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## DESIGN OF METAL SHEET STRUCTURE AS EVAPORATIVE COOLING PAD

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### Abstract

Evaporative coolers are used to keep a space cool. A vapor compression refrigeration system, often referred to as an air conditioner (AC), or an evaporation cooler are the two methods for cooling a space. Although the air conditioner is much superior to the evaporative cooler in terms of cooling a portion, it has very high initial and ongoing expenses, as well as being hazardous to the environment. So, in a nation like India, where the cost of any household appliance plays a significant part in deciding whether to purchase a product, having a better cost alternative is critical. As a result, evaporative coolers are the most cost-effective choice on the market. The current work addresses these issues and suggests that Modular Cooling Pads be used as an alternate cooling solution. The work has resulted in decreased maintenance and operational costs without sacrificing comfort. This article discusses the design and performance of revolutionary non-cellulosic evaporative cooling pads made from galvanized metal sheets. Solid works and ANSYS were used to design the cooler, which uses modular cooling pads as an evaporative medium. The results of the analysis in ANSYS Fluent show a temperature drop of 13 °C from the ambient state.

**Key words:** Evaporative cooler, Air conditioner, Environment, Modular cooling pad, Galvanized metal sheet.

### 1. INTRODUCTION

Evaporative air cooling, which uses the concept of heat absorption by water evaporation, seems to be the most efficient and environmentally friendly cooling method. An evaporative cooler consists of a pump, a fan, an evaporative medium, a reservoir or tank, and a motor. The fan draws hot air from outside the device and pushes it through the moistened pad, while the pump pumps water from the tank onto the cooling pad to wet it. As the air travels over the wet pad, it cools due to evaporation. The fan and motor have been calibrated to deliver the ideal quantity of airflow.

**Figure 1: Front view of evaporative cooler**

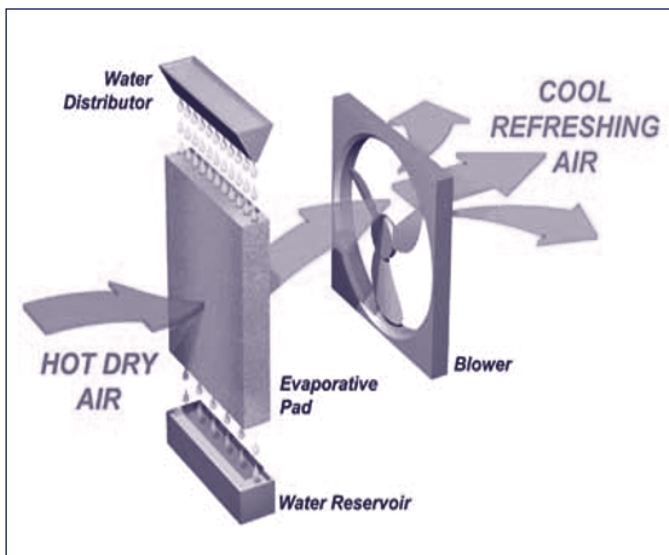


**Figure 2: Back view of evaporative cooler**



Direct evaporative cooling and indirect evaporative cooling are two types of evaporative cooling (*Evaporative Cooler Types. Pdf, n.d.*). By converting liquid water to water vapor, direct evaporative cooling employs the latent heat of evaporation to reduce the temperature and increase the humidity of the air. During this technique, the energy in the air does not change. Cool, humid air replaces the warm, dry air. The heat of the outside air is used to evaporate the water. When the relative humidity climbs to 70 to 90 percent, the cooling effect of human perspiration is reduced. The moist air must be discharged to the outside on a regular basis, or the air would become saturated, and evaporation will cease.

