Gray Water Treatment Using Solar Powered Thermosyphon Rankine Cycle

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Abstract– The utilization of renewable energy for desalination can solve the problems of energy crisis and fresh water shortage **.**

steam based on Rankine cycles are responsible for the majority of electric power generation in the world today. The technology is readily applicable to solar thermal systems as long as the energy collected can be transported to a central power block. Water is first compressed by a feed-water pump, then boiled and superheated before being expanded through a turbine which turns an electric generator. The low-pressure steam is then condensed in a heat exchanger and fed back to the feed-water pump to be reused**..**

A combined heat and power boiler is equipped with the Rankine cycle to produce electricity. This cycle is composed of four key parts: the generation of high-pressure steam, a turbine, a condenser, and a pump. Steam is generated in the boiler and then transferred to the turbine. Depending on the production setup (i.e., the preferred outcome and local restrictions, such as the cooling sources available), the back-end pressure of the turbine may vary between locations and individual plants. A lower pressure means a higher production of electricity but at the expense of less usable heat from the condenser.

The Rankine cycle is considered the most common and competitive power generation cycle to produce electricity from solar thermal energy

I. Introduction

Statement

Water shortage is a global problem. While other people in some parts of the world maybe enjoying enough supply of water others are faced with water shortage, also energy crisis is considered as a big problem that society faces nowadays.

Significance

Therefore, the problem of water shortage is not just a local, provincial, or national phenomenon but a global issue that affects individuals, industries as well as the economies at large. Hence, this study is significant since it seeks to address the impact of water shortage

Goals

The purpose of this study is to investigate the performance of a closed thermosyphon Rankine cycle, experimentally. Water is used as a working fluid.

-The output power increases with increasing of condenser cooling water flow rate.

The maximum output power produced at minimum area ratio but the optimum turbine rotational speed at a ratio .

II. literature review

Considering that the major component of greenhouse gases (GHGs) is carbon dioxide, there is a global concern about reducing carbon emissions. In this regard, different policies could be applied to reduce carbon emissions, such as enhancing renewable energy deployment and encouraging technological innovations. In addition, supporting mechanisms, such as feed-in tariffs, renewable portfolio standards and tax policies, are employed by governments to develop renewable energy generation along with implementing energy use efficiency for saving energy.

Many countries have started to install facilities that use renewable energy sources for power generation. The importance of alternative energy sources comes together with climate change challenges associated with the excessive use of fossil fuels. There are three primary motivators that stimulate the growth of renewable energy technologies: energy security, economic impacts and carbon dioxide emission reduction. The term “alternative energy” refers to any form of energy other than the conventional sources of energy, including hydropower. In recent years the focus has been on renewable energy sources.

IEA (2012d) refers to two significant global trends that should characterize the deployment of renewable technologies over the medium term. First, as renewable electricity technologies scale up, from a total global supply of 1,454 gigawatts (GW) in 2011 to 2,167 GW in 2017, they should also spread out geographically. Second, the more recent years of high fossil fuel energy use has led renewable technologies to become increasingly competitive on a cost basis with their alternatives in a number of countries and circumstances. According to IEA calculations, wind is the most competitive type of renewable energy technology among the other options, if local conditions such as financing, CO_2 emission levels and fossil fuel prices prove favorable (OECD, 2010).

III. Components

Main Components

(Filter – Pump – Solar Heater – Electric Heater – Steam Turbine – Condenser – GENERATOR).

Control system

The project is fully automatic using plc to control the level of water, turning heater on /off and control pressure valve. When the water reach the desired level the pump turning off then the heater turned on until the temperature reach the desired value finally the pressure valve turned on .

IV. Project Cycle

A. Chemical Treatment Systems

FILTER STAGES.

1-POLYPROPYLENE

IT IS A CANDLE MADE OF HIGH-QUALITY POLYPROPYLENE FIBERS FOR WATER USES USING MICROSHIELD TECHNOLOGY. IT IS THE ONLY CANDLE IN EGYPT WITH A 3-LAYER SYSTEM THAT PURIFIES WATER FROM IMPURITIES THROUGH THREE SUCCESSIVE LAYERS OF 5 MICRONS IN THE FIRST LAYER 3 MICRONS IN THE SECOND LAYER 1 MICRON IN THE THIRD LAYER, WHICH ENSURES THE HIGHEST DEGREE PURIFICATION OF WATER FROM IMPURITIES UP TO 99.9% OF DUST, RUST, IMPURITIES, INSECTS AND SAND.

2-WIRE MESH

USE IN COMMERCIAL APPLICATIONS, LIKE INSECT SCREENING OR ANIMAL FENCING.

3-ACTIVATED CARBON GRANULES

IT IS A CANDLE MADE OF HIGH-QUALITY ACTIVATED CARBON GRANULES, WHICH PURIFIES WATER FROM CHLORINE, ORGANIC SUBSTANCES, TASTE AND ODOR. ELIMINATION OF CHLORINE, ORGANIC MATTER, TASTE AND ODOR AND A NETWORK OF POLYPROPYLENE FIBERS TO PROVIDE YOU WITH A SECOND STAGE OF WATER PURIFICATION FROM IMPURITIES.

