Experimental And Theoritical Analaysis Of Solar Refrigeration Platform (Support System)

Mr. K. Sainath[1], A.Soma Shekar[2], Banoth Prabhakar[3], Dr. Suresh Akella[4]
[1]Associate Prof , Dept of Mechanical Engineering
[4]Prof. & Principal, Mechanical Engineering
[1, 2, 3, 4] Sreyas Institute of Engineering & Technology, Hyderabad

Abstract- *We know that Refrigeration is an important part of human life to make it comfortable and easy. But refrigeration's inter depends upon electricity requirement it is difficult to access the refrigeration in many parts of the world. On the contrary Solar energy is reached to every part of the world and once setits most efficient renewable energy and also cheap to maintain and operate. The Fusion of Refrigeration and Solar energy makes up the most efficient way to operate the refrigeration. By giving the Refrigeration Wheels for transport it can also be travelled to remote places and also can be carried when the Refrigeration is most required but cannot be accessed. It is most required the load distribution on the solar refrigeration system on the frame, platform (support system).*

Keywords- Compressor, Condenser, Evaporators, Expansion Valve, Solar Energy, Power Inverter, Battery.

I. INTRODUCTION

A refrigerator (colloquially fridge) consists of a thermally insulated compartment and a heat pump (mechanical, electronic or chemical) that transfers heat from the inside of the fridge to its external environment so that the inside of the fridge is cooled to a temperature below the ambient temperature of the room. Refrigeration is an essential food storage technique in developed countries. The lower temperature lowers the reproduction rate of bacteria, so the refrigerator reduces the rate of spoilage. A refrigerator maintains a temperature a few degrees above the freezing point of water. The Optimum temperature range for perishable food storage is 3 to 5 °C (37 to 41 °F). A similar device that maintains a temperature below the freezing point of water is called a freezer. The refrigerator replaced the icebox, which had been a common household appliance for almost a century and .a half.

The first cooling system for food involved ice. Artificial refrigeration began in the mid-1750s and developed in the early 1800s. In 1834, the first working vapor-compression refrigeration system was built. The first commercial ice-making machine was invented in 1854. In 1913, refrigerators for home use were invented. In 1923 Frigidaire introduced the first self-contained unit. The introduction of Freon in the 1920s expanded the refrigerator market during the 1930s. Home freezers as separate compartments (larger than necessary just for ice cubes) were introduced in 1940. Frozen foods, previously a luxury item, became commonplace.

II. LITERATURE SURVEY

Comparison of experimental and theoretical values of heat transfer rate, Coefficient of performance of water cooler and spilt AC by using a single compressor and rejected heat is used in geyser application. [1]

The aerospace applications are bonded to the low weight and high structural strength necessity, this leads to more research work in the field of composites. The composites hold more strength to weight ratio compared to the other conventional materials. Their strength mainly depends on the orientation of the reinforcement material and volume fraction of matrix and reinforcement. The sandwich composites are extensively used in aerospace applications where a conventional material's strength is increased by adding the layers of the composite material by prescribed orientations. [2]

Additive Manufacturing (AM) or 3D Printing has become very popular in industry and academia for prototyping or small scale production. It is very important to understand the mechanical properties of products manufactured through various additive manufacturing processes like Stereo lithography (SLA), Selective Laser Sintering (SLS), and Fused Deposition Modelling (FDM) and Polyjet. In this project, we propose to evaluate mechanical properties such as Dimensional Accuracy, Tensile property and Shore Hardness of components manufactured by various additive manufacturing techniques as per ASTM D638-10 type IV standard. [3]

Air-Conditioning cum Water dispenser system is a unique combination of air-cycle and water-cycle into a single unit. This system may consist of a compressor, condenser, evaporator, expansion valve, solenoid valve, reversing valve, copper tubes, heating, and cooling thermostats. Here we used a single compressor to compress the air cycle and water cycle. [4]

