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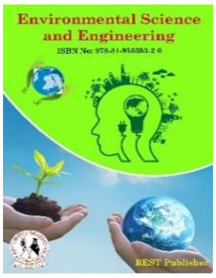

Design and Performance Analysis of An Instantaneous Water Cooler Utilizing Isobutane Refrigerant

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Abstract: *In this article, the rapid chilling impact of R600a gas on water is investigated. A refrigerator has various practical applications, including the cooling of water and the storage of food, medication, beverages, and other consumables. Chilled or cold-water consumption is higher among these. Every time the bottles or containers in the household refrigerator in our houses or motels are depleted, we have to open the door and close it again. Because of this, the refrigerator is not as effective as it may be. Our refrigerator uses a lot of power and is a major contributor to environmental damage due to the refrigerant it uses. Therefore, we devised a simple water cooler or chillier that uses R600a gas as a refrigerant to produce cold water in a fraction of the time (instantaneously) required by a conventional refrigerator. Automatic filling mechanisms, temperature-controlling sensors, and a leakage-detection device will all be integrated into this system. As a refrigerant, R600a (isobutene gas) is readily available and makes a positive environmental impact because it comprises only isobutene. It's a greener and more cost-effective solution to climate change. Effective as an alternative to R134a, it may help reduce energy consumption and have a positive impact on the environment.*
***Keywords**: Evaporator Tube, Condenser, Refrigerator, R600aCompressor, Capillary Tube, R600aGas*

1. INTRODUCTION

There are numerous other refrigeration cycles that can be used, and vapour-compression refrigeration is just one of them. Large public buildings, workplaces, private dwellings, hotels, hospitals, theaters, restaurants, and even automobiles have all made use of this technique. It's also put to use in a wide variety of commercial and industrial settings, including refrigerators at homes and businesses, large-scale warehouses for chilled or frozen storage of groceries and meats, refrigerated trucks and railroad coaches, and more. Large vapour-compression refrigeration systems are commonly used in a wide variety of industrial industries, including oil refineries, petrochemical and chemical processing plants, and natural gas processing plants. Removing heat from an enclosed place and redirecting it elsewhere is one definition of refrigeration. A heat pump is one term for a device that serves this purpose. When performing an energy analysis of a refrigerator, it is helpful to visualize the border around the area where the appliance is located. It's obvious that some heat, q2, is released at a higher temperature than the surrounding air. It is also obvious that the food inside the fridge is cooled since it releases some of its heat to the fridge, which "absorbs" it (albeit at a lower temperature than its surroundings). Every fridge receives energy, either thermal or electrical, which translates to work (w). Because heat cannot travel from lower to higher temperatures in everyday life, the refrigeration unit must absorb heat at lower temperatures before it can release it at higher temperatures. This is accomplished by using more energy than is necessary to run the refrigerator. For the boundary, the sum of the heat given off (q2) and the heat taken in (q1) and the work taken in (w) is equal to the total energy input. The efficiency of a refrigerator is measured by its ability to remove heat from food while using as little electricity as possible. The coefficient of performance (COP) is defined as the ratio of the amount of heat removed to the amount of work done using electrical energy (w). Maximum ratios are preferable. C.O.P= $q1/w$=q1/(q2-q1) Calculate the theoretical COP by dividing the theoretical refrigerating effect (N) by the theoretical compressor work (W) or the temperature entropy work (TW). The real COP of a cooling system is the ratio of the energy used to cool the system to the energy used to run the compressor, as measured in watt-hours. The relative COP is the measured COP divided by the calculated COP. A true number, it has no base or fractional part

2. BASIC REFRIGERATION PRINCIPLE

Putting a cup of hot coffee down on a table and leaving it there for a long will cause the coffee's heat to be transmitted to the cup, the table, and the air around it. Over time, the coffee will chill as the heat is transmitted. In the same way, refrigeration removes heat from an item and releases it into the surrounding air. The core of the idea is the transmission of heat. We could go into detail about entropy and the rules of thermodynamics, but we won't. That isn't required to grasp this idea. Whether or not you're into science, you've probably heard this one before. Your dinner will go cold if you take it off the heat and don't eat it immediately away. Warming occurs if milk is left out on the counter. The temperature of your dinner and milk would really equal that of the room. Since your dinner is warmer than the room, heat is transferred from it. Your milk absorbs heat energy from the surrounding space because it is colder than the air outside the fridge. The temperature of your dinner and the milk both rise and fall as heat energy is transferred between the objects involved. The principle of heat transfer is directly relevant to our daily lives. During the colder months, we alter the inside temperature of our home by relocating heat generated by a fireplace, radiator, or electric heater. In the summer, though, we want to do the inverse—exchange heat from within the home for heat outside the house.

