An Introduction to the Functioning of Natural Refrigeration System

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Abstract

Natural refrigeration is an age old process and the recent interest in it is due to the green and alternate energy initiatives. Refrigeration is the process of transferring heat from one source to another as per requirement for desired application. Natural refrigeration process comes with various technical challenges. In this paper, a simple natural refrigeration system is designed utilizing phase change physical principles for better performance and cost effectiveness. An evaporating cooling phenomenon plays a major role in cooling of liquid particles in this natural refrigeration system design .This computational investigation demonstrates the potentials of natural refrigeration system design for consumer application, for example - perishable food storage container. Further for better performance, the change in design and shape optimization will be reported. This study can play a key role in the growth of refrigeration industry for commercialization of low cost natural refrigeration.

Keywords: Evaporative cooling, turbulent flow, natural refrigeration application.

1. Introduction

Now a day most of the refrigerators work on electricity and need some extra materials usually chemical gases like Freon, HFC-134a (1,1,1,2-tetrafluoroethane), R-600a as a refrigerant. These gases not only depletes ozone layer but are sometime harmful to humans too. And as said above refrigerators works on electricity, and some people can't afford it especially those who are living in rural area either due to electricity problem or because of high price.

So we have introduced a new refrigerator (as shown in figure 1, figure 2 and figure 3) which don't need any electricity or chemical gases which are hazardous to environment and is fully ecofriendly. We have named it **"NATURAL REFRIGERATOR"**. It just need **soil, water and wind** as a working medium which we think is available everywhere on this earth. It can be carried to anywhere due to its compact size and light weight. And the most important thing, its working temp is up to **4 degree Celsius** (estimated). The phase change in physical phenomenon is an effective approach to engineer thermal energy for innovative and engineering applications. Melting, freezing, vaporization, condensation and sublimations are different terms of phase change. One of the major application of phase change is a natural refrigeration system. For modeling evaporative cooling, there physical phenomenon have been taken into account: turbulent flow of the air around the refrigeration, heat transfer in all domains, and transport of water into air. A storage volume of 1.786 cubic feet was designed in 2D environment with axisymmetric feature to reduce the convergence time and for better accuracy. As a result evaporative cooling physical phenomena, a desired cooling environment has been achieved for natural refrigeration application