This document presents a theoretical study, and Design and Experimental results give the performance of R134a refrigerant as an alternative to the ozone layer depleting R22 refrigerant R134a refrigerant has no ozone layer depleting property and inconsequential global warming potential forR22. As per the rules of Montreal and Kyoto protocol the world community has decided to reduce the production and consumption of HCFC-22 from the refrigeration and air-conditional industry completely by 2020. In R22, chlorine is the element that depletes the ozone layer, with ozone depletion potential 0.05 and global warning potential 17000, which affects the environment. [14]

III. TECHNICAL EXPLANATION OF REFRIGERATION SYSTEM

A vapor-compression cycle is used in most household refrigerators, refrigerator-freezers, and freezers. In this cycle, a circulating refrigerant such as R-134a enters a compressor as low-pressure vapor at or slightly below the temperature of the refrigerator interior. The vapor is compressed and exit the compressor at a very high-pressure superheated vapor, the superheated vapor travels under pressure through coils or tubes that make up the condenser, the coil or tube are passively cooled by exposure to air in the room. The condenser cools the vapor which liquefies.

As the refrigerant leaves the condenser, it is still under pressure but it is slightly above the room temperature of the system. The liquid refrigerant is forced through a metering or throttling device, also known as the expansion valve (essentially a pin-hole sized construction in the tubing) to an area of much lower pressure. The sudden decrease in pressure results in explosive-liked flash evaporation of a portion (typically about half) of the liquid. The latent heat absorbed by the flash evaporation is drawn mostly from the adjacent still-fluid refrigerant, a phenomenon known as auto-refrigeration. This cold and partially vaporized refrigerant continues through the coil or tubes of the evaporator unit, a fan blows air from the refrigerator or freezer compartment (box air) across these coils or tubes and the refrigerant completely vaporizes, drawing further heat from the box air.

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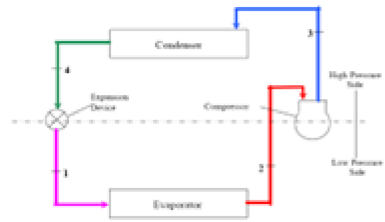

Fig1.1 Schematic Representation of VCRS

IV. COMPONENTS OF REFRIGERATOR

1. COMPRESSOR

Rotary compressors are ‘high-pressure shell’ type compressors. The suction on these compressors is taken directly into the compression chamber. Gas compressed in the compression chamber is discharged into the compressor casing. It should be noted that from a cold start-up, high-pressure shell-type compressors take longer to reach their normal operating pressure in the compressor shell. This is partly due to the larger volume of the compressor casing and partly as a result of refrigerant being trapped in the oil. Any refrigerant in the oil has to completely evaporate before condensing pressure can reach its operating level.

2. EVAPORATORS

Evaporators are one of the main reasons why refrigeration, and therefore air conditioning, became practical for use in both home and industrial cooling. Simply put, an evaporator allows a contained pressurized liquid to turn into a gas. Evaporators allow a contained pressurized liquid into gas.

3. CONDENSER

A system that involves heat transfer uses a device called condenser. A condenser is a device or unit used to condense a substance from its gaseous to its liquid state, by cooling it. In doing so, the latent heat is given up by the substance and will transfer to the condenser coolant. Condensers can be made according to numerous designs, and come in many sizes ranging from rather small to very large. For example, a refrigerator uses a condenser to get rid of heat extracted from the interior of the unit to the outside air. Condensers are used in air conditioning, industrial chemical processes such as distillation, steam power-plan, and other heat-exchange systems. The use of cooling water or surrounding air as the coolant is common in many condensers. Analysis of Roll bond evaporator.

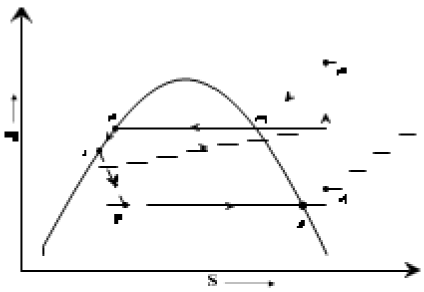

Fig 3.1 graphical representation of condenser

4. EXPANSION VALVE

The purpose of the expansion valve is to rapidly reduce the pressure of the refrigerant in the refrigeration cycle. This allows the refrigerant to rapidly cool before entering the evaporator.