Figure 3: Direct Evaporative Cooling



The direct evaporative coolers that use khus, wood wool, or honeycomb mesh as the evaporative medium have several disadvantages. The rate of fluid evaporation from the skin, nose, lungs, and eyes is slowed by humidified air. Corrosion is accelerated by high humidity in the air, especially when dust is present. Electronics and other equipment's life can be significantly shortened because of this. When there is a high quantity of humidity in the air, water condensation can occur. This can be a problem in some instances (e.g., electrical equipment, computers, paper, books, old wood). Evaporative media must be replenished on a frequent basis to maintain cooling performance. Although wood wool pads are inexpensive, they must be renewed every few months. Higher-efficiency rigid media is more expensive, but it will last longer proportional to the water hardness; in really hard water areas, rigid media may only last two years before mineral scale build-up reduces performance to an undesirable degree. An evaporative cooler is a frequent breeding ground for mosquitos. A poorly kept cooler is considered a hazard to public health by many authorities. Inadequately maintained or malfunctioning systems can release mould and pathogens into the interior air, causing sick building syndrome and harming asthma and allergy sufferers. Wood wool in dry cooler pads could catch fire even if there are only a few sparks(Wikipedia, n.d.). This research project is aimed at resolving these issues. Evaporative medium plays a key role in reducing these issues, hence in this study, a sheet metal framework was used as an evaporative medium to construct a cooler. Evaporative cooling systems have been the subject of numerous studies to better understand the various approaches to increase cooling efficiency and to estimate the potential of these elements in different conditions and locations. K. Sudhakar, Deepak Bishoyi Experimented with a direct evaporative cooler. They are attempting to compare the performance of two distinct cooling pads, the first of which is an Aspen cooling pad and the second of which is a honeycomb cooling pad. Honeycomb cooling pads outperform aspen cooling pads, according to their studies (Bishoyi & Sudhakar, 2017). Comparative analysis of crossflow indirect

evaporative air coolers was provided by Sergey Bolotin et al. A numerical analysis of two crossflow indirect evaporative air cooler configurations: a traditional crossflow heat exchanger and a regenerative crossflow exchanger. Performance analysis based on a mathematical model established allows for the establishment of preferred operating parameters that ensure relatively high efficacy while minimizing pressure drops and water consumption (Bolotin et al., 2015). Experimental examination of water spraying in an indirect evaporative cooler from the perspectives of nozzle type and spray strategy was provided by Tiezhu Sun et al. According to their findings, the water distribution has a significant impact on the performance of indirect evaporative coolers (IEC)(Sun et al., 2020). Experimental investigation on spray evaporative cooling system used to air-cooled chiller condenser was given by Hua Yang et al. Their findings suggest that proper application of spray cooling systems can reduce the power consumption of air-cooled devices, resulting in energy saving(Yang et al., 2020). Demis Pandelidis et al. conducted an experiment on eight different plate materials for evaporative air coolers. Synthetic materials are better suited to the role of plate materials in evaporative air coolers, according to the findings(Pandelidis et al., 2021). Theoretical and practical study on heat and mass transfer of a porous ceramic tube type indirect evaporative cooler is presented by Tiezhu Sun et al. The best performance of the porous ceramic IEC prototype was demonstrated in an experimental research(Naderi et al., 2020). J.K. Jain and D.A. Hindoliya presented their findings on the performance of two innovative evaporative cooling pad materials. In a laboratory, coconut and palash fibres were tested using a specially designed test setup. According to their findings, palash and coconut fibres have a lot of promise for use as a wetted media in household and commercial direct evaporative coolers(Jain & Hindoliya, 2011). In Australia, Michael Bennett and John Bell experimented with direct evaporative cooling. They are attempting to assess the importance of direct evaporative cooling in several Australian cities. Their findings show that direct evaporative cooling is particularly significant in Australian climates(Guan et al., 2015). An equation for determining the wet bulb temperature from ambient temperature and humidity was devised by Waleed A. Abdel- Fadeel and Soubhi A. Hassanein, as well as an equation for computing the outlet air humidity and temperature in the direct evaporative cooler. The equations generate results that are very similar to those in existing psychrometric charts(Abdel-Fadeel & Hassanein, 2012). In a direct evaporative cooler, A. Fouda and Z. Melikyan attempted to develop a simplified model for heat and mass transport analysis. According to their findings, the computed and experimental results are in good agreement(Fouda & Melikyan, 2011). Nandy Putra, Bintang Fikri, and Evi Sofia put a direct-indirect evaporative cooler with a heat pipe to the test for efficient heat and mass transfer. By arranging the heat pipe and evaporative cooler as a multistage direct evaporative cooler with a pre-cooler, the saturation efficiency of a multistage direct evaporative cooler with a pre-cooler was enhanced(Fikri et al., 2020). Kapilan N., Manjunath Gowda M., and Manjunath H. N. performed a Computational Fluid Dynamic Analysis of an Evaporative Cooling System. The experimental and CFD

