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Design of Water Heater cum Water Cooler Using Refrigeration System

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ABSTRACT

The purpose of this study is to use water cooler and water heater to improve the convenience of the user so that they can use the water cooler and mobile water heater properly and comfortably. This study focuses on how refrigeration and water heaters use thermoelectric pads as a cooling and heating medium. Peltier works when the voltage is flowing from the power bank. The temperature difference on the surface of the processor allows the heat to occur at a fast rate. Arduinouno is used as a voltage regulator and temperature sensor to improve product performance. concept designs are designed, created and evaluated. The final prototype will include some markers that will be used as temperature readings by cooling and heating. Based on the results shown, the prototype can achieve the desired result with optimized energy consumption. When the temperature supplier produces a good temperature, the amount of water temperature will rise and the heat in the water will reach thermal equilibrium until the cold and hot temperatures reach a better minimum. Therefore, the temperatures in the cold and hot areas are more efficient in achieving thermal equilibrium in rising water.

I. INTRODUCTION

REFRIGERATION SYSTEM

The mechanism used for lowering or producing low temp. in a body or a space, whose temp is already below the temp. Of its surrounding, is called the refrigeration system. Here the heat is being generally pumped from low level to the higher one &is rejected at high temperature.

Refrigeration

The term refrigeration may be defined as the process of removing heat from a substance under controlled conditions. It also includes the process of reducing heat& maintaining the temp. of a body below the general temp. of its surroundings.In other words, the refrigeration means a continued extraction of heat from a body whose temp is already below the temp of its surroundings.

Refrigerator & Refrigerant

A refrigerator is a reversed heat engine or a heat pump which takes out heat from a cold body & delivers it to a hot body. The refrigerant is a heat carrying medium which during their cycle in a refrigeration system absorbs heat from a low temp. system& delivers it to a higher temp system.

Refrigeration Cycle

In refrigeration system the heat is being generally pumped from low level to higher one & rejected at that temp. This rejection of heat from low level to higher level of temp can only be performed with the help of external work according to second law of thermodynamics. The total amounts of heat being rejected to the outside body consist of two parts:

- The heat extracted from the body to be cooled.
- The heat equivalent to the mechanical work required for extracting it.

A refrigerator is a reverse heat engine run in the reverse direction by means of external aid.

Every type of refrigeration system used for producing cold must have the following four basic units:

• Low temp thermal sink to which the heat is rejected for cooling the space.

• Means of extracting the heat energy from the sink, raising its level of temp before delivering it to heat receiver.

• A receiver is a storage to which the heat is transferred from the high temp., high pressure refrigerant.

• Means of reducing the pressure & temp of the refrigerant before it returns to the sink.

The processes of the cycle are evaporation, compression, condensation & expansion.

By reversing the heat engine cycle completely & by changing the working agent, a refrigeration cycle is

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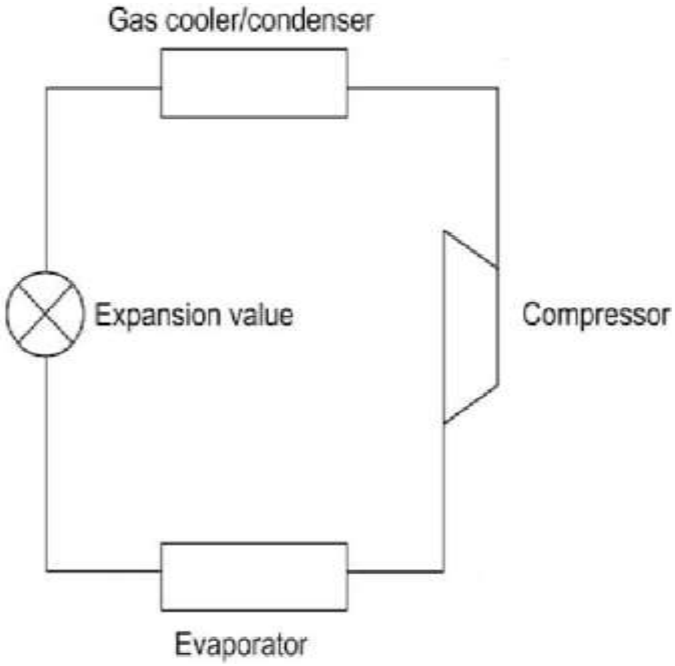
obtained.