3. WATER COOLERS

Regardless of the outside temperature, water coolers keep water at a consistent temperature. They generate refreshingly cool water, often between 7 and 13 degrees Celsius, to quench the thirst of workers in sweltering conditions. The body's physiologic need for warm or normal water to function properly is met, but in the sweltering heat of summer, this water does little to satisfy the thirst.

4. TYPES OF WATER COOLERS

There are two basic varieties of water coolers: those with tanks and those without. The evaporator coil of a storage-style water cooler is permanently affixed to the outer surface of the tank's walls via soldering. Galvanized steel or stainless-steel sheets can be used to make the tank. A float valve regulates the amount of water in the tank. The water cooler of this type will need to operate for an extended period of time in order to cool the large volume of water stored in the tank. The machine will automatically shut down if the temperature reaches the thermostat's predetermined threshold. As the cooler's water is used up and replaced with fresh water, the machine's temperature gradually rises and it begins running again. This means that there is a constant supply of icy water.

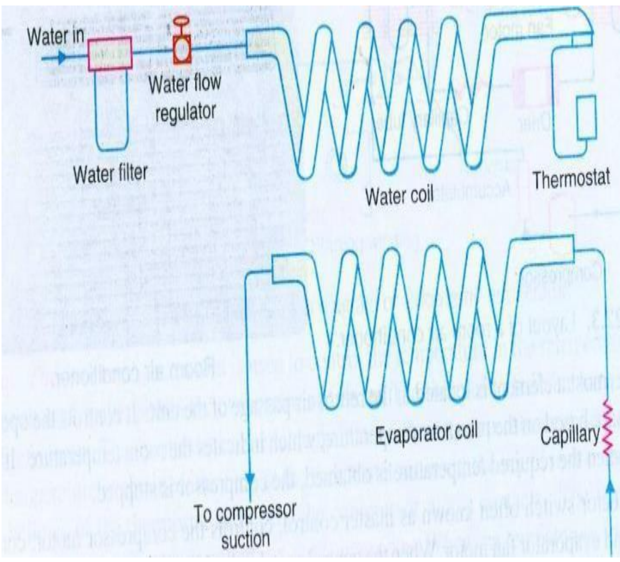

FIGURE 1. Cooling Coil of Instantaneous type Cooler

The evaporator of an instantaneous water cooler is made up of two cylindrical coils made of copper or stainless tubing. One coil contains the evaporating refrigerant, and the other contains the water to be cooled. The evaporator uses conduction to transfer heat away from the water to the refrigerant. There are three subsets of water coolers: (a) bottle coolers, (b) pressure coolers, and (c) self-contained coolers. Remote type, these are discussed, in detail, as follows: (a) Bottle type: An instant water cooler of the bottle variety stores water in a bottle or reservoir as suggested by the name. Because it is often used to cool water delivered in 25-liter glass bottles, which are placed atop the unit, no connection to the city main inflow is necessary. Pressure type: Water is provided under pressure in this form of rapid water cooler. The cooler's inlet connection at the back receives water from the city's main water supply. A pre-cooler is the next step in the process. The cooler's condensation water is reused to cool the pre-cooler. Since the temperature of wastewater is typically quite low, it can be used to effectively chill the supply water by circulating through a pipe coil that is wrapped around the drainage line. The cooler's workload is lightened thanks to this setup. The length of the pre-cooler pipe coil and the amount of waste water being treated determine how much cooling may be achieved. After being pre-cooled, the water is pumped into the storage tank, where it continues to lose heat to the refrigerant. The storage tank has a self-closing valve or bubbler installed at the bottom, where the water output pipe connects. The water in the pipe is heated to a specific temperature using a thermostat. Self-contained remote Type cooler: A mechanical refrigeration system is used in self-contained, remote-type coolers. The water is chilled in a remote cooler and then piped to the location of choice for consumption. This setup is practical and does not necessitate additional room close to the office. Types of water flow: a. Parallel flow, b. Counter flow, Parallel flow: When two different fluids are flowing in parallel through the same pipe or apparatus, we say that they are flowing in parallel. Counter flow: When two different fluids are flowing in opposite directions through the same pipe at the same time, this is known as counter flow. It works with water coolers that cool water instantly. Capacity of Water Coolers Q=mw cp (Ti-To) where mw=Rate of water consumption cp=Specific heat of water Ti=Inlet temperature of water and To=Outlet temperature of water is the cooling load for the water cooler. There is a breakdown of the cold water needs for different scenarios. Extensive statistical sampling was used to compile these numbers. For obvious reasons, refrigerants like ammonia, sulphur dioxide, etc. are no longer used. For refrigeration capacities of up to 1 tonne (1TR), R-12 is typically used, whereas R-134 is typically used for capacities of 2 TR or more, and the two are often combined for bigger units. Water consumption estimates should factor in the amount of cold water that is wasted. Glass wool or thermocole insulation, often between 40 and 60 millimeters in thickness, is used to ensure little heat loss.

