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An Effective Combined Cooling with Power Reduction for Refrigeration cum Air Conditioner, Air Cooler and Water Cooler: A Review

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Abstract- In 21st century the world facing problem of electricity, to overcome this problem worldwide many researches going on. Many of the world's largest growing industries as well as electricity producers companies said that around 30% of electricity is consumption worldwide for the application of refrigeration and air conditioning. The manufacturers of refrigerants and refrigeration, air conditioning equipment, governmental agencies, and environmental groups continue working together toward the goal of reduced environmental impact via reduced emissions and improved energy efficiency. Examples of progress are presented for several sectors of refrigeration and air conditioning, followed by projections for further significant reductions. Although this paper will emphasize environmental impact for power reduction. Looking forward refrigeration has adverse effect on environment. Further cooler uses water so as to give cool air outside, for this application much more quantity of water has been used every year. Also to make this efficient woods product known as 'wood wool / khas' have been used which became a major reason of deforestation. To restrict all these, an attempt is made to have an optimized unit of refrigeration cum air conditioning which will overcome the problem of electricity required for running both the application so far and again help to save water and wood, also maintain an ecological balance between people and surrounding. Both the system will run on single cost of refrigerator so that the normal person can afford the system and will have pleasure to take a pleasant comfort.

Keywords: Refrigeration and Air conditioning, Optimized, Deforestation, Ecological Balance, Emphasize, Consumption, Pleasant

Introduction:

Cooling systems like air conditioning, Refrigerator, Air Coolers, Water Cooler systems are high electric power consumption's; these systems also have huge impacts on the ecosystem. A proper use or choice with an energy saving plan should be considered in order to make the development of ecosystem sustainable so that a harmony between people and environment could be formed. The best innovative work has done in 20th century was refrigeration where Refrigerator recognized and developed in earlier of 20th century and Air Conditioner is lately in that of 20th century. However it has become the prime necessity in 21st century. In over span of three decades, there is continuously increase in energy demand due to everlasting population increases in India. This has led to increase in pollution and power cost that cannot be afforded by normal person. The continuous cycling observed in those equipment's reduces their lifetime and increases power requirement. Worldwide acknowledge and said that refrigeration and air conditioning systems are responsible for roughly 30% of total energy consumption, therefore unquestionably with a major impact on energy demand. Researchers in many countries have been involved in developing refrigeration and air conditioning systems that deal with the drawbacks of conventional systems. The need of proper energy consumption is a worldwide concern and the big question arises for reducing energy wasting included proper used of energy and also how to lower power consumption. Instead of all these aim must be achieved without compromising comfort and other advantages brought by the use of energy, and with same efficiency and quality of installations. The concept of this project explores the possibility of combining four units i.e. Refrigerator and Air-Conditioner, Air-Cooler, Water Cooler into a single unit, such that the running cost should be reduced. This is how we are trying to make the environment and a common person comfortable. By this product a normal person could have a sound sleep so that his productivity for the next day increases.