Main parts of the HVAC system

Compressor

The compressor is used to pass refrigerant from evaporator at low pressure to condenser at high pressure. Where it increases the pressure of refrigerant to required value

(OR)

This component is the heart of the system. Pumps refrigerant and oil throughout system. Separates the high-pressure side of the system from the low-pressure side if compressor fails no cooling is possible.

TYPESOFCOMPRESSORS

The most common compressors used in chillers are reciprocating, rotary screw, centrifugal, and scroll compressors. Each application prefers one or another due to size, noise, and efficiency and pressure issues. Compressors are often described as being either open, hermetic, or semi hermetic, to describe how the compressor and/or motor is situated in relation to the refrigerant being compressed. Variations of motor/compress or type scan lead to the following configurations

- Hermetic motor, hermetic compressor
- Hermetic motor, semi-hermetic compressor
- Open motor(belt driven or close coupled),hermetic compressor
- Open motor(belt driven or close coupled),semi-hermetic compressor

Piston screw scroll centrifugal

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a.Condenser

It is used to reject the heat to atmosphere from refrigerant by changing the phase of refrigerant from liquid to evaporator

(Or)

Condenser coil is what gets rid of the heat in the system Can be water or air cooled, however most are air cooled in retail application Located outdoors (air cooled) Fins on coil are subject to corrosion in salt water environment. Special coatings can be applied. Fins are subject to damage from hail Traps dirt and require periodic cleanings.

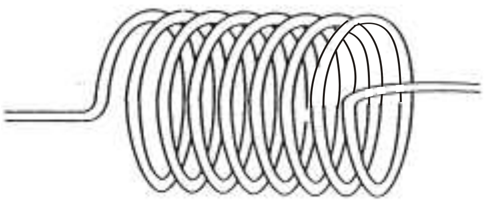
Water cooled condenser

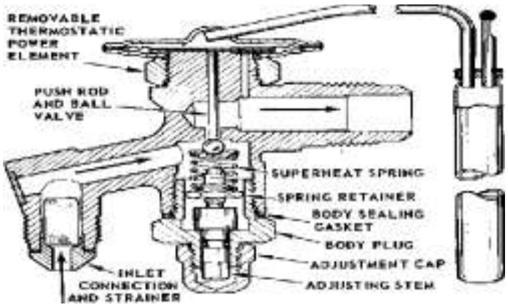
b.Expansion valve

Expansion valve is used to reduce the pressure of refrigerant.

(OR)

Located at the evaporator coil Provides the correct amount of refrigerant to the evaporator coil for proper cooling Separates the high-pressure side of the system from the low-pressure side Failure could cause compressor failure and loss of system cooling capacity Frequently overlooked in diagnosing system problems Requires manual setting of superheat for proper operation.





Capillary Expansion valve   Thermostatic Expansion valve

c.Evaporator

It is used to change the phase of refrigerant from liquid to vapour and produces cooling effect.

(OR)

Provides cold air to the space located after the system air filters return air is blown over the coil and chilled removes moisture from air (condensate) Traps dirt that gets past air filters, reducing cooling capacity (95% is bacterial) requires periodic chemical cleaning.

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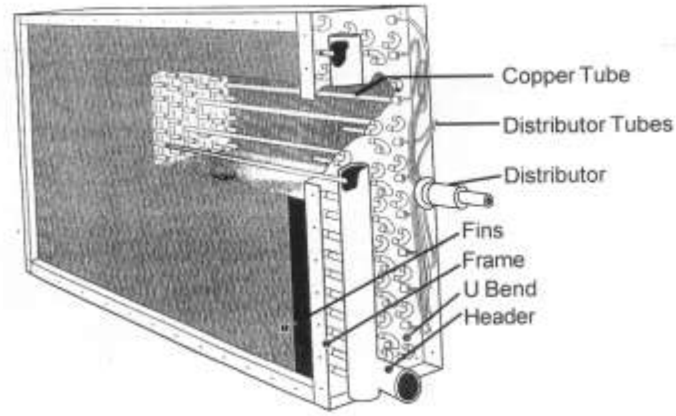


Evaporator coil

Supporting parts of HVAC

a. Drier

It is used for removing of the moister and dust contents of refrigerant.