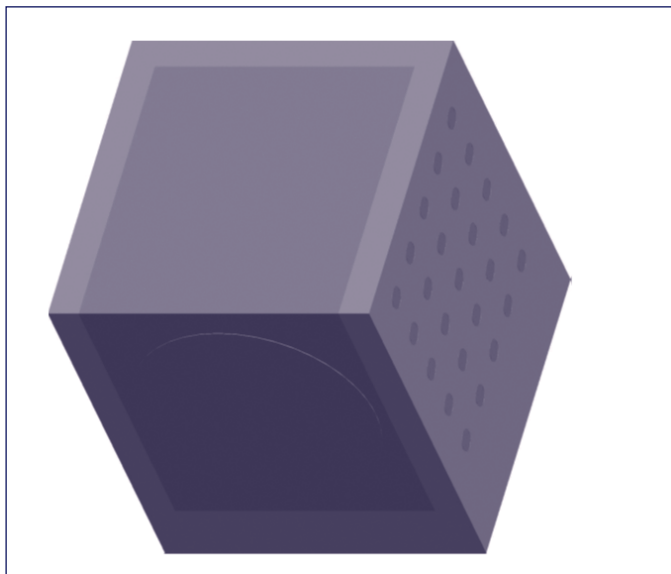
results of the system are identical, according to their findings (Kapilan et al., 2016). Mohammed A. Alodan and Abdulelah A. Al-Faraj devised and tested non-cellulosic evaporative cooling pads constructed of galvanised metal sheets. The investigations in this study yielded very good cooling efficiency results when compared to reported findings of commercial cellulose pads (Al-Faraj et al., 2005).

**2. METHODOLOGY**

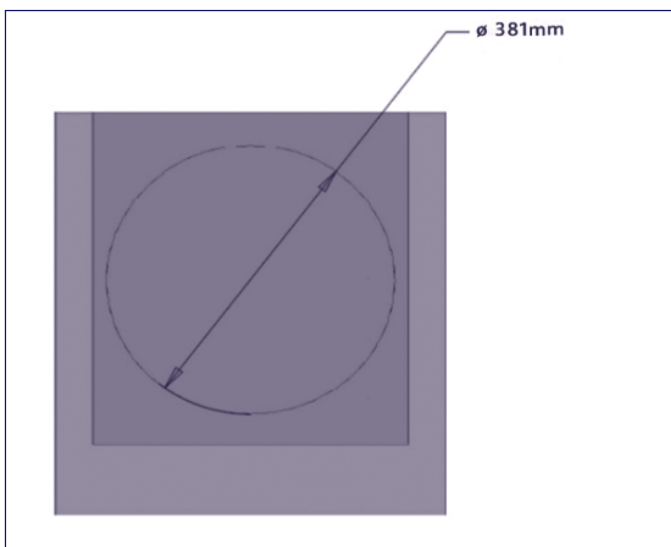
According to the previous studies I got the concept of cooling pad in evaporative cooler which shows better result than another evaporative cooler. The cooler model which using cooling pad as evaporative medium is designed and analysed in the Ansys software. Medium size evaporative cooler is taken as reference for the design cooler model.

**2.1. Evaporative Cooling System Design:** In this experiment medium size evaporative cooler with cooling pad of dimension 779.78 x 584.2 x 543.56 mm<sup>3</sup> is designed in ANSYS, which is shown in below figure 4.

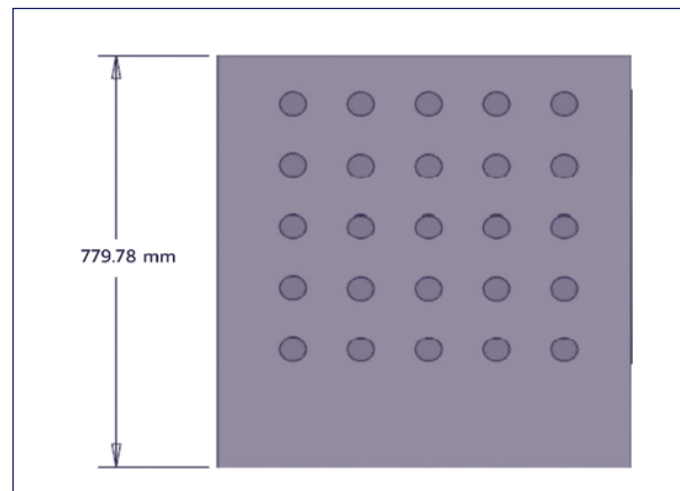
**Figure 4.a: Isometric View of Cooler**