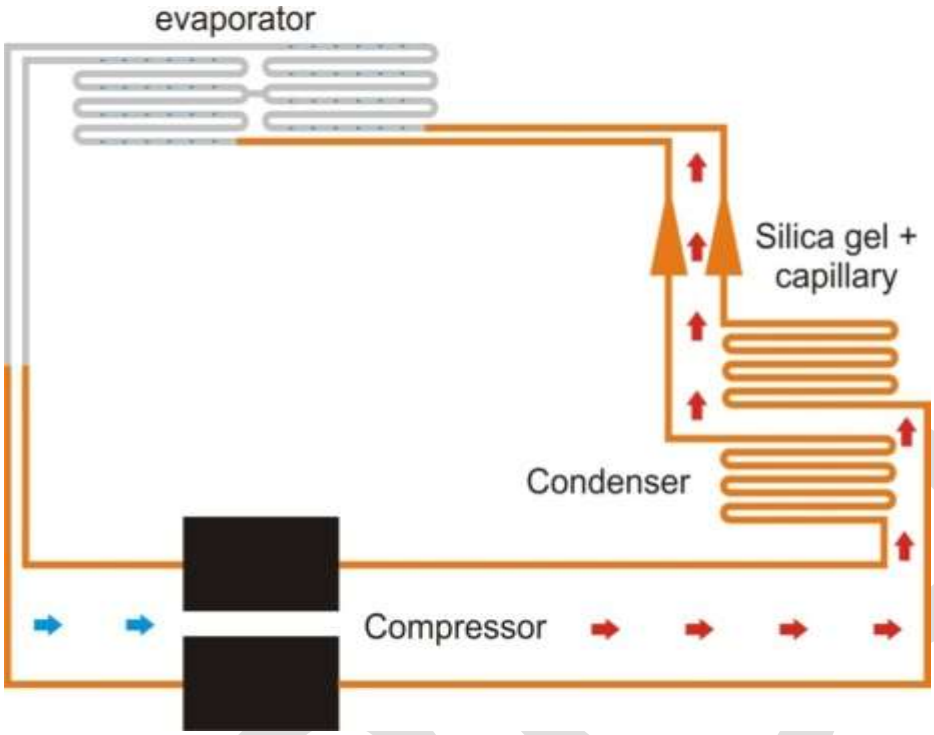

Fig. 1 Schematic diagram of Refrigeration Cycle (VCRS)

Literature Review:

L.O.S. Buzelina, S. C. Amicoa, [1] et.al (2005) discuss on an alternative solution to reduce energy consumption in industrial refrigeration systems is proposed and introduced. A typical industrial refrigeration system was conceived, built and modified in the laboratory, receiving a novel power law control system, which utilizes a frequency inverter. The operation and energy consumption of the system operating either with the new control system or with the traditional on–off control were compared to realistically quantify the obtained gains. In this manner, the measured temperature data acquired from several points of both systems and the energy consumption in kW h during a 24 h experimental run period are compared. From the experiment he concluded that the closed-loop power law controlled system shows a much smaller variation of the cold chamber internal temperature and electrical energy consumption economy of 35.24% in comparison with the traditional on–off system, under the same operating conditions.

U. V. Kongre, M. B. Salunkhe, [2] et.al (2013) discussed about the design contributions for evaporator, condenser and capillary tube. Based on conventional methodologies the design calculations were done. Further discusses the designed methods which are suitable for combined conventional air-conditioning and dispenser.

Tassou and Qureshi, [3] et.al (1994) showed that the use of a frequency inverter in refrigeration for compressor speed control may cause harmonic distortions in the systems and a power factor reduction which, in turn, increases energy consumption. However, benefits such as a better temperature control and a lower response time for abrupt thermal load changes were also mentioned.

M. Fande, A. M. Andhare [4] et.al (2015) discuss on the experimental investigation of the effect of HFC refrigerant R134a on a vapour compression refrigeration system by using two expansion devices with the conservation of energy by waste heat recovery system. He used two different evaporators for air cooling and water chilling respectively and a water cooled condenser is used to produce hot water. The existing system can be easily retrofitted as a waste heat recovery device and the existing R22 refrigerant can be replaced by R134a with minor modifications. After experimentation the maximum temperature achieved in water tank with 50 litre of water is 45 C during 3 to 4 working hour. After that performance of system decreases so it needs a regular use of that hot water which can be further used for household and industrial purposes.

Prof. S. K Gupta [5] et.al (2014) has discussed about the attempt he made to merge Domestic Refrigerator and Air conditioner into a combined system such that an ordinary man can have a sound sleep which automatically increases his working productivity for the next day. To fullfilled it in minimum construction, maintenance and running cost, he made an attempt which is quite useful for domestic purpose so that his ultimate aim of the project that is those who cannot afford an Air Conditioner can have the comfort of Air Conditioner could be completed.

S. A. Nada et.al [6] published a paper on"Performance analysis of proposed hybrid air conditioning humidification-dehumidification system for energy saving and water production in hot and dry climatic region" in which he discussed onThe objective behind the proposed system is energy saving and production of fresh water.

J. K. Dabas et.al [7] discuss about his study on the behavior of performance parameters of a simple vapour compression refrigeration system while its working under transient conditions occurred during cooling of a fixed mass of brine from initial room temperature to sub-zero refrigeration temperature. The effects of different lengths of capillary tube over these characteristics have also been examined. It was concluded that Larger capillary tube decreases the tendency of refilling of evaporator but offers less 'evaporator temperature' effective in lower range of refrigeration temperature. Shorter capillary tube ensures higher COP initially but which deteriorates at a faster rate in lower temperature range. Capillary tube length must be optimized for maximum overall average COP of the system for the complete specified cooling job.