OR

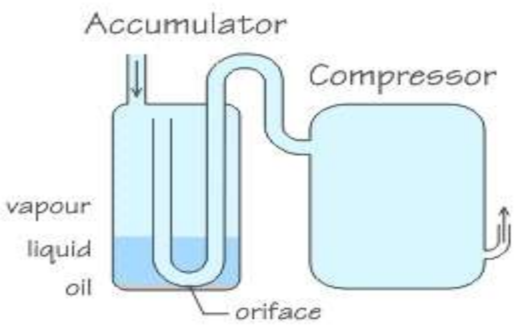
Receiver/driers contain a material called desiccant. The desiccant is used to absorb moisture (water) that may have gotten inside the A/C system during manufacture, assembly or service. Moisture can get into the A/C components from humidity in the air. This is the "drier" function of the receiver/ drier.

b. Accumulator

It is used for the separation of the vapor and liquid

OR

The AC accumulator is a holding vessel that receives refrigerant after it leaves the evaporator. Its primary function is to convert any remaining liquid refrigerant into its gaseous state before it enters the compressor. It also contains a desiccant, a moisture absorbing element to help "dry out" the refrigerant.



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c. Solenoid valve

It is used for reducing the refrigerants over flow a solenoid valve is an electro mechanical valve frequently used to control the flow of liquid or gas. Solenoid valves are found in many applications and are commonly used in refrigeration and air conditioning systems. Their function is simply to turn refrigerant flow on and off.

Applications of refrigeration in 7 different categories

1. District Cooling
2. Electricity Production
3. Chemical and Petrochemicals
4. Pharmaceutical
5. Food & Beverages
6. Data Centres
7. Other industries

Production and current applications

Worldwide production of R-22 in 2008 was about 800 Gg per year; up from about 450 Gg per year in 1998, with most production in developing countries.R-22 use is being phased out in developing countries, where it is largely used for air conditioning applications. Air conditioning sales are growing 20% annually in India and China.

R-22 is prepared from chloroform:

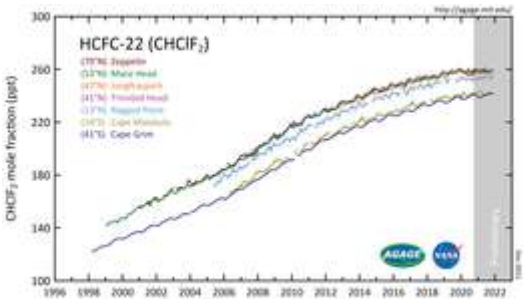
$HCCl_3 + 2\ HF \rightarrow HCF_2Cl + 2\ HCl$

An important application of R-22 is as a precursor to tetrafluoroethylene. This conversion involves pyrolysis to give difluorocarbene, which dimerizes:

$2\ CHClF_2 \rightarrow C_2F_4 + 2\ HCl$

The compound also yields difluorocarbene upon treatment with strong base and is used in the laboratory as a source of this reactive intermediate. The pyrolysis of R-22 in the presence of chlorofluoromethane gives hexafluoro benzene.

Environmental Effect



HCFC-22 measured by the Advanced Global Atmospheric Gases Experiment (AGAGE) in the lower atmosphere (troposphere) at stations around the world. Abundances are given as pollution free monthly mean mole fractions in parts-per-trillion.

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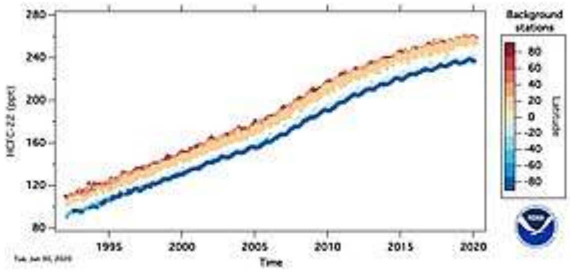
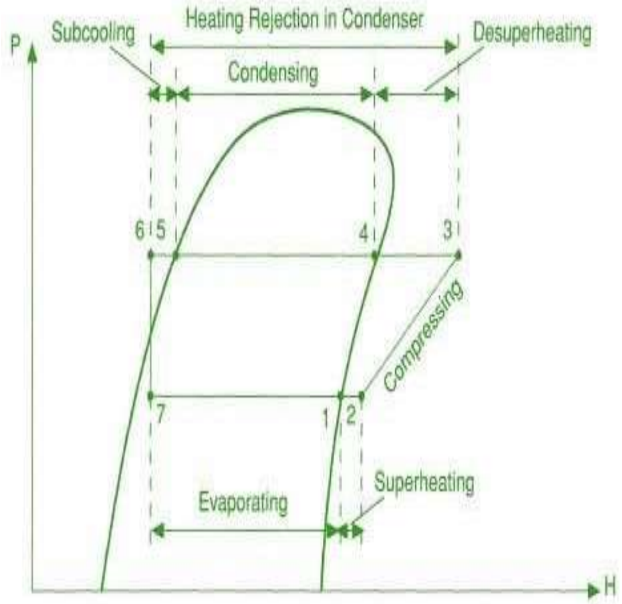