5. EXPERIMENTAL SETUP AND METHODOLOGY

The immediate water cooling is the main emphasis of this project, which features an R-600a compressor, condenser, thermostat, and two 14-inch-diameter copper tubes. One tube transports the water and the other the refrigerant (which functions as an evaporator). Actual setup of the model Methodology: wound in a parallel fashion, with the ends linked via spot welding for maximum surface area. This procedure will greatly improve the thermal conduction between the two tubes. The cooling process is enhanced by the counter-flow design.

FIGURE 2. Experimental Setup and Methodology

winded parallel to each other and both are joined with spot welding to better contact between each other. By this process thermal conduction between these two tubes will be high. And it follows counter flow method for better cooling effect. Experimental Procedure: coil out of another copper tube, both of equal length. Spot welding secures their attachment, ensuring maximum tube-to-tube contact and hence maximum heat conduction. These copper tubes lead to the capillary tube, which leads to the filter, which leads to the condenser. This condenser was then linked to the outlet of the compressor, with the evaporative coil linked to the compressor's inlet. A water tube is linked to the water supply in the opposite direction from the evaporator coil's flow of refrigerant. Next, use N2 gas and soap water to test for leaks at all of the connections and joints. Removing air and moisture from the system with a vacuum generator. Then, using the gas charging unit, fill the process with isobutene (R-6000a), bringing the total amount of refrigerant to 50 gr, and sealing the system with the valve. Last but not least, you need to double-check your power sources and all of the system's valves and connections. The project should be executed to get the values.

6. RESULTS AND DISCUSSION

In a standard water cooler using R600a as a refrigerant, it takes 20 minutes for the water's temperature to drop from 300C to 18.40C; in an instant water cooler, it only takes 10 minutes.

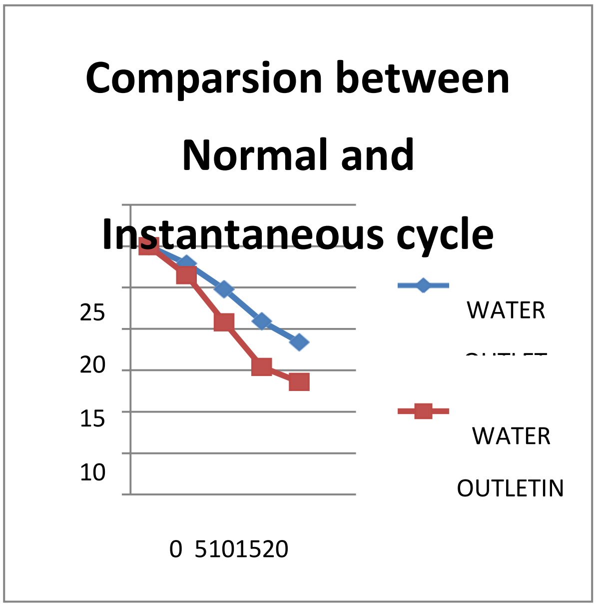

FIGURE 3. Comparison between Normal and Instantaneous Cycle

instantaneous water cooler is 10 minutes is saved. So that instantaneous water cooled is the better option to obtain the water at low temperature with in short duration.

7. CONCLUSION

The current work acts as an instant water chiller in this article. The instantaneous water cooler project draws the conclusion that water cooling in a heat exchanger or evaporator depends on, the rate at which water is being pumped into the heat exchanger. Coolant moving via a water pipe. b. Extremely hot. C. Water cooling capacity in gallons. d. Capacity, functionality, and effectiveness of the whole system. When compared to other high-capacity water coolers, the Over Instantaneous Water Cooler has superior performance in terms of both cooling capacity and energy efficiency. Water temperature at the output might be anywhere from 130 to 150 degrees Celsius.

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