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To Increase Efficiency of Air-Cooled Condenser by Using Hollow Cylindrical Fins: A Review

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Abstract- In 1970's in United States of America the history of introduction of Air-Cooled Condenser was traced. However, interest of researchers shifted towards this area from last few decades. The reason of this shift was the increased awareness of the world towards environmental safety, security and efforts to minimize the pollution level. Taking the above mentioned issue in concern heat-transfer by convection in Air-cooled Condensers is being studied in this work. Those are the several ways to increase the efficiency of condensers like first increasing the air flow rate by using the fan. Second by lowering the temperature of air which will be used as coolant .Third by using the water as coolant. But for the third way huge amount of water availability will be required. Fourth, by using the shading of condenser to minimize high temperature effect caused by solar radiation. Fifth, Wind walls can be used to shift the direction of air according to the requirement of condenser. Sixth, by changing the shapes of tubes in which refrigerant flows for improving the COP of refrigeration plant. The tube in which refrigerant is flowing, can be inclined that specific angel, to increase the refrigeration effect. Also outside cleaning of Fin also improve heat transfer coefficient. Primarily, this research paper target to improve the efficiency of air-cooled condensers. Also we focus to reduce the harmful effects on environment that may occur while using more electric power. As we use lesser energy so consequently Financial loses are also minimized. Moreover, the maintenance cost of equipment used in refrigeration plant will be reduced.

Keywords: Efficiency, Air-cooled condenser, Environment, Fin, Refrigerant etc.

I. INTRODUCTION

Due to the fast growth of industrialization and deforestation of Earth in last few decades, the atmospheric temperature has been increased, this phenomena occurs due to depletion of Ozone layer and huge emission of carbon. The temperature of the Earth is increasing rapidly. Since the temperature of the earth is rising exponentially. It creates uncomfort to humans. Consequently the use of air condition is increasing day by day that results in more consumption electric power.

Therefore, continuous efforts are being done by researchers to improve the coefficient of performance of air conditioners, refrigerator and ice plants. So that the power consumption may be reduced and efficiency of the air conditioners may be increased.

Air-cooled condenser

Air cooled condenser is a device which is used to cool flowing fluids inside the Finned tubes by flowing the atmospheric air over the Finned tubes. A Bus radiator is a general example of air cooled

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condenser. There are the two causes for using air cooled condenser.

a) The efficiency of the plant will be increased.

b) It is a better solution as compared to shell and tube heat exchanger and cooling tower as it doesn't require water.

The heat exchanger may be of various sizes such as small as a car radiator and as big as several acres of land. The air cooled heat exchanger are used in the plants where atmospheric conditions and plants situation do not favor other cooling systems.

The benefits of using Air-Cooled Condenser are:-

a) Easy installation.
b) No risk of chemical & thermal pollution of cooling material.
c) Plant may be established at any location, as it doesn't require water.
d) Maintenance cost will be decreased.
e) No used of water treatment chemicals.
f) Water saving technique.

Air-Cooled Condensers which are using Fins are largely used in window air conditioner, split air conditioner, refrigerators and in ice making plants. As compared to the water cooled condensers for the equal amount of heat transfer, the air cooled condensers operation is cheaper. The Air-Cooled Condenser uses the circular tubes and different types of Fin. The efficiency of Air-Cooled Condenser can be improved by using various techniques. For example by cleaning the inner tubes surface, by using tubes of different shapes such as flat tubes, and by using different shaped Fins.

Fouling Tendencies of Air-Cooled Condensers

The outer surfaces of the tubes and the Fins of Air-Cooled Condenser have the fouling tendency by insects, dirt, beat, polythene and grass etc.

The fouling tendencies reduce the efficiency of power generation of turbo machinery sometimes water spray can be used to improve the heat removing capacity of Air-Cooled Condenser by decreasing the surface temperature of the tube. If the poor quality of water is used it causes formation of scales on the tubes and the Fins which decrease the heat transfer capacity.

Different methods of cleaning Air-Cooled Condenser

There are the three techniques for cleaning the outer surfaces of air-cooled condenser.

- FIRE HOSE
- HIGH PRESSURE HAND LANCE
- FULLY AUTOMATED CLEANING MACHINE.