DESIGN OF WATER HEATER CUM WATER COOLER
SUBCOOLING AND SUPERHEATING
SUBCOOLING OF REFRIGERATION



Refrigeration is the extraction of beat, or the transmission of heat by mechanical methods, from onelocation to another. Sub cooling in refrigeration implies cooling the refrigerant in liquid state atuniformpressure, to a temperature that is less than the saturation temperature, which corresponds tocondenserpressure.

SUPERHEATING OF REFRIGERATION

After liquid refrigerantenters an evaporator, it is normally entirely vaporized before it arrivestheoutlet of evaporator. The liquid is vaporized at low temperature, while the vapour is ald after the liquidhas been totally evaporated. As the cold vapour flows though the evaporator, it continues to absorbheat, and becomes superheated. As the vapour becomes superheated, it absorbs sensible heat in theevaporator. Thus, the effect of refrigeration for y pound of refrigerant is enhanced Refrigerant absorbsnot only the heat required to per it, but also an extra quantity of sensible heat, due to which it is superheated.

EFFECT OF SUPERHEATING

Superheating is the sensible heating of refrigerant vapour at invariable pressure in the evaporator to atemperature more than the temperature of saturation corresponding to theevaporatorpressure. Thoughtheeffectofrefrigerationisincreasedbysuperheating,thedensityofvapourwhichquitstheevaporator andenters the compressor is reducedConsequently, the quantity of vapour whichentersthecompressorisdecreasedbysuperheatingThusweseethatthecapacityofthesystemofrefrigerationincreaseswithsuperheatingofthevapour,andsimultaneouslytherefrigerationcapacityis decreased with the decrease in density during superheating The result of these two opposite trendsmust be served to establish whether or not the refrigerating capacity of a system is increased bysuperheating. However, superheating ensures total evaporation of the liquid

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refrigerant before gees inthecompressor.

SYSTEM DESCRIPTION AND MODELLING

The Experimental test rig is fabricated by incorporating the novel use of heat Exchanger betweencompressor and condenser without using conventional cycle are dedicated system The Experimentalsystem equipped with a domestic refrigeration system with components of compressor, condenser,Expansion Value (Capillary tube), Evaporator and Heat Exchanger (Tube-in-tube) as shown in figure 1,is designed to operate with R-134a refrigerant as working fluid The test rig is used to evaluatethecoefficientofperformanceandRefrigerationEffect;powerconsumedtorunsystemandcompared withtheconventional VCR system, and effectiveness of heat exchanges is evaluated.
The following parameters were calculated

1. Effectiveness of heat exchanger.
2. Degree of sub cooling to condenser and superheating to compressor.
3. Co-efficient of performance of system

The experimental vapour compression refrigeration system with integrated sub cooling means operating the heat exchanger with co-current flow in between compressor and condenser and the heat exchange takes place between outlets of compressor and evaporator. The schematic of experimental VCR cycle as shown in below figures.

Schematicdiagramof ConventionalVCRwithheatexchanger.

Components

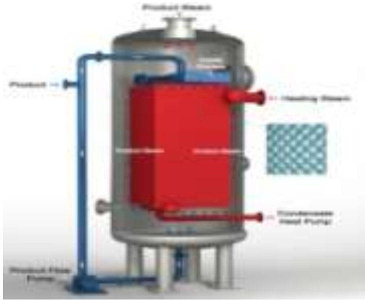
All components of VCR system such as compressor, condenser, and capillary tube, evaporator,thermocouplesand pressuregaugesareshown below

Compressor
Compressorusedishermiticallysealedcompressorcanproduce280PSIPRESSUREANDROATESAT 2850RPMandthiscompressor capacityis1/8TRCapacitywithrating-230v,50Hz andsinglephase

Condenser
In this wcr system air cooled condenser is used. Then the refrigerant will be sent into the condenser bythe copper tubes. A fan is placed behind the condenser for the forced het convection to cool therefrigerant.

capillarytube

After the condenser, refrigerant will sent into the expansion valve (capillary tube). Here capillary tubeinnerand outerdiametersare0.5mm, 1.5 mm.