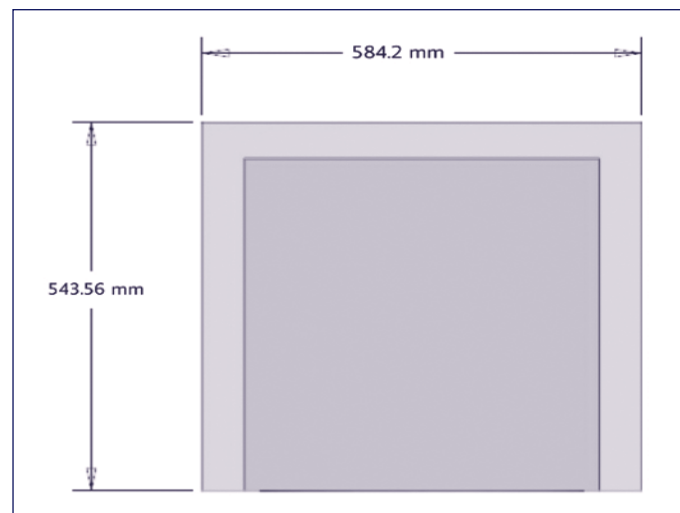
**Figure 4.b: Front view of Cooler**



**Figure 4.c: Side View of cooler**



**Figure 4.d: Top View of Cooler**



In above model 70 cooling pads, at left 25, right 25 and 20 pads at the back were used for air suction and water distribution. In front surface of dimension 779.78 mm x 584.2 mm hollow cut of diameter 381 mm was used for cooled air outlet. In this model the cooling pad of square of shape of dimension 101.6 x 101.6 x 66 mm<sup>3</sup>, hollow tube at centre of diameter 40.64 mm and length of tube 66 mm is used which is shown in below figure 5.