Total dissolvent salt (TDS)	**Total Hardness (T hard)**	**pH**
575 PPM	**350 PPM**	**7.5**

B. Pump

The actual Rankine cycle differs from the ideal Rankine cycle because of pressure drop in the heat exchangers and inefficiency of the expander and pump. This results in a larger pressure difference across the pump than across the expander. The pump for the test stand should be capable of at even more to compensate for pressure drop in the heat exchangers.

C. Solar Heater

On the basis of the type of energy collection; solar energy collectors can be classified into three types flat plate, evacuated tube and concentrating collectors; on the basis of mode of operation they can be broadly classified into two types viz. active and passive. Solar water heating systems can be either active or passive depending on their operating conditions. An active system uses an electric pump to circulate the heat transfer fluid whereas a passive system has no pump. These can further classified into direct and indirect types. A direct solar water heating system circulates household water through collectors and is not appropriate in climates in which freezing temperatures occur; indirect type uses a heat transfer fluid. These active or passive modes of energy transport can be used in any of the flat plate, evacuated or concentrating type of collector. To evaluate the thermal performance of a solar water heater; collector efficiency curve is an important physical property of a solar collector.

D. Electric Heater

is a closed vessel in which fluid (water) is heated. The heated or vaporized fluid exits the boiler for use in rotating the turbine. The pressure vessel of a boiler is made of alloy steel. In the power plant using a steam cycle for power generation, the primary heat source will be coil heaters.

E. Steam Turbine

After studying the types of turbines, we found that the best suitable type for this project is Impulse turbine because it is the least in cost, the easiest to design and the highest efficiency.

F. Condenser

Water Cooled Condenser

The reduction of heat from refrigerant by using water as the main mechanic to ventilate is to aid the refrigerant to condense. The quality of water and refrigerant that exchange making the temperature of water increases and evaporates. Water will blow vapour into the air which can be divided into two systems.

G. DC-Generator

The part responsible for converting the kinetic energy obtained by belt into electrical energy of direct current, and storing it in a battery.

V. Nomenclature

A_o	Total nozzles exit area, m^2
Ar	Area ratio, %
A_s	*Surface area of the insulator*, m^2
B	The amplitude
d_n	Total nozzles diameter, m
D_s	Outer diameter of insulator, m
F	The vibration frequency
Fr	The volume of working fluid to the total volume of thermosyphon Rankine engine, %
H	Heat transfer coefficient of convection, $W/m^2.K$
h_{fg}	The change of specific enthalpy from saturated liquid to saturated vapor in the condition of the evaporator, J/kg
I	Current, Amperes
L	Length, m
L_S	The length of the evaporator and adiabatic section
$\dot{m}$	The rate of mass flow of vapor, kg/s

N	The turbine rotational speed, rpm
P	The produced power of thermosyphon Rankine engine, W
Q	The heat transfer rate in the evaporator section, W
Q_{loss}	The heat losses in evaporator and adiabatic section
q	The heat flux
R	Radius of the rotor, m
T	Temperature, ℃
T_s	$Surface\ temperatuer\ of\ insulator$
T_∞	Ambient temperature
U	The velocity of the nozzle, m/s
V	Voltages, volts
$\dot{V}$	Condenser cooling water flow rate, LPM
V_a	The absolute velocity of the vapor with respect to stationary observer, m/s
V_r	The exit relative velocity of vapor with respect to the rotor, m/s
V^+	Filling ratio, volume of the working fluid to the evaporator

APPENDIX

FUNDED FROM (ASRT)

ACKNOWLEDGMENT

I would like to express our sincere gratitude for supporting me throughout our Graduate Project. First, I wish to express My sincere gratitude to my supervisor, **Dr.Mohamed Aly** , for his enthusiasm, patience, insightful comments, helpful information, practical advice and unceasing ideas that have helped me tremendously at all times in my research and writing of this thesis. His immense knowledge, profound experience and professional expertise that enabled me to complete this research successfully. Without his support and guidance, this project would not have been possible. I couldn't have imagined having a better supervisor in our study.

CONCLUSION

The purpose of this study is to investigate the performance of a two-phase closed thermosyphon Rankine engine, experimentally. Water is used as a working fluid.

The present experimental work investigated the effects of the filling ratio total nozzle exit area to the turbine inlet area and condenser cooling water flow rate

The conclusions of the present study are:

The optimum-filling ratio is 13.6% approximately

- The output power increases with increasing of condenser cooling water flow rate.
- The maximum output power produced at minimum area ratio but the optimum turbine rotational speed at an area ratio of 3.1%.
- The maximum value of the output power without load from the present turbine .

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Fig. 1: The whole project

Fig. 2: The control unit

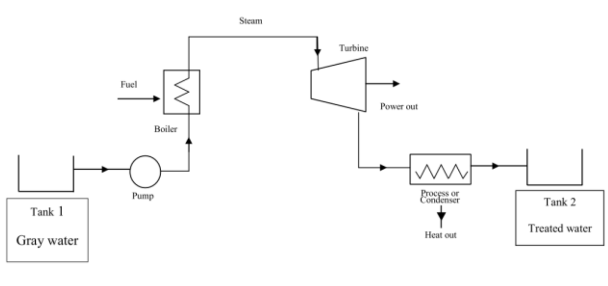

Fig.3: Rankine cycle