Evaporator

Evaporatorisnothingbutthepartwhichcanproducerefrigeranteffect.Totalvolumeofevaporatorspaceis 10liters

DESIGN&PERFORMANCEOFHEATEXCHANGER

Heat Exchanges are devices which are used for the process of beat exchanging between two these are atdifferent temperature levels These are installed at different applications different capacity like powerplants food processing units refrigeration and air conditioning,chemical industries and space,aeronautical applications. In heat exchanges two Ah are flowing in shell side and tube side (which arehot and cold fluids). When the two as are flows in same direction is called as co-current flow Heatexchanges,similarly thew offluids in oppositedirection iscalled counterflowheat exchanger.

In these experiment tube-in-tube heat exchangers is employed with counter flow between compressor andcondenser. The heat exchange process takes place between outlet of presser and outlet of evaporator asshown in above figure because the temperature difference between these two fluids are high so the heatexchangesprocess occurred

High temperature refrigerant (or) super heated vapour refrigerant flowing through tube side and lowtemperature liquid refrigerant flowing through shell side. The temperature differences between thesefluids were measured by using T-type thermocouples. The heat transfer rate (Q), over all heat transfer co-efficient(U)andtheeffectivenessofheatexchangerwhichmeasuredastheratioofactualheattransfertothemaximum possibleheattransfer between fluids werecomputed.

Performance Parameters of Refrigerant Compressors

Performance of an air-conditioning system depends on the design of various components, such as evaporator and compressor. 80 to 85% of the efficiency of an air-conditioning system depends on the compressor. You can obtain the remaining efficiency by enhancing the system capacity. You can enhance the system capacity by efficiently designing and selecting the other system components, such as condenser, blower, evaporator, and expansion valve.

This article describes various types of compressors, such as rotary, screw, and scroll. It describes their construction and performance curves, and explains how different compressors work. In addition, the article describes how the operating and system design parameters of the refrigerating compressors enhance their performance. It also explains how you can enhance the performance of an air-conditioning system by increasing the refrigerating capacity and decreasing the power requirement of the system.

Psychrometry

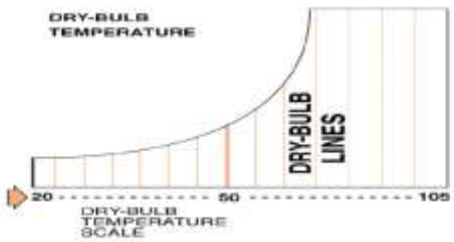
Psychrometry is the science dealing with the physical laws of air – water mixtures. To obtain comfort, and select an appropriate HVAC system, the psychometric conditions must be known.

Properties of Air on a Psychometric Chart

- Dry-bulb temperature
- Wet-bulb temperature
- Dew-point temperature
- Relative humidity
- Humidity ratio
- Sensible heat
- Latent heat
- Enthalpy

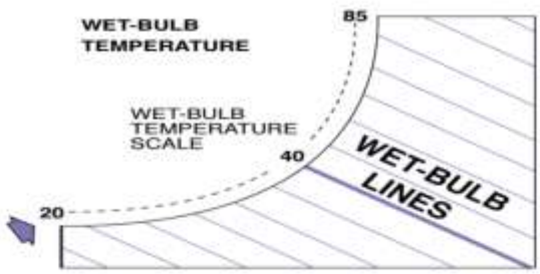
Dry bulb temperature

- The temperature measured by the thermometer.
- In psychrometric chart the dry bulb temperature is indicated by vertical lines.
- If we move from left to right it indicates heating.



Wet bulb temperature

The temperature measured by the wet wick. In psychrometric chart it is indicated by the inclined lines. From bottom to top it is heating.