2. **Figures**

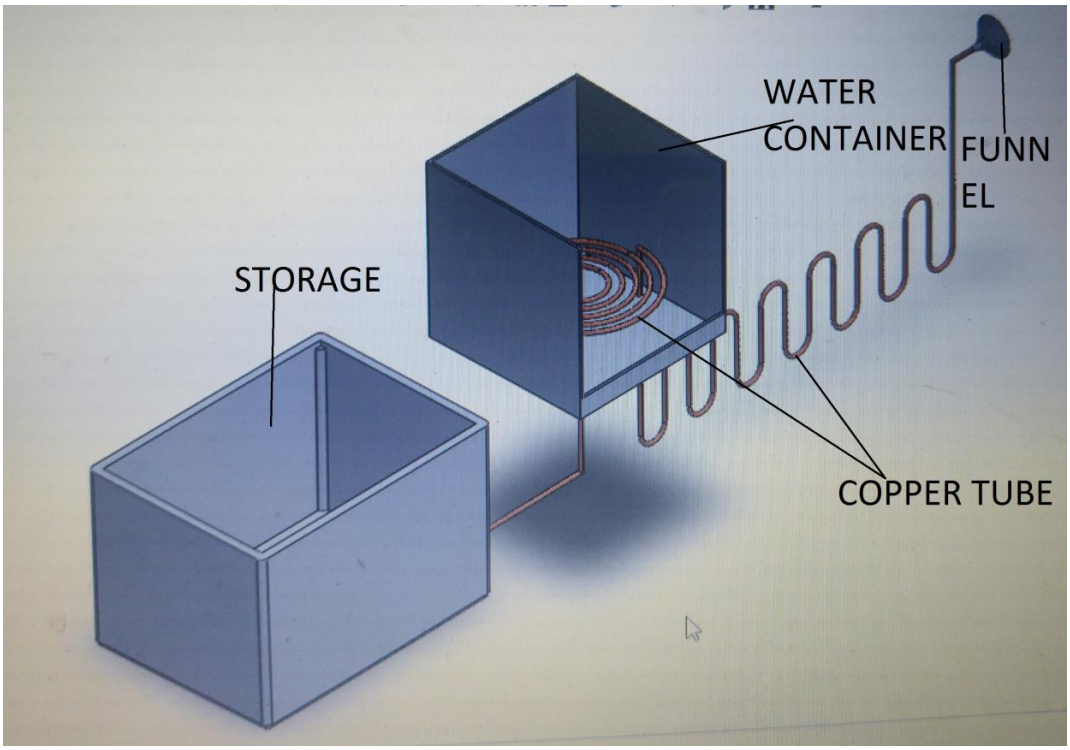

Figure-1 solidworks model of the refrigertaor

Figure-2 Actual model of the refrigerator

3.Working

When a liquid evaporates it loses energy. This is why sweating cools us down. The sweat on our skin evaporates and it takes a bit of energy from our skin with it. This loss of energy provides us with a cooling effect.

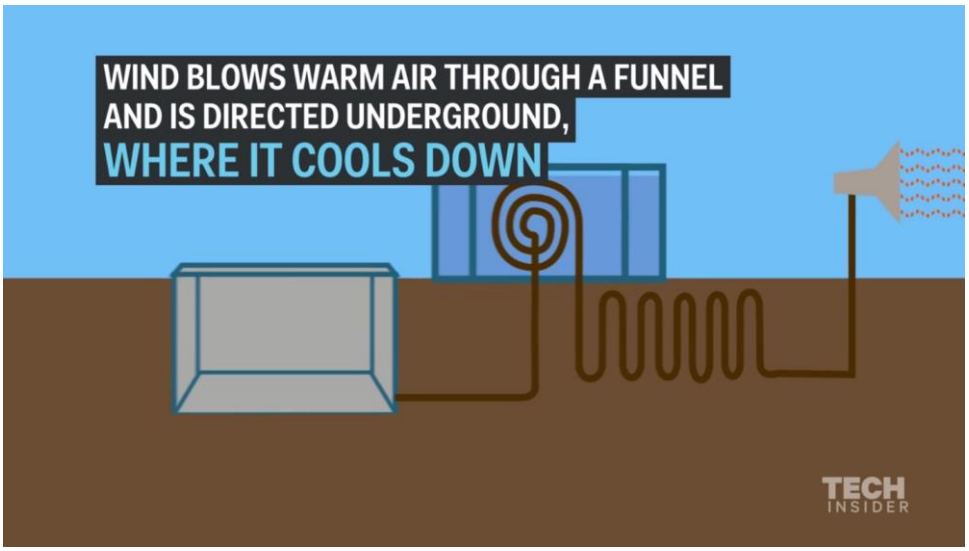

Figure-3 wind bowing pattern

Temperature is a measure of the average kinetic energy of the molecules in a substance. Sometimes the molecules near the surface of a liquid collide just right and they provide one molecule with enough kinetic energy to overcome the intermolecular forces in the liquid and it escapes (evaporates) from the liquid. As more and more of these high kinetic energy molecules escape, the remaining molecules have, on average, lower and lower kinetic energy. This is the very definition of cooling – lower average kinetic energy. Evaporation slows down as the liquid gets cooler because the molecules have less average kinetic energy and they don't collide 'just right' as often. So evaporation will only cool the liquid so much before the process slows to a stop.

Evaporative cooling is limited by the current wet bulb temperature. No matter how much liquid evaporates or how fast it evaporates the minimum temperature that can be reached by direct evaporation is the wet bulb temperature. A wet bulb temperature is an indication of the amount of water vapor (relative humidity) in the air.

