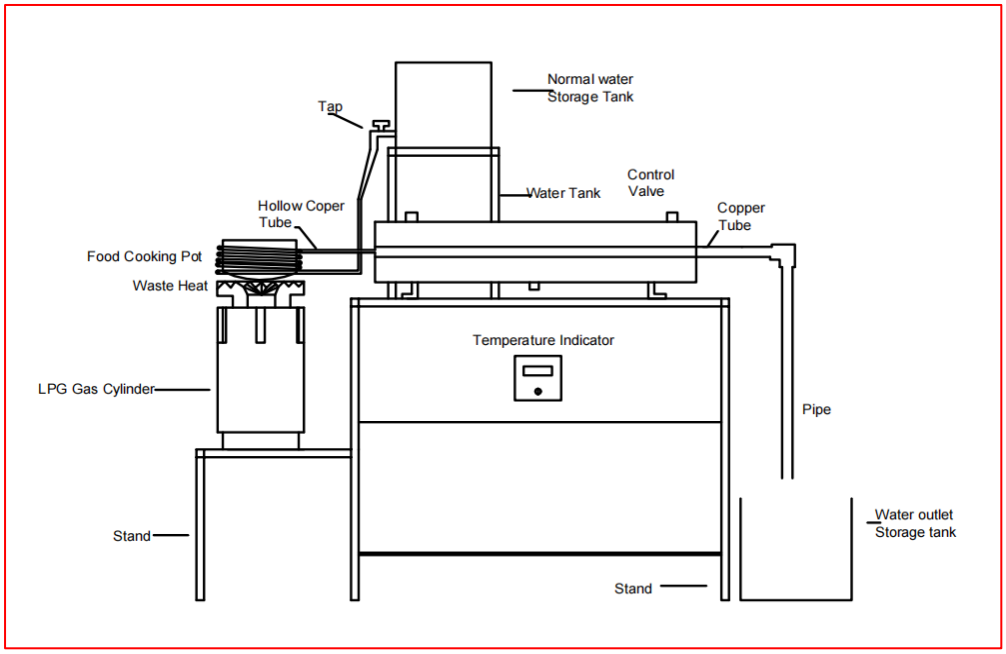

Fig.1. Working Diagram of project

The primary Gas Stove will emit a huge amount hot gases which are a result of combustion of the L.P.G gas and of course due to cooking, weather it may be boiling or frying of any food component. Since all the modular Kitchens are using copper tube as the equipment which will actually suck all the hot gases that are being emitted so as to maintain comfortable working conditions. (Also, conventionally these hot gases are directly being delivered to the environment).

As per the working design a spherical Heat Exchanger is designed, which will have an inlet of the normal tap water available at normal temperatures (T1) and use the heat of the emitted gases so as to increase the temperature of the water to (T2).

Further after using the heat the remaining gases will be spent out to the environment and called as the Remained Emitted Gases (R.E.G).

Therefore the hot water that is required for many residential purposes will now be just available after cooking, which will save a considerable amount of Electrical Units that will be used by the Electrical Geysers or the amount of L.P.G gas.

These are actually the mechanical supports which will support the heat exchanger inside the walls of the waste heat in heat recovery passing thought copper pipe

The heat exchanger that is being employed is a spherical plate type heat exchanger, that will poses a very simple design. As per the proposed design the Heat Exchanger will be fabricated in two materials. The bottom part of the Heat Exchanger will be of a material named as Material and the top part will be fabricated with a material named as Material . The mid section i.e. the Plate that will be separating the Working fluid and the Water to be heated will be also of the material named as Material

These valves will actually control the inlet and the outlet of the water that is to be heated for the desired purpose. The valve 1 will direct the inlet flow of the water and the valve 2 will direct the outlet flow of the water which will be at a higher temperature than the inlet.

Above the gas stove vessel is kept .around the vessel hollow copper tube wound up to the five turn. One end of the tube is connected with normal storage tank which is place above the height respect to height of vessel. The vessel is one open and close type valve connected to regulate the flow of water. Another end of the tube connected with big copper tube which is inside the hot water storage tank.