Tarang Agarwal et.al [8] discussed in his paper about a cost-effective method to increase the COP and utility of a domestic refrigerator using R-134a refrigerant. In his experiment a cabin was installed on the top of 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 thereby increasing the overall COP of the refrigerator. Further, the utility was increased since it can serve the purpose of cooking (oven), geysers etc. Besides, the refrigerator may be used as conventional refrigerator by keeping the cabin door open in case of absence of heat sink. He was concluded that one can increase the COP upto 11% just by using a cabin on the top of the refrigerator unit. Further increase in COP is possible; however enhancements will involve higher costs.

M.R. Abdelkader et.al [9] discuss on free cooling techniques can be used to substantially reduce energy costs. During cold weather, the outside ambient temp help in saving energy in refrigeration work. The minimum temperature of the ambient air supply enables free cooling technique to store fresh fruits and vegetables. This technique of energy-efficiency measure can save enough compressor electric power to pay for modulating damper installation costs in approximately one year. Free cooling has a kind of motorized damper that conducts the two flows of internal and external air. When the damper is open it takes the air necessary cooling directly from the exterior, excluding compressor operation. It starts the evaporator fan that takes external air if Texternal < Tinternal. A case study has been carried out for 17 Ton cooling load in a storage room and the COP can be reached to the only energy consumption is from the use of evaporative fans.

Raman Kumar Singh [10] (2015) discuss about the Human comfort conditions deal with the conditions of environment around us, viz**.** hot and cold. The control of temperature of air around us is done by controlling the output water from the water cooler. He made a novel idea to control air temperature around us by the incorporation of cooling system in a single unit. This unit would be an economic utility at all places to provide comfort conditions to the people. Faster, mightier & smaller is still the keyword for every invention and development he concentrate on the compactness and efficiency of every product. Accordingly he have designed and fabricate an economical and reliable unit known as ―Water Cum Room Cooler(Three in one air conditioner).

Dr. U. V. Kongre, et.al [11] (2013) discuss about the multifunctional system he was built which gave output hot and cold water with hot and cold air . The paper introduced basic design principles and the test analysis performed in the laboratory also mentioned comfort conditions and suitable coefficient of performance with respect to atmospheric condition, without sacrificing the air conditioning output. The air-conditioner cum water dispenser was manufactured for air, water & air-water cycle combined. The air cycle provides good results with conventional optimum efficiency. The water cycle also predicts better results, but then water cycle alone is not useful. Hence the combine air conditioner cum dispenser by utilizing conventional air-conditioning. The dispenser gives required efficiency in terms of coefficient of performance.

K. Nagalakshmi et.al [12] (2014) discuss about the design and performance analysis of refrigeration system using R12 & R134a refrigerants.The purpose he mentioned behind his research is to investigate behavior of R134a refrigerant. This includes performance and efficiency variations when it replaces R12 in an existing system as well as changes involved in maintaining the system charged

with R134a. After demonstration on his project he found that, from the results and graphs that COP of R12 is little greater than COP of R134a. Even though COP of R12 is greater than R134a it must be replaced with R134a because R134a refrigerant is non-toxic and does not flare up within the whole range of operational temperatures, Ozone depletion potential ODP=0, global warming potential GWP=0.25 and Estimated Atmospheric life EAL=16. Again in high temperature refrigeration facilities, specific cold-productivity when operating on R134a is also a bit higher than that of R12. Further increasing of dehumidifying ability of filter dehydrators due to high hygroscopic property of R134a system-synthetic oil.

Vivek Sahu, Pooja Tiwari,et.al [13],(2013) has published a paper on " Experimental Investigation of the Refrigerator Condenser by varying the fin spacing of the condenser". This paper presents the experimental analysis of domestic refrigeration system by using wire operating parameters like heat transfer rate ,condenser pressure and condenser temperature , refrigerating effect is increased by using wire-on-tube condenser comparatively power consumption remain same as with air cooled condenser in a domestic refrigeration system. Therefore wire-on-tube condenser can replace the ordinary air cooled condenser in a domestic refrigeration system and in this he mentioned that Discharge pressure with small fins spacing is highest than the larger fins spacing used in same project.