1. FIRE –HOSE- When the water consumption is in large quantity, a fire hose causing the less washing effect due to the low pressure used. Since the surface of the tubes and the Fins is galvanized, it will not get damaged by this process.
2. The fire hose method is not found efficient for cleaning as the remains of fouling material get pressed between the Fin tubes and can not be cleaned out by this process. This pressed fouling material creates obstacle in heat transfer process as well as restricts air flow.
3. HIGH PRESSURE HANDLANCE- This cleaning method uses high water pressure and low water consumption. The high water pressure causes the damage the galvanized surface. Sometimes the Fins get shaped off. Due to the such condition the plant becomes out of service.
4. FULLY AUTOMATED CLEANING MACHINE- This technique uses large amount of water but the pressure is used in such a way as to avoid damages in galvanized surfaces and Fins. The benefit of this that the unit remains functional during the process of cleaning.

II. GLOBAL SCENARIO

In the world today approximately 20% of electricity is consumed in air conditioning & electric fans. Increasing requirement of air conditi0oning is proving threat to environment due to carbon emission and it is also over- loading the power generation plants. Due to the lack of good policies the demand of air conditioning and power requirements will be increased in future. Although these demands can be managed through the implementation of the policies to improve efficiency of the equipment. The consumption of air

conditioning is increased with the population growth and rise of purchasing power.

In the coming thirty years, the demand of air conditioners will consume a bigger part of electricity production. Electricity consumption can be reduced by improving the efficiency of equipment with having comfort of air conditioning. In 2021, the value of Global air conditioner market was USD 131.08 billion. In 2022, this value grew to USD 139.99 billion and it will increased up to USD 236.96 billion by 2030. The consumption of air conditioner increased by more than 6% between 2020 and 2023, Due to global warming, rise in Financial status the traditional cooling methods are being pushed back and the demand for air conditioners growing day by day. More than 1.5 billion A.C. units were installed till the end of the 2023.

Although in hot climate areas only 15% of the total population of these area is using air conditioners in 2023. Many of the south Asian regions and sub sahara's African areas are still lacking this facility. Due to this fact a huge part of population is suffering from heat strokes, discomforts and various health issues. The heat stroke deaths among population aged 65 years or older increased by 61% between 2002 -2004 and 2019-2023. Which lead to approx. more than 3 lacs deaths per year. On the other hand the thousands of lives per year during 2019-2023. Approximately one lac ninety thousands lives were saved per year. During 2019-2023.

The covid-19 pandemic expansion adversely affected the consumer expenditure in 2020. In 2021, due to the global warming and industrial demand the market of air conditioner raised once again. Now a day air conditioners are not only used in homes and workplaces but also in shopes, party halls, hospitals and movie halls.

III. INDIAN SCENARIO

During last five decades India has suffered 700 heat wave incidents in which 17000 persons lost their lives. Due to the geographical location and weather, the use A.C. in India is being increased day by day with Financial growth of population. The use of A.C. in India has increased 3 times since 2010. Out of hundred houses there are 24 houses which have the air conditioner. In these 24 houses, few houses may have more than one air conditioner. The electricity consumption in India for air conditioners will be more than the consumption of Whole Africa by 2050. India will become carbon free country in 2070 by using insulating material over houses and good COP air conditioner. Our electricity consumption will be reduced 15% till 2050.

This saving of power by using good star-rating air conditioner will be more than the power production of Netherlands. India will become largest power consumer country in coming 30 years. The urban population of India will increase by 74% along with the three times growth per capita income till 2050. The steel production of India will raise three times and cement production will be doubled. Also the use of air conditioners by Indian houses will be increased by nine times till 2050.

Air conditioning demand and power requirement to meet this is increasing in India. Air conditioning has two aspects as it is necessary for the health of lacs of people, on the other hand it effects Eco-system. Due to rising temperature in India air conditioner has become a requirement instead of luxury. In order to protect human health without harming the environment it is the demand of the time to make better C.O.P. Air conditioners having small size and consuming less electricity.

India is the second largest populated country of the world so the large amount of power generation is required. It is also necessary to use latest power saving equipment. Solar energy,air conditioner is the solution of the problem as the geographical location of India provides it opportunity to use solar energy. It will also reduce carbon footprint.