Inside the hot water tank normal water feed there is a one value to feed the water inside the tank. When the cooking stove turn on flammable hot gas generated for the cooking .Where around the vessel copper tube will be heat and same time normal water tank control value will be open for passing thought water into the copper tube to flow the heat one side to another side in that procedure normal water heat also and passing thought .This hot water for hot storage tank in which big copper tube is attach inside the tank.

This copper tube will be hit for source of hot water and waste hot heat also and big copper tube hot energy transfer to the normal water inside the hot storage tank.

Thermocouple is attach to show the temperature different between input water of tank and output of tank. when another temperature indicator also attach when the water is heated for the one side to the another. They will be temperature indicator also attach in four place.

First temperature indicator is attach into the copper tube of a input tube and second temperature indicator is attach into the normal water inlet pipe and third temperature indicator feed into the hot water storage tank to so the temperature and last Four temperature indicator is attach with the big copper tube to so the temperature.

The assembly of waste heat water heater mounted on fabrication stand whose attached cylinder gas keep stand also the height of hole assembly is 1meter it is comfortable fir operating the height of small gas cylinder is 300mm were attach stove in the attaches stove cooking pot are kept for the cooking food , which is capacity of cooking pot is 2 l liter , around the gas flam one small diameter copper tube is wound diameter of copper tube is 6mm, this copper tube hollow in construction internal diameter of copper tube is 5mm, the gas use in gas cylinder is L.P.G (liquefied petroleum gas), the copper tube total length is 2 meter which wound around the fame able gas where waste in the environment .

The one end of copper tube is attached to the input normal storage tank, normal storage tank is more than the level of copper tube winding, height is 300mm, the tank capacity of normal storage water tank is 4 litter there are 1 top to closed and open for passing water through pipe according to need we can open the top and close the top ,one end of small copper tube is attached to the hot water storage tank the hot water storage tank is made up off steel which diameter is 100mm and length is 350mm in this tank one big copper tube passing through of copper tube is attached through hollow pipe.

When are end of copper pipe is open end to pas water outside we can say that outlet also, the hot water storage tank is fully insulated with material of insulating to protect the head of internal to drawn out to the environment in the hot water storage tank one normal water valve is attached to feed the water inside the tank and one outlet hot water valve to attached to draw outlet water bellow the hot water tank in the right side of hot water tank one end of big copper tube is out.

This outer pipe is attached with PVC pipe to draw heat waste into the another waste water storage vessel, this hole assembly are released to temperature hence we are attached one thermocouple to detect the temperature of various unit there are 4 temperature detection facility is attached with where fourth thermocouple is attached with input normal water storage tank ,second thermocouple is attached with waste water copper outlet pipe first thermocouple is attached to the hot water input small copper tube and third thermocouple is attached with inside the hot water storage tank to detect the hot water temperature digital thermocouple is attached where reading is shown after selection of knob 1,2,3,4 point as per the describe thermocouple points.

Now start the gas stove using lighter to burn the gas where already one cooking pot is kept not add the water inside the cooking piot or cooking food as per need. after that wait upto the 5 minute to heat the copper tube ,now open the top of normal storage tank when top open the top of normal storage tank when top open normal water passes through the copper tube and inside water is automatically gate beat from waste heat and inside water of copper tube waste heat and passing to wartd the big hot water storage tank wahere inside the big copper tube.

This hot water give its heat to inside normal water and heat that normal water due to this process temooerture increase of normal water and copper tube water drawn out to the waste water vessel. When the hot water of small copper tube interning into the big water tube there temperature increase up to 90o C. and after passing though big water tube decrease temperature and shown temperature 70o C.