S. C. Walawade, B. R. Barve, et.al [14] has published a paper on "Design and Development of Waste Heat Recovery System for Domestic Refrigerator". The main objective of this paper is to study "Waste Heat recovery system for domestic refrigerator". An attempt has been made to utilize waste heat from condenser of refrigerator. This heat can be used for number of domestic and industrial purposes. The study has shown that such a system is technically feasible and economically viable also he made an attempt to recover the waste heat from 165 L refrigerator used for domestic purpose and from this he concluded that this combination of refrigerator and food warmer is efficient and it will help to conserve an enormous amount of energy.

Dr. A. G. Matani , Mukesh K. Agrawal [15] has published a paper on "Effect of capillary diameter on the power consumption of VCRS using different Refrigerants". In which he discussed about experimental study he was conducted to observe the Power consumption of different environmental friendly refrigerant mixtures (HC mixture and R401a) and he observed the effect of working parameters like diameter of capillary tube, working pressures and inlet water temperatures, which affect the power consumption of vapour compression refrigeration system. It was observed that R401a consumed more power than HC mixture and R134a, but there is less mass quantity of HC mixture and R401a is required in the same system. So there is less effect in environment due to leakage further he analysed a system with the new refrigerant blend as substitute for R134a was made and concluded that Power consumption per ton of refrigeration of HC mixture (R290/R600a) was lower than other two refrigerants at all working pressure and inlet water temperature at capillary diameter 0.050 inch. So it can be used as Working medium in air conditioning system. also Power consumption per ton of refrigeration of R401a is always higher than other two refrigerants, so it is not efficient in use in general purpose.

Jala Chandramouli, Dr. E.V.Subbareddy [16] et.al (2015) has published a paper on "Design, Fabrication and Experimental Analysis of Vapour Compression Refrigeration System with Ellipse shaped Evaporator coil." In this paper he discussed about objective his project is to increase the performance of the system by increasing the heat transfer rate through the evaporator. Heat transfer from the evaporator increased by the changing the shape of the evaporator and by extended surfaces.He used to conduct an experiment for the ellipse shaped design evaporator of a vapour compression refrigeration system used for a domestic refrigerator of 165 litter's capacity.By incorporating the ellipse shaped evaporator of the refrigeration system he concluded that the C.O.P enhance of by 1.5%, as a result of 1.5% increase in refrigeration effect and 1% reduction in compressor work and same in heat absorption.Further, system pressure is slightly increased, the ellipse shaped evaporator increases the C.O.P compared to existing evaporator, which is perhaps due to reduction in compressor work and increase in refrigeration effect.

P. Sarat Babu, Prof. N. Hari Babu, [17] (2013) has published a paper on "Experimental Study of A Domestic Refrigerator/Freezer Using Variable Condenser Length." In which he used to optimize condenser length for domestic refrigerator of 165 litres capacity. It may give a chance to find a different length other than existing length will give better performance and concluded that the optimum length of coil is 7.01m also through his experimental investigation he found that the optimum length of coil is 7.01 m instead of standard value 6.1m.

S. B. Lokhande, Dr. S. B. Barve [18] (2014) has published a paper on "Design & Analysis of Waste Heat Recovery System for Domestic Refrigerator." In which he discussed the objective of his paper is to study "Waste Heat recovery system for domestic

refrigerator". An attempt has been made to utilize waste heat from condenser of refrigerator. This heat can be used for number of domestic and industrial purposes. In minimum constructional, maintenance and running cost, this system is much useful for domestic purpose. It is valuable alternative approach to improve overall efficiency. From the results tabulated it can be concluded that with time the energy consumption of the refrigerator decreases for certain time and then it remain constant. The refrigerating effect keeps decreasing as the temperature difference between the refrigerant and article placed is decreased. The C.O.P. remains almost constant though it decreases a little bit. With hot case, as if we add up heating effect in desired effect, then the c.o.p. is increased.