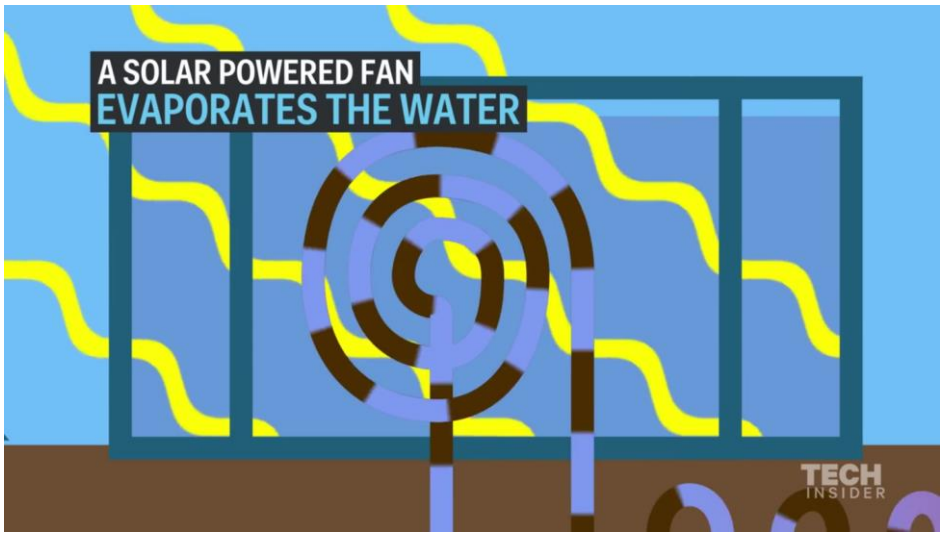

Figure-4 Evaporation

Imagine water in a jar where the higher energy water molecules near the surface of the liquid are escaping into the air above the water as shown in figure 6. If we put a lid on the jar, the water molecules will continue to accumulate and sometimes the collisions of these

molecules will result in the molecule leaving the air and returning to the liquid water. If the jar is left alone, eventually the activity will equalize. The average energy of the molecules leaving the liquid will equal the average energy of the molecules returning to the liquid. This equilibrium is what we would call 100% relative humidity. The energy lost to evaporation is equal to the energy gained from condensation. You can determine how close you are to the equilibrium point by taking the wet bulb temperature of the air and comparing it to the dry bulb temperature of the air. If the wet bulb temperature is lower, it indicates that there is still room for molecules to transfer from the liquid into the air.

4. **Temperature Readings**

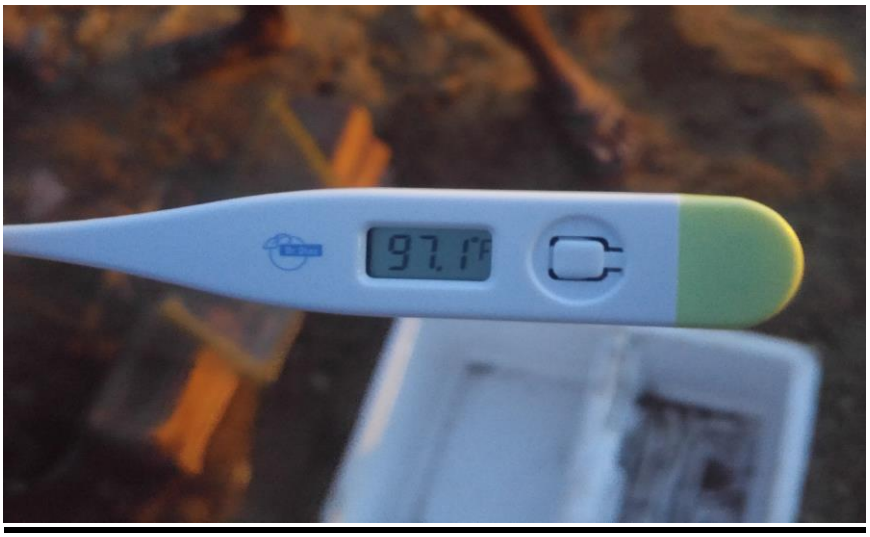

Figure.5 Temperature recorded outside (atmospheric temp.)