Inside of the hot water storage tank temperature increase up to 40o C or more than 40o C. which water will be useful for over necessary work as per over need this hole process is called as heat exchange

Calculation

- Hot fluid inlet and outlet temperature.
- 1. $Th_i = 90°C$
- 2. $Th_o = 70°$

- Cold fluid inlet and outlet temperature.
- $Tc_i = 20°C$.
- $Tc_o = 40°C$
- Velocity of cold fluid
- $u_c = \frac{\text{distance}}{\text{time}}$ m/s
- $u_c = \frac{0.010}{3}$
- $u_c = 3.33 \times 10^{-3}$m/s

- Velocity of the hot fluid.
- $u_h = \frac{\text{distance}}{\text{time}}$ m/s
- $u_h = \frac{0.35}{7}$
- $u_c = 0.05$ m/s

- mass flow of cold fluid .
- $m_c = \delta A_c u_c$
- $=1000 \frac{kg}{m^3} \times \frac{\pi}{4} d^2 \times u_c$
- $= 1000 \times \frac{\pi}{4} \times 0.10^2 \times 3.33 \times 10^{-3}$

- m_c = 0.0261 $^{kg}/_{s}$
- mass flow of Hot fluid .
- $m_h = \delta A_c u_c$
- $=1000 \frac{kg}{m^3} \times \frac{\pi}{4} d^2 \times u_c$
- $= 1000 \times \frac{\pi}{4} \times 0.025^2 \times 0.05$
- m_h = 0.0245 $^{kg}/_{s}$
- Special Heat .
- $C_{p_w} = 4.187$ kj/kg
- $C_{p_w} = C_{p_c} = C_{p_h}$
- Capacity rate.
  - $C_c = m_c C_{P_c}$ kw/ k
    - $= 0.0245 \times 4.187$
    - $C_c = 0.109$ kw/k
- $C_{min} = 0.1025$
- $C_{max} = 0.109$

$$Q_{act} = m_c c_{p_c} (Tc_o - Tc_i)$$

- $= 0.0261 \times 4.187$ (90-70)

$$Q_{act} = 2.185 \text{ kw}$$

$$Q_{act} = m_h c_{p_h} (Th_i - Th_o)$$
$$= 0.0245 \times 4.187 \text{ (90-70)}$$

- $Q_{act} = 2.051$ k
- $Q_{max} = C_{min} (Th_i - TC_i)$
  $= 0.1025$ (90-40)
  $Q_{max} = 5.125$ kw
- Now,

$$\in = \frac{Q_{act}}{Q_{max}}$$

- $= \frac{2.185}{5.125}$

$\in$ = 0.426

Project Image

6. Advantage

1. The recovery process will add to the efficiency of the process and thus decrease the cost of waste heat and energy consumption needed for that process.
2. Thermal and air pollution will dramatically decrease since waste heat of high temperature are emitted from plate since most of the energy is recycled
3. Reduction in the equipment sizes as fuel consumption reduces so the control and security equipment for handling the fuel decrease also, filtering equipment for the gas is no longer needed in large sizes.
4. Reduction in auxiliary energy consumption reduction in equipment size means another reduction in the energy fed to those system like pump, filter fans etc.

5. Disadvantage

1. Maintenance of equipment in the additional equipment required maintenance cost.
2. Heat exchanger tend to be larger to recover significant quantities which increase capital cost
3. Units add size and mass to overall power unit .especially a consideration on the mobile power unit of vehicles.
4. Capital cost to implement q waste heat recovery system may out weight the benefit gained in het recovered its is necessary to put a cost to the heat being offset.
5. Often waste heat is low quality temperature. it can be difficult to efficiency utilize the quality of low quality heat contained in waste heat medium.

6. Application

- It is should be useful household purpose.
- It is should be use restaurants kitchen.
- Reheating for hot water driers.
- Majorly all of the Indian kitchens use L.P.G i.e. (Liquefied Petroleum Gases) for the purpose of cooking.

7. Conclusion

One could recover a significant amount of waste heat that was previously just being released into the ambient environment or atmosphere by putting into practise the proposed Design. It would be possible to save 40–50% on the electrical units that were being used to heat water for home uses, which would be more than enough to conserve energy. Waste heat is being used and utilised.

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