Adrian Mota-Babiloni, Joaquin Navarro-Esbri, et.al [19] (2015) has published a paper on "Commercial refrigeration- An overview of current Status" in which he discussed about the most recent developments in commercial refrigeration available and also mentioned a good amount of results provided these systems, covering some advantages and disadvantages in systems and working fluids. He mentioned about latest researches which have objective of energy savings and to reduce CO2 indirect emissions due to the burning of fossil fuels. He also discussed about system modifications trigeneration technologies and better evaporation conditions control. Further he concluded as his paper reviews the state-of art of recent developments and contains and covers important topics such as supermarket refrigeration system energy efficiency, GHG emission control regulations, HFC phase-out and low GWP alternatives. The important point mentioned here is energy consumption analysis of each supermarket is very important to identify the most beneficial energy saving techniques. From the analysis of supermarket he mentioned in paper, Among all Trigeneration is an interesting option in supermarkets that produces great energy and CO2 emission savings, especially when CO2 is the working fluid selected. New GHG regulations impose strong GWP limitations that are going to phase out currently used HFC refrigerants in commercial refrigeration.

S. A. Nada, H. F. Elattar et.al [20] (2015) discussed about Performance of integrative air-conditioning (A/C) and humidification–dehumidification desalination systems proposed for hot and dry climatic regions. The proposed systems aim to energy saving and systems utilization in fresh water production. Four systems with evaporative cooler and heat recovery units located at different locations are proposed, analyzed and evaluated at different operating parameters. Other two basic systems are used as reference systems in proposed systems assessment. Fresh water production rate, A/C cooling capacity, A/C electrical power consumption, saving in power consumptions and total cost saving (TCS) parameters are used for systems evaluations and comparisons. After analyzing the system results show that the fresh water production rates of the proposed systems increase with increasing fresh air ratio, supply air temperature and outdoor wet bulb temperature, powers saving of the proposed systems increase with increasing fresh air ratio and supply air temperature and decreasing of the outdoor air wet bulb temperature, locating the evaporative cooling after the fresh air mixing remarkably increases water production rate, and incorporating heat recovery in the air conditioning systems with evaporative cooling may adversely affect both of the water production rate and the total cost saving of the system..

Kiyoshi Saito et.al [21] (2012) has published a paper on "Latest system simulation models for heating, refrigeration,and air-conditioning systems, and their Applications" in which he discussed about the simulation model they create for a heat pump, room air-conditioner, desiccant dehumidifier, indirect evaporative cooler, fuel cell, solar panel in order to reduce the energy consumption in the refrigertion and air conditioning.Again Paper describes high-accuracy simulation models for a CO2 heat pump, absorption heat pump, and desiccant dehumidication system also discuss the simulator that they developed, based on those models for reducing energy consumption.

Chengchu Yan, Xue Xue, et.al. [22] (2015) has published a paper on " A novel air-conditioning system for proactive power demand response to smart grid." In which he discussed about a novel air conditioning system with proactive demand control for daily load shifting and real time power balance in the developing smart grid. This system consists of a chilled water storage system (CWS) and a temperature and humidity independent control (THIC) air-conditioning system, which can significantly reduce the storage volume of the chilled water tank and effectively enable a building with more flexibility in changing its electricity usage patterns. The power demand of the proposed air-conditioning system can be flexibly controlled as desired by implementing two types of demand response strategies: demand side bidding (DSB) strategy and demand as frequency controlled reserve (DFR) strategy, in respond to the day-ahead and hour-ahead power change requirements of the grid, respectively.

Conclusion:-

As per experimental study to reduce electricity consumption for refrigeration cum air conditioner, air cooler and water cooler, Also save water and forest which are affected a great impact to maintain an ecological balance and to make it cost effective, so normal person can offered this product. Environmental groups and governmental agencies have cooperated over the last two decades to bring about reductions in refrigeration and air conditioning systems energy consumption and refrigerant emissions.

The reductions have been possible through a combination of factors:

Increased environmental impact awareness, commitment of industry personnel, improved systems technology and operating/service procedures, and governmental regulations. These successes give us great confidence in continuing efforts for reduction of climate change impact of refrigeration and air conditioning system. HFC refrigerants have high societal value in providing safe and reliable refrigeration and air conditioning. At equivalent costs of other options, climate change impact from minimal refrigerant emissions can be more than offset by improved energy efficiency

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