IV. LITERATURE REVIEW ON EFFECIENCY OF CONDENSER

An academic work was done on performance property of an air cooled condenser under surrounding condition in December 2011. In this work efforts of types of air flow as well as surroundings conditions were studied. In this work it was found that A.C.C.'s performance decreases under high atmospheric temperature and stormy situation. The heat transfer increases if the Fin is clean. Cleaning from outside increases coefficient of heat transfer. Vapor temperature and heat rejection

depends upon the atmospheric condition. The efficiency of air cooled condensers decreases if the air flows with high speed. Turbine back pressure also rises with increase in atmospheric temperature. The results of the winds on the volumetric effectiveness can be decreased by using the Skirts.

The hot air circulation also rises with high rate of air flow. In these days wind walls are utilized ton decrease this effect. Another way is to raise the speed of fan. Due to this the consumption of power is increased.

Nir, [1], Gianolio and Cuti [2] have also reported that he transfer will reduce due to the reduction of the row's as decreased in turbulence level all over the core flow.

In another research the authors [3] also described on this matter. When condenser tubes row's reduced to six to four, it causes decrease in flow resistance. The heat transfer may also decrease. Other cause to decrease the number of tube row's is because of the phenomenon of back flow, an immanent issue of multi row condenser design which is described in details in [3] and [4]. There are two types of fan position for condenser design, in first the air is forced by the fan through the condenser, in second type the air is sucked by the fan through the condenser. Both position use very different parameters which having effects on heat transfer and pressure drop. To the best awareness of the author apart from the measurement of [2] no other measurement of heat exchanger efficiency in realistic fan flows have been published and the measurement of [5] were a Finite scope of geometric parameters.

The thermo dynamic analysis shows the relation between the efficiency and the condenser size. Pussawat watch aradumrongsak, Sampan Rittidech [6] tried to raise the performance of air cooled condenser with the utilization of hybrid condenser. K.Sumeru, C Sunardi, M.Fsukri [7] in their research utiloised condensate water to facilitate sub cooling to the compressor discharge for split air conditioning system and described about the gain in C.O.P.

Hua Chen, W.L.Lee F.W.H.Yik [8] explained that while using water cooled condenser in place of air colled condenser the C.O.P. in a split air condition unit is increased by 17.4 %. A. Sirichaoroenpanich, S.Wiriyasart, R.Prurapark, P.Naphon [9] raised the thermal performance of and air conditioning unit by using a cooling water loop with the concentric helical coiled tube heat exchanger between the condenser and compressor for cooling the refrigerant. S.S.Hu, B.J.Huang [10] used house water cooled air conditioner with cellulose pad for filling material for cooling tower also observed that the C.O.P. of this type of air conditioner is greater than the conventional air conditioner. W.L.Lee, Hua Chen, F.W.Hyik [11] developed a method to forecast the operational performance and utilization of energy for the use of water cooled air conditioner. Jingyuan Xu, Jianying Hu, Limin Zhang, Ercang Luo [12] reproduced novel shell tube and conventional shell tube heat exchanger to attain better heat transfer capacity. E.Hajidavalloo [13] described about the decrease in power consumption by using cooling pads on both side of air conditioners. Xianojing Zhu et al [14] in their research found that the wet bulb temperature has a great effect on the heat transfer capacity than the relative humanity of a evaporated condenser.

V. RESEARCH GAP

Many efforts and experiments have been done by various researchers to improve the efficiency of air cooled condenser,. Some of the researchers tried to reduced the atmospheric temperature by using the shed over the condenser. By this effort the effect of solar radiation can also be keep down. Another effort done by the researchers to clean the tube in which the refrigerant is flowing to increase the heat transfer. Some authors have suggest to improve the efficiency by cleaning the Fins from the outside. It was also recommended to use the wind wall to reduce the speed of wind. Some author researchers proposed to spray water over the Fins to increase the output of condenser. In few works it was advised to use the cooling pad outside the condenser to reduce outside temperature. Some experimenters recommended use of force draft and induced draft to enhance the performance of condenser.

In air cooled condenser the heat transfer took place due to the convection process. Convection depends on the four factors- coefficient of heat transfer, surface temperature of Fink, temperature of the surrounding air and the heat transferring area of the

Fin surface. IN this research work the area of the Fin has been increased by using the same quantity of metal. Since the heat transfer is proportional to the area of the Fin, as the area of the Fin increases, heat transfer will increase proportionally. By this effort, the efficiency of the condenser will be increased, simultaneously the C.O.P. of the air conditioning, refrigerator, ice plants will be increased. Since the same quantity of metal is used the process becomes cost effective. By using this technique electric power consumption will be reduced which will be lead to the reduction of carbon emission.

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