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Electric Power Generation Using Refrigeration Waste Heat

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Abstract: Electricity is most important one of the human life and industries. But the available energy is very less. Today the demand of energy is increasing tremendously, but available energy lacks in supply. This problem is overcome by this project. In this paper the main stress is given on energy conservation by using technique of utilizing waste heat from Refrigerator/Air conditioning system. The refrigeration system always tends to produce an excess of low temperature heat which is commonly referred to as "waste heat". In this heat which is lost to the environment, however, may be recovered to a certain extent and reused to our advantage instead. A possible way of reutilization of the wasted energy has been thought of .The device which are capable for converts this heat into useful form like electricity. The mechanism and design such a device, which is connected to the refrigeration system, it utilize the waste heat for generation of electricity has been done. In this case, we have considered the waste heat is a heat source and the principle of thermoelectricity has been used.
Keywords: energy conservation, refrigeration system, thermoelectricity, waste heat.

I. INTRODUCTION

Energy is a basic requirement for the existence and development of human life. Waste heat recovery and utilization is the process of capturing and reusing waste heat for a useful purpose. Waste heat which is rejected from a process at a temperature enough high above the ambient temperature permits the recovery of energy [8]. From the research found out that by amount of electrical energy is found from domestic refrigerator and the hot case can be saved. We found recovery of heat from the condenser reduces the heat load to surrounding and makes surrounding comfortable from the research [16]. By using the method of energy conservation can improves the thermal efficiency of the system should be obtained from the research [18].From the research paper [1], the pyroelectric waste heat should be produced from the waste heat conduction. In this paper authors have investigated and proved the electricity produced from refrigeration waste heat with the aid of thermoelectric generator. The thermoelectric generator is the solid state device which is made up of P and N type semiconducting materials.

II. Flow chart

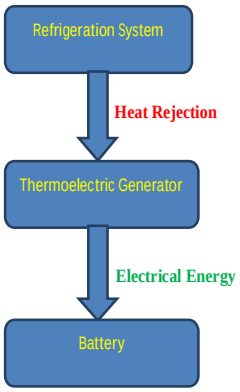

Fig 1: waste heat recovery system

This shows the basic flow of energy conservation. The heat from the refrigeration system (condenser) is fed directly into the

thermoelectric generator. And this thermoelectric generator directly converts the heat energy to electrical energy. This electrical energy is stored into the battery.

III. THE MAIN COMPONENTS ARE

Compressor, Condenser, Expansion valve, Evaporator, Thermoelectric Generator, Battery
Compressor requires work, W. The work is supplied to the system. Condenser which reduce the temperature of a system and emits the heat. There is no exchange of heat during throttling process through the expansion valve as this process occurs at constant enthalpy. Thermoelectric generator is governed by simple solid state devices called thermoelectric power generators which are capable of conversion of heat energy into electrical energy. Thermoelectric generators convert heat into electricity through the Seebeck effect. However, thermoelectric generators have lower efficiency when compared to many other power generation devices. The generated electrical energy stored by the battery.

