Development and Modification of Air Conditioning Test Rig

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Abstract- *Energy requirement for refrigeration and air conditioning applications bears a huge share of total energy consumption around the world. Since, thermal comfort plays a very important role on the health, working efficiency and activities of all living beings, especially, temperature and humidity. In the excessively hot climates it is necessary to reduce the temperature and humidity whereas in the cold climate there is a need to increase the temperature. When the temperature drops below thermal comfort level, especially in the winter season, the heating systems are employed. In some countries, where the atmospheric temperature is very low, natural heating like solar energy is not sufficient, the heat pump and fuel fired systems are proven to be suitable heating devices. In hot climates, thermal comfort achieved through the use of air conditioning systems.*

The energy balance is a basic method of any process investigation, which makes the energy analysis possible, points out needs to improve the process and is the basis to develop exergy balance. Energy balance results would disclose the efficiency of energy utilization in particular parts of the process and allow comparing the efficiency and the process parameters with the currently achievable values in the most modern installations. They will also establish the priority of the processes requiring considerations, either because of their excessive energy consumption or because of their particularly low efficiency.

Both the theoretical and experimental performances of the above system have been evaluated and the effects of various operating parameters were studied. The proposed absorption cooling system uses the mixture of ammonia-water as refrigerant-absorber pair having an evaporator temperature of 2oC and the concentration of the ammonia in the strong and weak solution of 0.42 and 0.38, respectively using an air cooled condenser and absorber. The system is tested with heat input from an electric heater of 1.5 kW capacity and a pressure of 10.7 bars. The COP is found to be 0.599 and this is attributed to higher generator temperature

Keywords- Solar Hybrid Air Conditioner, Evacuated tube, solar collector, Energy Saving.

I. INTRODUCTION

The art of measuring the moisture content of air is termed "**psychrometry**". The science which investigates the thermal properties of moist air, considers the measurement and control of the moisture content of air, and studies the effect of atmospheric moisture on material and human comfort may properly be termed "**psychrometrics**''.

Air conditioner is used to provide cooling by the use of mainly four components Compressor, Condenser, expansion device and evaporator. These four components are operate with a refrigerant which works as heat carrier in this system. It extracts the heat from evaporator in the form of latent heat and rejects that heat to atmosphere through the condenser. Therefore heat rejection capacity depends on difference between refrigerant temperature at condenser and atmospheric temperature. Quantity of heat rejection also affects the quantity of heat absorption through evaporator. It is clear that more heat rejection will result more heat absorption. Atmospheric temperature varies according to Environmental condition i.e. during the summer atmospheric temperature becomes higher which decreases the temperature difference between refrigerant and atmosphere, results less heat rejection which decreases the overall performance of refrigeration system. In this paper, by experiment on Air conditioner test rig we proved that lower the condenser temperature means higher the performance of refrigeration system. Performance of refrigeration system can be improved by provide the evaporative cooling effect on condenser by spray of water on condenser which add the evaporative cooling effect on condenser. In last publication of December 2013 we have proved that by evaporative cooling on condenser the C.O.P is increased by 39.04% which is great achievement. Same if uses evaporative cooling effect on air conditioning unit that will reduce the size and operating cost of air conditioning unit.

II. LITERATURE REVIEW

The exergetic analysis of actual vapour compression refrigeration cycle. System discussed is R134a based vapour

compression tutor. Paper discusses the component's exergetic destruction and cycle's exergetic efficiency. Over the last seven decades Chlorofluorocarbons (CFCs) have been used in refrigeration and air.

Conditioning because of the favourable characteristics that they possess such as: low freezing point, non-flammability, non-toxicity and chemically stable behaviour that the flammability, non-toxicity and chemically stable behaviour. But it has been recognized that the chlorine released from CFCs migrate to the stratosphere and destroys the ozone layer of the earth causing serious health problems. In 1987 many countries across the world signed the Montreal Protocol, an international treaty to control those substances that deplete the ozone layer. Ozone depletion allows harmful ultraviolet rays from sun of to enter the earth's atmosphere which leads to several diseases. According to the Montreal Protocol, 190 signatory countries have to phase out CFC's and other ozone depleting substances by 2010. According to this protocol all developed countries had to ban the use of all CFC's that were being used in refrigeration and air conditioning equipment till 1999. Due to global warming the temperature of the earth is increasing continuously the which results in melting of glaciers at high speed which in turn leads to rise of water level in oceans affecting marine life and the coastal regions. Owing to its high ODP (=1) and GWP (=8500) R12 has to be phased out. In India the manufacturing of new components using R12 has been banned since December 31, 2002. Till January 1, 2007 the country has achieved 85% reduction in CFC phase out. For domestic refrigeration R134a is a better substitute because of its similarity in thermodynamic properties to R12. R134a is having low ODP i.e. 0 and moderate GWP i.e. 1300 in comparison with R12. A comparison of performance between R12, R134a and R290 was carried out by Xu et al. They found the difference of performance was very small between R12 and R134a refrigerants. Thermodynamic processes in refrigeration systems release huge amounts of energy in form of heat to the surroundings. Heat transfer from the system to the surroundings occurs at finite temperature difference which leads to irreversibility. System performance degrades due to irreversibility's. The losses in the thermodynamic processes that make up the cycle are calculated by considering them individual systems. Exergy analysis is best tool in evaluation of design, optimization and performance of energy systems. It helps in determining maximum performance of the systems and key points of exergy destruction. In case of complex systems component wise exergy analysis is performed. Potential improvement in the system can be obtained after calculating exergy destruction. There are various studies on the exergy analysis of refrigeration and other systems. Venkataramana et al. has performed exergy analysis of an air conditioner containing refrigerant R22, substituted by R134a, R290, and R407. Results indicate that COP and exergy efficiency of R290 vapour compression refrigeration system (VCRS) is higher and the values for R407 and R134a VCRS were found to be lower in comparison of R22. Chandrasekhran performed exergy analysis of vapour compression refrigeration system using R12 and R134a as refrigerants and concluded that COP increases when evaporator temperature increases for both refrigerants. COP of R134a is slightly higher at lower temperature and COP of R12 is higher at high evaporator temperature. Variation of exergetic efficiency of both refrigerants is similar to that of COP [6]. Shiva Reddy et al. has investigated the exergetic analysis of vapour compression refrigeration system with R134a, R143a, R152a, R404A, R407C, R410A, R502, and R507A. In this he studied that R134a performed better in all respect and R407 performed poor. Bolaji et al. has performed design and performance evaluation of cooler refrigerating system working with R134a. Bolaji et al. checked the exergetic performance of air conditioning test-rig of domestic refrigerator using R12, R134a and R152a. The results showed that the average COP of R152a was nearly close to that of R12 and the highest efficiency defects were obtained using R134a as refrigerant. Various studies reviewed focused on exergetic analysis of various systems. In this paper, exergetic analysis of vapour compression refrigeration test rig using R134a as refrigerant has been studied. This is a basic experiment performed in every engineering institute. The vapour compression refrigeration test rig is situated at Refrigeration and Air conditioning Lab in the Mechanical Engineering Department. This serves the purpose of demonstration of actual vapour compression refrigeration cycle. The test rig is around 10-15 years old and was R-12 operated. But according to Montreal Protocol R12 had to be phased out and therefore test rig was retrofitted with R134a refrigerant in 2010. System's component wise exergy destruction is presented and second law efficiency of system has been obtained.