5. SOLAR ENERGY

Solar energy is the energy that is radiated from the sun. In the sun's core nuclear fusion takes place, this releases energy, which is in the form of electromagnetic waves reaches the surface. This light and heat from the sun that is harnessed using a range of ever-evolving technologies such as solar heating, photovoltaic, solar thermal energy, solar architecture, molten salt power plants, and artificial photosynthesis. The large magnitude of solar energy available makes it a highly appealing source of electricity. The United Nations Development Programme in its 2000 world's energy assessment found that the annual potential of solar Energy was 1,575 – 49,837 exajoules (EJ). This several times larger than the world energy consumption, which was 559.8 EJ in 2012.

V. PHOTOVOLTAIC EFFECT

Solar power is the conversion of energy from sunlight into electricity, either directly using photovoltaic cells or, indirectly using concentrated solar power. A solar cell, or Photovoltaic effect. Photovoltaic is the direct conversion of light into electricity at the atomic level. Semiconductors like silicon, when doped with impurities exhibit a property known as the photoelectric effect that causes them to absorb photons of light and release electrons. When these free electrons are captured, an electric current is produced. The power produced from the photovoltaic panels is D.C current which can neither be stored in the battery nor by using Inverter converts the D.C current to A.C current.

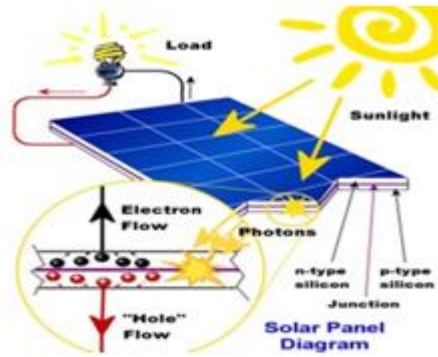

Fig a pictographic representation of the photovoltaic effect

SPECIFICATION OF SOLAR PANELS

1 panel of 40 watts

Open circuit voltage = 22 volts
Maximum power voltage= 19.25 V
Closed-circuit current = 1.11 amps
Dimensions =

1 panel of 20 watts

Open circuit voltage= 22 volts
Maximum power voltage= 19.8 V
Closed-circuit current= 2.8 amps
Dimensions =

VI. POWER INVERTER

A power inverter or inverter is an electronic device or circuit that changes direct current (DC) to alternating current (AC). The input voltage, output voltage, and frequency and overall power handling depend on the design of the specific device or specific circuit. The inverter doesn't produce any power, the power is provided by the DC source. A power inverter can be entirely electronic or maybe a combination of mechanical effects and electronic circuits. Static inverters do not use moving parts in the conversion process. The circuit that performs the opposite function, converting AC to DC is called a Rectifier.

VII. BATTERY

The battery we used is a lead-acid battery that produces electricity form the lead electrode as positive and Lead-oxide electrode as negative and the potential difference between the two electrodes produces electricity.

7.1 ELECTRICAL CONDUCTION MECHANISMS

Lead and lead-dioxide are good electrical conductors. The conduction mechanism is via electrons jumping between atoms. The electrolyte contains aqueous ions (H+ and SO4-2). The conduction mechanism within the electrolyte is via the migration of ions via diffusion or drift.

Charged sulfate ion approaches an uncharged lead atom onthe surfaceof the electrode. A Lead atom becomes ionized and forms an ionic bond with sulfate ion. Two electrons are released into a lead electrode.

Charged sulfate and hydrogen ions approach lead-dioxide molecule (net uncharged) on the surface of electrode Lead atom changes ionization and forms an ionic bond with sulfate ion. Two water molecules are released into solution.

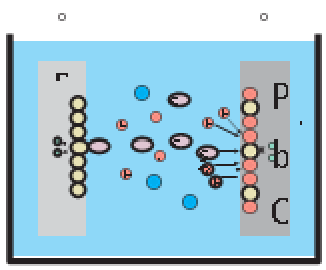

Fig 7.1 Pictographic Representation of Battery Developing Voltage

7.2 CHARGING

The Connection of an electrical power source forces electrons to flow from positive to negative terminals. This increases the charge and the voltages at the electrodes. The chemical reactions are driven in the reverse direction, converting electrical energy into stored chemical energy. As the battery is charged, the lead sulfate coating on the electrodes is removed, and the acid electrolyte becomes stronger.