A. Experimental setup

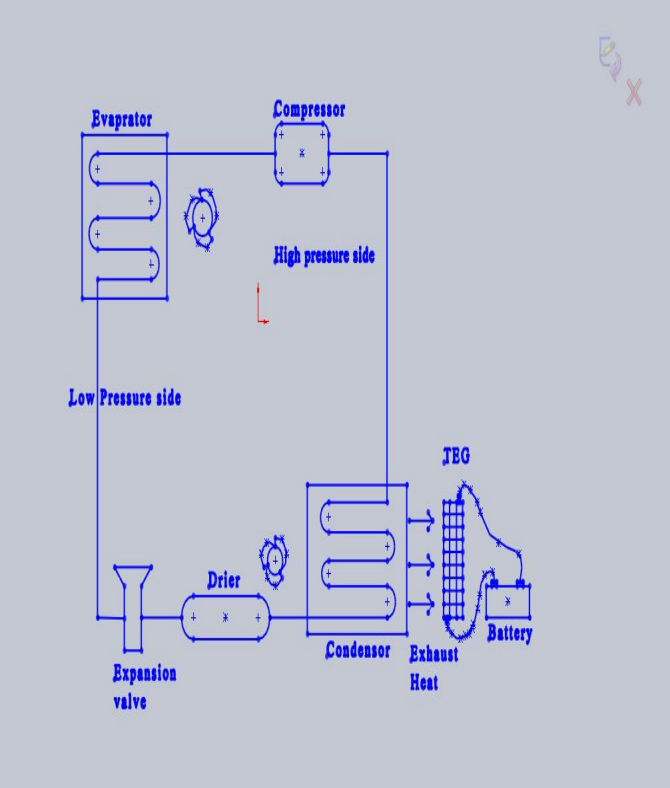

Fig2: Refrigeration system with Thermoelectric Generator

IV. WORKING PRINCIPLE

Thermoelectric power generation is mainly based on “Seebeck effect” discovered by Thomas Seebeck. When a temperature difference is applied between the two junctions of two dissimilar metals, a voltage is generated which is called the Seebeck Voltage and this phenomenon is the guiding principle behind thermoelectric power generation. Two dissimilar metals maintained at different temperature, when connected by a wire, will produce potential difference. The working diagram of refrigeration system with TEG (thermoelectric Generator) is shown below.

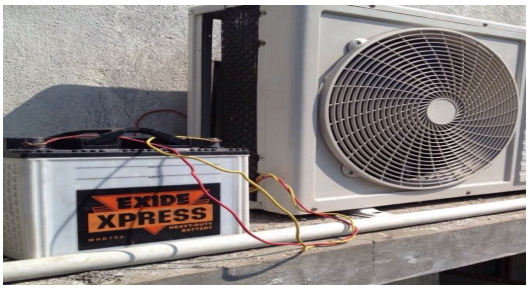

Fig 3: Experimental setup (front view)


Fig 4: Experimental setup (top view**)**

V. MATHEMATICAL MODELING

7 ton refrigeration plant uses R12 refrigerant. It enters the compressor at -5^0 C as saturated vapour. Condensation takes place at 50^0 C and there is no under cooling.

From P-H and T-S Diagram

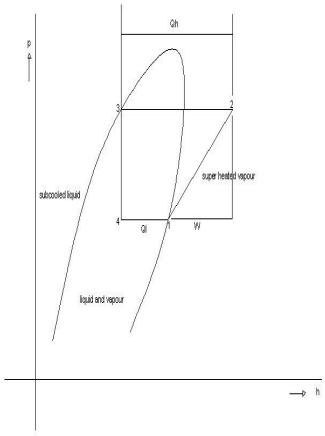

Fig5: p-h Diagram

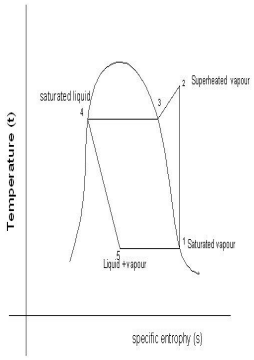

Fig6: T-S Diagram

At point 1 [dry], T1= -5^0 C, pressure p_1 =12.19 bar, enthalpy $h_1=h_g$=187.397 KJ/Kg.

At point 2 [superheated], T2=50^0 C, pressure p_2=0.086 bar, enthalpy h_2=210 KJ/Kg.

At point 3 [liquid] enthalpy $h_3= h_f$=84.686 KJ/Kg.

Coefficient of Performance

$= (h_1 - h_4) / (h_2 - h_1)$.

= (187.397– 84.868) / (210 – 187.397)

COP = 4.54.

Work done = (Refrigeration Effect / COP)

= 24.5 / 4.54

W = 5.4 KW.

Heat rejected to the Condenser

$q_1 = w + q_2$

= 5.4 + 24.5

Q_1 = 29.9 KW.

Power generated,

$$\mathbf{P_{out} = \eta\, Q_{in}.}$$

Where,

η - Thermal efficiency

P_{out} - measured power output of the device (watts)

Q_{in} -measured input heat to the device (watts).

Power generated,

$$P_{out} = \eta Q_{in}$$

$$= 0.0221 \times 29.9$$

$$= 0.66 \text{ KW.}$$

VI. RESULT AND ANALYSIS

By using this 7 ton capacity refrigerator, 30% of waste heat is recovered by the condenser side and this waste heat is fed into the face of thermo electric generator and the potential energy is gained. This potential energy is converted into the form of 0.66 KW of electrical energy. The following graph is plotted between the Tons of refrigerator and the Power produced by using this system.