III. CONCLUSION

Solar air conditioning system is a great innovation which pushes solar energy leaps ahead while promoting positive impact on the environment. The system is able to achieve up to 45% energy saving during daytime, thus significantly reduces the electricity peak load during the day. Meanwhile, the AC compressor will contribute up to 25% of energy saving during night time. The main modifications needed are AC compressor, higher capacity condenser and evacuated tube solar collector.

IV. COMPONENT SPECIFICATIONS

STEAMER

Here comes the most crucial step for your research publication. Ensure the drafted journal is critically reviewed by your peers or any subject matter experts. Always try to get maximum review comments even if you are well confident about your paper.

Initially, steamer volume was 3 lit. and heater capacity as 1 KW. The heater inside the steamer was kept in horizontal position which was not generating the heat uniformly.We replaced the steamer with volume of 7.5 lit and heater capacity with 3 KW. Heater was kept in vertical position which causes uniform heat generation.

ANEMOMETER (LEUTRON-AM-4201)

It is used to measure the inlet air velocity. The probe should be used less than 25 m/s otherwise blades may brake and cause danger.

COMPOUND GAUGE

A compound gauge is a device that can display both positive and negative (vacuum) pressures. You need to use a compound gauge when you are measuring a system that is exerting both positive and negative pressure on the gauge

PRESSURE GAUGE

Pressure measurement is the analysis of an applied force by a fluid (liquid or gas) on a surface. Pressure is typically measured in units of force per unit of surface area. Many techniques have been developed for the measurement of pressure and vacuum. Instruments used to measure and display pressure in an integral unit are called pressure gauges or vacuum gauges.

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V. CALCULATION

Referigeration effect

P1=4.4615 h1=255 h3=h4=110

P5=18.59

h2=295……....from r134a P-h chart

COP(th.)= (h1-h4)/(h2-h1)

COP(th.)= 3.625

Compressor work = 2.12 KW

COP (act.) = RE/Wc

= 0.932

COP (rltv.) = COP (act.)/ COP (th.)

= 0.25

Efficiency = COP (act.) / COP (carnot)

=17.25%

VI. SPECIFICATION

DRY AIR

The term ‘dry air’ is used to indicate the water free contents of air having any degree of moisture. Dry air is never found in practice. Air always contains some moisture.

SATURATED AIR

Moist air is said to be saturated when its condition is such that it can co-exist in natural equilibrium with an associated condensed moisture phase presenting a flat surface to it. For a given temperature, a given quantity of air can be saturated with a fixed quantity of moisture. At higher temperatures, it requires a larger quantity of moisture to saturate it. At saturation, vapour pressure of moisture in air corresponds to the saturation pressure given in steam tables corresponding to the given temperature of air.

DRY BULB TEMPERATURE (DBT)

It is the temperature of air as registered by an ordinary thermometer (tdb).

VII. CONCLUSION

a) We have find sensible heating and cooling of air.
b) We have find refrigeration effect air, (COP) act. and (COP) rel. , compressor work, efficiency, during various processes.
c) Studies various processes of heating and cooling by using various components. We studies that properties of air changed by preheating or by increasing moisture content.
d) We studies various principles of psychrometry, psychrometric chart and various terminologies used in psychrometric chart
e) We studies about refrigerant R134a, there properties, effect on environment, refrigeration effect, and also compare with some other refrigerants.
f) So many components used in air conditioning test rig and we studies there specifications, properties, range etc.

g) We have studies refrigerant charge and oil miscibility aspects.
h) Study maintenance, and diagnosis of air conditioning test rig, and other components used in setup.
i) Now setup is modified after installing and replacements of some components such as steamer, gasket, anemometer, ammeter, fan controller, etc.

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