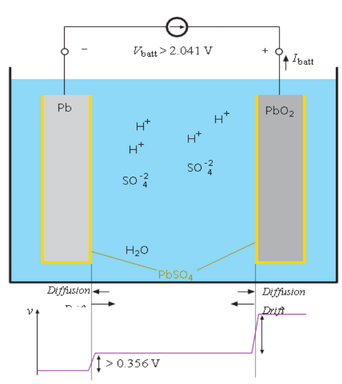

Fig 7.3 Pictorial representation of Charging

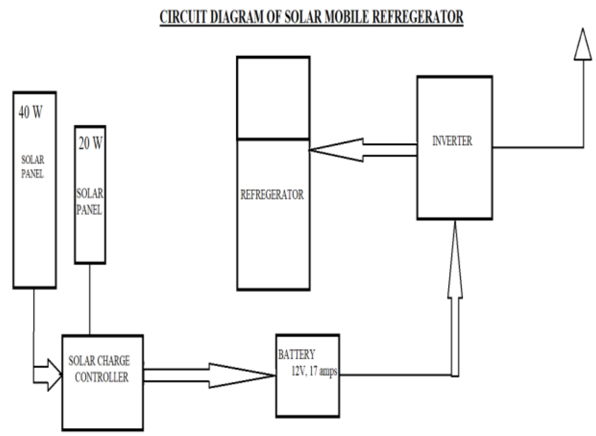

Fig 8circuit diagram of solar mobile refrigerator

7.3 Specifications of our Battery

1 Battery
Voltage: 12v
Current: 17ah
Wattage: 204w
Dimensions:

Calculations

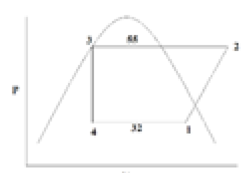

Fig representation of the refrigeration cycle

Suction Temperature = 32.2c
Condenser Temperature = 55c
Liquid Temperature = 32.2c

From Refrigeration tables

At 32c	At 55c
Vf = 0.0008459	Vf = 0.0009284
Vg = 0.0256	Vg = 0.0131
Hf = 95.5	Hf = 131.65
Hg = 267.3	Hg = 277.05
Sf = 0.3541	Sf = 0.4665
Sg = 0.9184	Sg = 0.9093

Where

In Specific Volume, m^3/kg

Vf = Saturated liquid Vg = Saturated vapor

In Enthalpy, kJ/kg

Hf = Saturated liquidHg = Saturated vapour

In Entropy, kJ/kg.K

Sf = Saturated liquid Sg = Saturated vapor
COP= refrigeration effect÷ Work done
Refrigeration Effect = h1-h4
Work done = h2-h1
To find h1
s1=s2

Where, s2 = 0.9093 (at 32c gaseous state)
s2 = sf1 + xsfg1
0.9093 = 0.3541 + x (0.5643)
x = 0.98
Now
h1 = hf1 + xhfg1
= 95.5 + 0.98 (172)
= 264.06 KJ/kg
Now,
Work done = h2 – h1
= 277.05 – 264.06
= 12.99 KJ/kg

Refrigeration Effect = h1 – h4
Or
= h1 – hf3
= 264.06 – 131.65
= 132.41 KJ/kg
COP = R.E ÷ W.D
= 132.41 ÷ 12.99
= 10.19

Power Consumed

For 1KJ of energy, the power required is 0.27w
i.e., for 132KJ of energy
132KJ = 36w/h
The Battery like to use is a 12v 17ah battery.
The power produced by this battery is 204 w.
The time required for the complete drain of the battery.
Time = 204w
36w
= 5h

Solar

The solar panel we like to use is a 30w DC panel.

1hr of this panel will produce 60w, the time required for charging.

1h = 60w
?h = 204w
1/x = 30/204
X = 7h

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