Dew point temperature

The temperature which moisture starts to condense out of the air. Dew point is also known as saturation temperature. Dew point temperature is determined by moving from a state point horizontally to the left along lines of constant humidity ratio until the upper, curved, saturation temperature boundary is reached

II. RESULTSANDDISCUSSIONS

CALCULATIONSOFCOPOFCONVENTIONAL WCR

P-HdiagramofR-134aisused tocalculatecopof WCR systemwhichis showninbelow.

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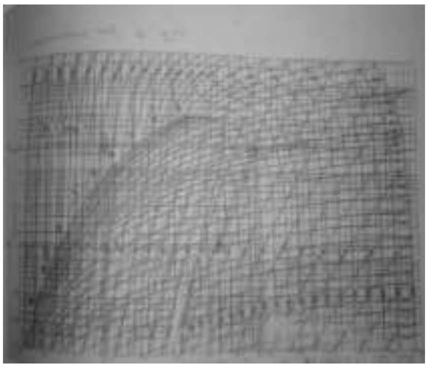
a.COPat 15minutes
P-H diagram of R-134 at 15 minutesFromthe P-h chart ofR-134arefrigerant

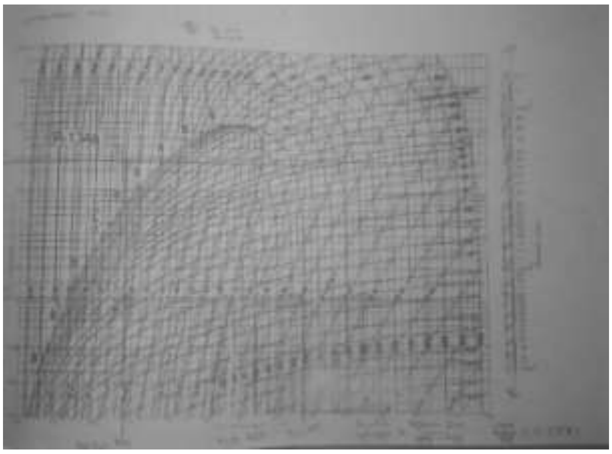


h1=419Kj/kg
h2 =485 Kj/kg
h3=h4=hfʒ=245Kj/kg
Workdoneby the compressor (W.D)=h2-h1 =485-419

(W.D)= 66Kj/kg
Refrigerationeffect (R.E) =h1-h4=419-245
(R.E) =174Kj/kg
Coefficientofperformance (COP) =R.E/W.D=174/66

(COP)=2.63

b.COPafter30minutes



III. CONCLUSION

By using a water cooler and heater you can save 80% of the energy consumed. Besides, this experiment can be used in cooling rooms, offices and halls and also cools water becomes a universally accepted option in India too.

Depending on specific situations, this run parallel to, compete with or even replace air conditioning system. When that happens the cost of water cooling and air conditioning devices will come down dramatically.

Through the temperature tested, we can find that, the cooling temperature would increase slowly after reaching a minimum of 24ºC, while the heating temperature would increase slowly after reaching a minimum of 31.5ºC. Therefore, the recommendation to maintain a lower temperature in the cold / hot areas is to use a more efficient peltier on both containers. This is because when the peltier is more efficient, the cold and hot temperatures will reach a higher level of capability. When the temperature supplier produces a good temperature, the amount of water temperature will increase and the heat in the water will reach the thermal equilibrium resulting in the cold / hot temperatures reaching a better minimum. Therefore, the temperature in the cold / hot section will be more efficient in achieving thermal equilibrium in rising water. For the second proposal, heat sinks are also a factor in changing the temperature because as the heat sink size increases, heat will have more space to flow in the heat sink. This causes both temperatures to flow into the container more effectively.

IV. FUTURE SCOPE

Electric water heaters are essentially pre-installed thermal batteries that are sitting idle in more than 50 million homes across the U.S.," says a new report on the subject by the electricity consulting firm the Brattle Group, which was composed for the National Rural Electric Cooperative Association, the Natural Resources Defense Council, and the Peak Load Management Alliance.

The report finds that net savings to the electricity system as a whole could be $ 200 per year per heater – some of which may be passed on to its owner – from enabling these tanks to interact with the grid and engage in a number of unusual but hardly unprecedented feats. One example would be "thermal storage," which involves heating water at night when electricity costs less, and thus decreasing demand on the grid during peak hours of the day."

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