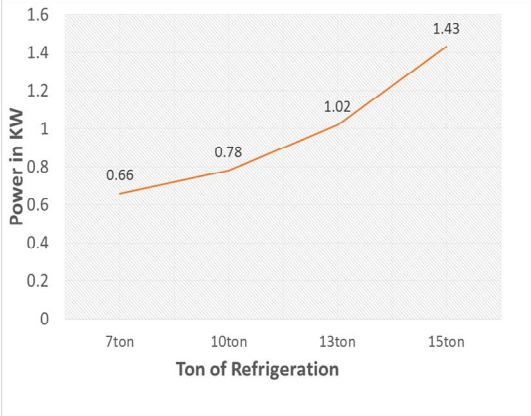

Fig 7: Performance Graph

VII. CONCLUSION

The result has identified that there are large potentials of energy saving through waste heat recovery system. It is an excellent method to conserve the waste heat. It is made to recover the waste heat from 7 ton refrigerator used for cold storage purpose. The waste heat recovery increasing the thermal efficiency of the system and reduces the green house gases damped to the envinronment. In this waste heat recovery system the exhaust temperature is converted into the electrical power. This waste heat recovery system can be suitable for medium and large food processing cold storage units.

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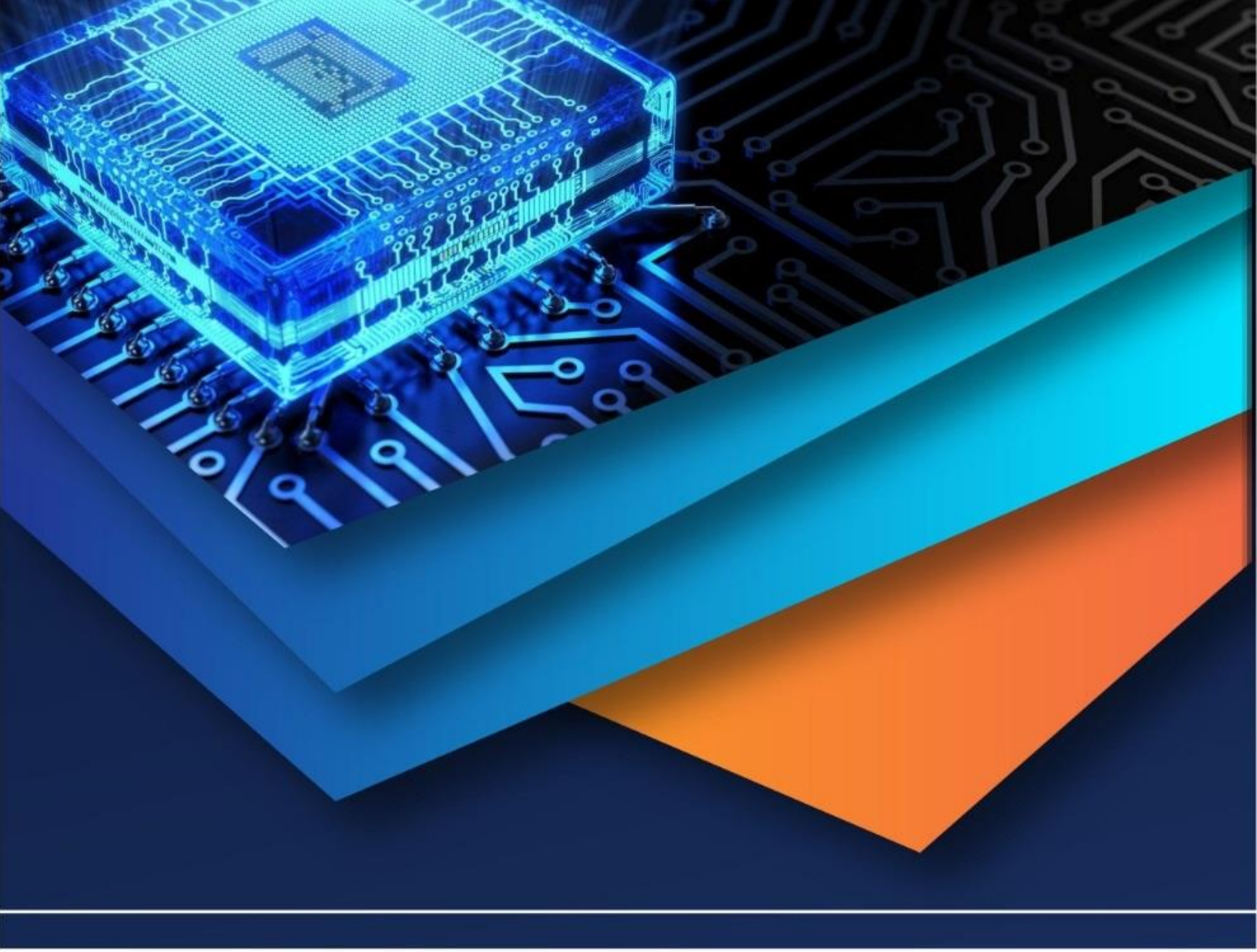

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