**Figure 5.a: Isometric View of Single Cooling pad**

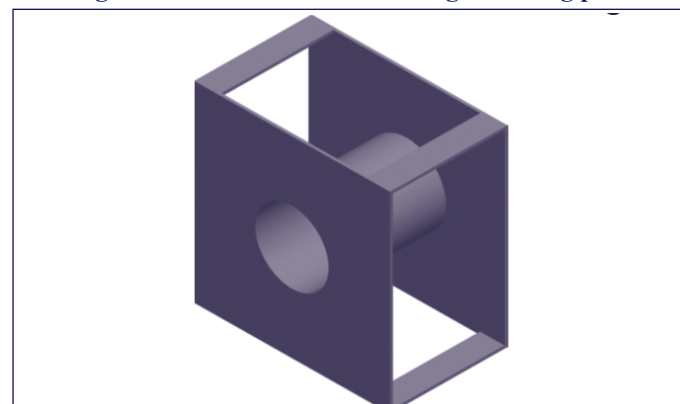


Figure 5.b: Front View of Single Cooling pad

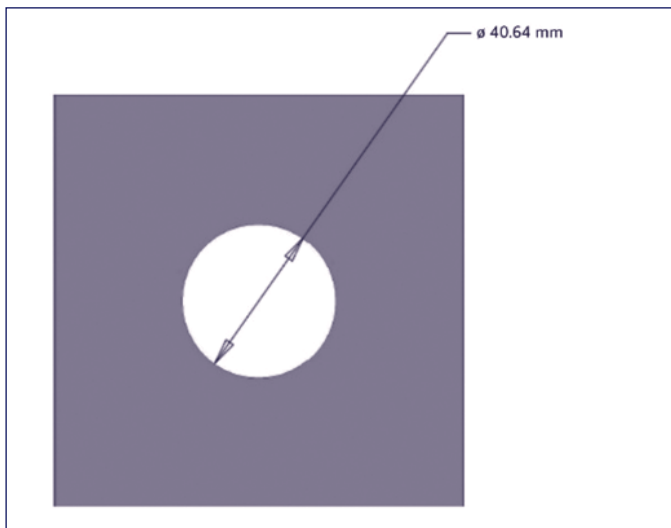


Figure 5.c: Top View of Single Cooling pad

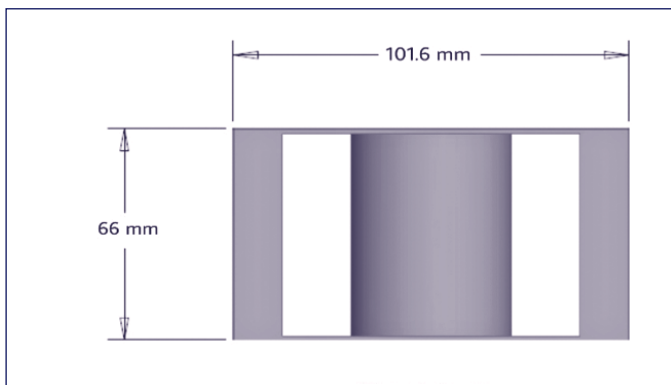
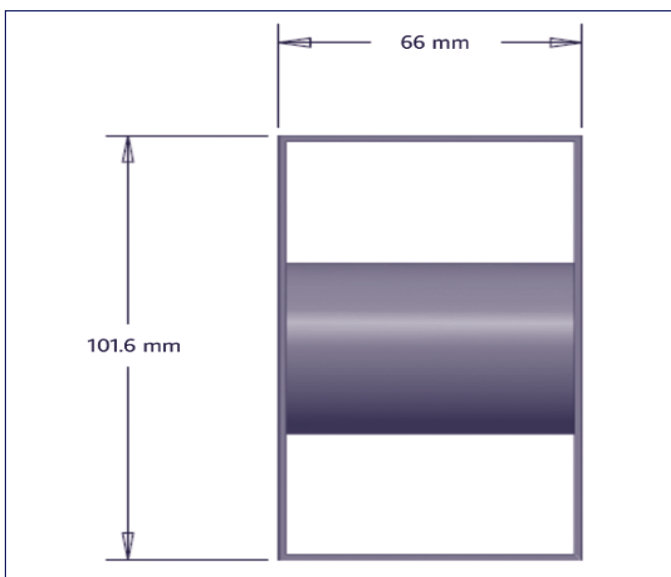


Figure 5.d: Side view of Single Cooling pad

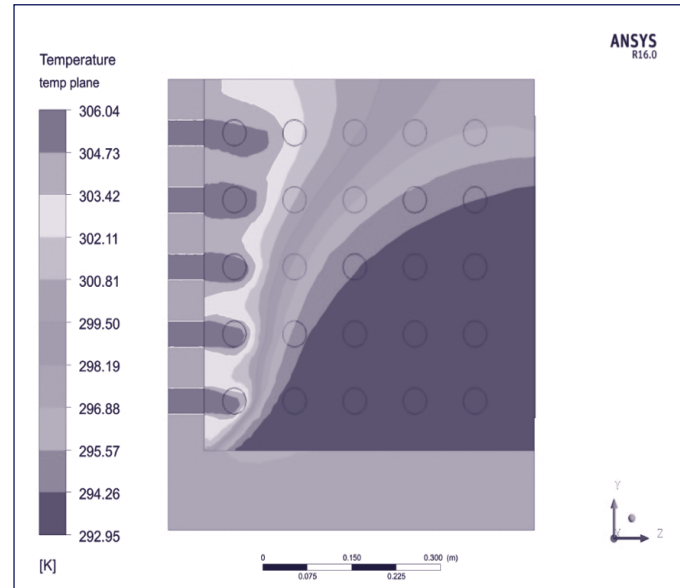


### 3. RESULT AND DISCUSSION

Figures 5 and 4 show the single cooling pad and overall design of the model. The cooler model shown in figure 4 was analysed in ANSYS. The boundary condition for analysis of model is

inlet temperature is  $33^{\circ}\text{C}$  ( $306.15\text{ K}$ ), velocity of air is assumed  $1\text{ m/s}$ , Outlet temperature is  $20^{\circ}\text{C}$  ( $293.15\text{ K}$ ). After applying the boundary condition, the outcome is shown in figure 6. Figure clearly shows that the maximum temperature drop by the cooler is around  $13^{\circ}\text{C}$ .

Figure 6: Temperature variation of Cooler



The temperature change of the cooler is depicted in Figure 6, and the boundary conditions utilized for analysis are Ideal. It's possible that the temperature analysis of the physical model yields a different result, but it's evident from this study that the physical model's result is like the ANSYS models.

### 4. CONCLUSION

Evaporative coolers that use khus or honeycomb mesh as the evaporative medium have a number of limitations. The evaporative medium of an evaporative cooler is critical to its proper operation. This research work presents a novel type of cooling pad which can be replace Khus and other cellulose pads. The temperature drop is significant in this study which is similar kind of result given by the traditional type of evaporative cooler. When using a modular cooling pad, the change in medium revealed in this study is simple to adapt, and the cooler's life is also extended. The significant temperature drop may also be seen in the ANSYS findings. The findings of this study show that modular cooling pads can be utilised in evaporative coolers instead of khus or honeycomb type media.

### 5. FUTURE SCOPE

The goal of this study is to see if a modular cooling pad may be used as an evaporative medium. The ANSYS result demonstrates that a modular cooling pad may be adapted to improve cooler performance. The ANSYS result alone is insufficient to justify the future possibility of changing the medium in an evaporative cooler, hence a physical model of the cooler is recommended for a better understanding of the new form of modular cooling pad. Researchers are also interested in the many prospective advances in the design of the cooling pad, as well as the material selection.

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