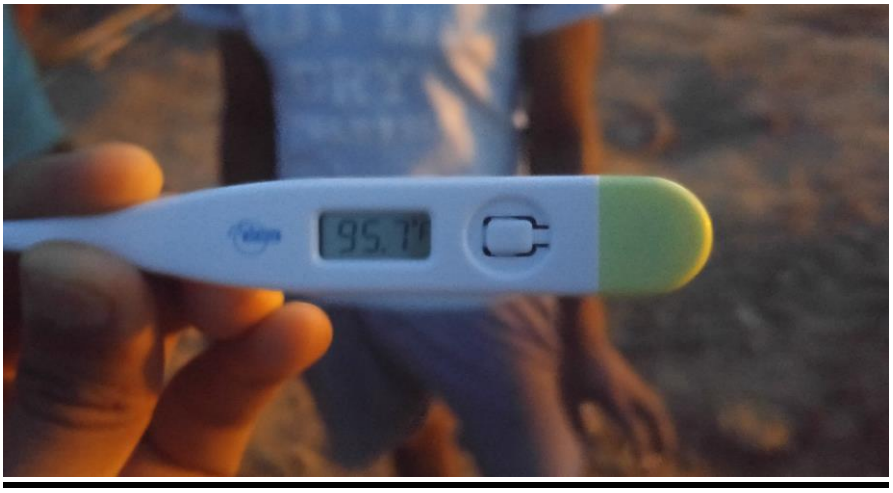

Figure.6 Temperature recorded outside (atmospheric temp.)

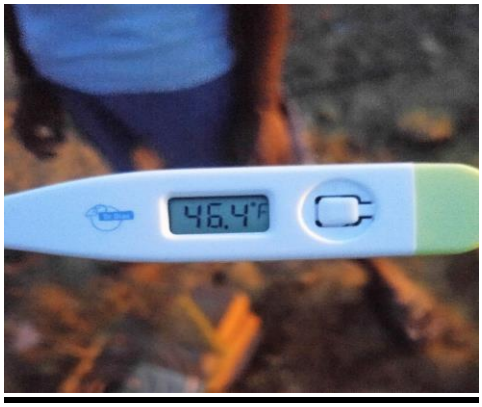

Figure.7 Temperature at the end of copper tube attached to the storage.

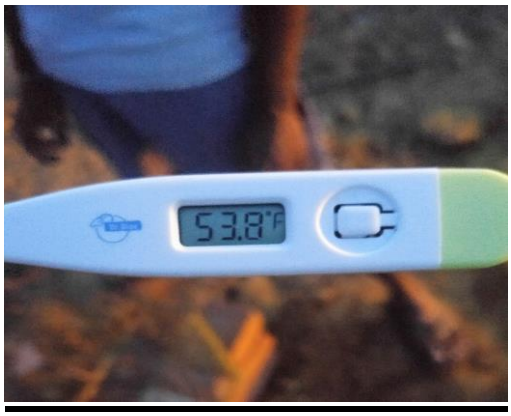

Figure.8Temperature at other parts of the storage

5.Graph

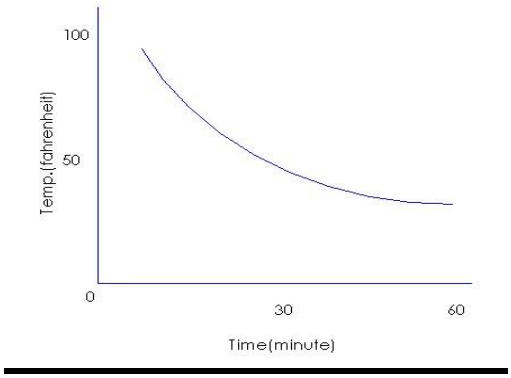

Figure 9. Temp. v/s time graph

Initial temperature: - 97.1 at time T: - 0 minutes.

Final temperature: - 46.4-53.8 degree Fahrenheit at time T: - 60 minutes.

The graph made according to readings clearly shows that the temp has fallen from 97.1 degree Fahrenheit to 46.4 degree Fahrenheit in interval of 1 hour.

6. CONCLUSION

During construction of the device several minor changes were made to the design. Each of these changes we feel was justified as they made for easier construction while maintaining the performance of the with respect to the project goals. The device passes its final inspection and was deemed to have a professional appearance by the project coordinator. The device was discovered to have ample precision and total heat transfer capabilities while meeting its accuracy requirement.

7.References

1.Refrigeration and Air Conditioning" [Book] by C.P. Arora.
2.Textbook of Refrigeration and Air Conditioning" by R.K. Rajput
3.www.youtube.com
4.www.wikipedia.com
5.www.mit.edu
6.Tech Insider