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EXPERIMENTAL STUDY OF HEXAGONAL REFLECTOR USING FLAT PLATE SOLAR COLLECTOR

Rakesh Kumar[1], Dr. Shailendra Dwivedi[2]

1- Research Scholar, Department of Mechanical Engineering, LNCT Bhopal, email- rk.roushan21@gmail.com

2- Professor, Department of Mechanical Engineering, LNCT Bhopal, email- shailendrad@lnct.ac.in

ABSTRACT

The thought process of this paper is related to design and fabrication of the Hexagonal reflector solar collector. The collector concentrates the sun powered vitality and changes over into the concentrated radiation without utilizing the concave or convex mirrors for warming or heat exchange into the water. The Hexagonal type solar reflector concentrates together coordinate radiation of the sun toward the collector. For maximizing the concentrated of radiation from reflector, which can be balanced by changing its point significant position of sun. The radiation comes from sun's vitality was changed into heat and after that heat was exchanged to the water. A design is proposed and carried out the tests. As well recognize the behavior of warming through model against of diverse position of sun and combination of angle. The perception has moreover considered that the model temperature changes and taken into the portion of heat exchange.

KEY WORDS: Solar energy, solar water heating system, flat plate collector, Hexagonal reflector

INTRODUCTION

Energy is the quantitative property that must be transferred to a body or physical system to perform work on the body, or to heat it. Energy is a conserved quantity; the law of conservation of energy states that energy can be converted in form, but not created or destroyed. Common types of energy include the kinetic energy of a moving object, the potential energy stored by an object's position in a force field (gravitational, electric or magnetic), the elastic energy stored by stretching solid objects, the chemical energy released when a fuel burns, the radiant energy carried by light, and the thermal energy due to an object's temperature. Mass and energy are closely related. Mass and vigor are closely related. Due to mass–vigour equivalence, any object that has mass when stationary (called rest mass) also has an equivalent amount of vigor whose form is called rest vigor, and any additional energy (of any form) acquired by the object above that rest vigor will increase the object's total mass just as it increases its total energy. Living life forms require energy to remain alive, for example, the vigor people get from sustenance human individuals expects vigour to reason, which its gets from vigor assets, for example, petroleum products nuclear fuel, or sustainable power source. The procedures of earth's climate and bionetwork are driven by the brilliant vigour earth gets

from the solar and the geothermal vitality confined inside the earth. Living organisms require energy to stay alive, such as the vitality humans get from food and oxygen. Human civilization requires energy to function, which it gets from energy resources such as fossil fuels, nuclear fuel, or renewable energy. The total vitality of a system can be subdivided and classified into potential energy, kinetic energy, or combinations of the two in various ways. Kinetic energy is determined by the movement of an object – or the composite motion of the components of an object – and potential energy reflects the potential of an object to have motion, and generally is a function of the position of an object within a field or may be stored in the field itself. Active energy is undaunted by the development of an item – or the composite movement of the instrument of an article – and potential energy mirrors the capability of an item to have movement, and by and large is a component of the situation of an article inside a field or might be put away in the field itself. For instance, naturally visible mechanical energy is the total of translational and rotating active and potential energy in a structure disregards the motor energy because of temperature, and atomic energy which combines use possibilities from the atomic power and the fragile power), in others. When machinating dynamic energy (work to quicken an enormous body from zero speed to various limited speed) relativistic ally – utilizing Lorentz changes rather than Newtonian mechanics – Einstein uncovered an abrupt side-effect of these estimations to be a vitality term which does not disappear at zero speed. He called it rest energy. Energy which all gigantic body must obtain notwithstanding when being very still. The measure of energy is in a straight line near to the mass of the body: For instance, judge electron–positron absolute decimation, in which the rest energy of these two character particles (proportional to their rest mass) is changed over to the shining vitality of the photons framed simultaneously. In this framework the issue and antimatter (electrons and positrons) are crushed and changed to non- matter (the photons). However, the all out mass and complete energy don't change for the term of this collaboration. The photons each have no rest mass however by and by has sound energy which displays a similar dormancy as did the two unique particles. This is a reversible procedure– the contrary procedure is called pair development – in which the rest mass of particles is framed from the brilliant vitality of (at least two) destroying photons. In general relativity, the pressure energy tensor fills in as the beginning spot term for the gravitational field, in unpleasant likeness to the manner in which mass fills in as the asset term in the non-relativistic Newtonian guess. Energy and mass are signs of one and the comparative basic physical property of a framework.

Solar Energy-

Sun based is the preparatory put of all vitality on the planet soil. It may be a huge atomic reactor where hydrogen gas is ceaselessly burning at tall temperature and weight. Sun oriented vitality come into being as of the thermonuclear combination responses taking put in sun powered. The vitality produced by sun based into the space is built up on the soil as electromagnetic brilliant vitality. Out of the sun oriented radiation reaching the soil, 90% comprise of radiations within the run 320 nm to 1400 nm, 46% of this radiation is within the able to be seen locale, 400 nm to 700 nm. The soil assimilates radiation basically within the obvious locale and emanates radiation within the infra ruddy locale (3 p to 40 p with greatest at

10p).

Applications of Solar Energy

The best application of solar energy is in heating buildings and providing hot water which in developed countries like USA consumes about 26% of the fuel supply. Figure 3 illustrates the detailed heating system in a solar heated house. Solar light is collected on plates on the roof and heat transferred to a circulating water system. It has been calculated, this in US, an average house with a collection area of 1300 ft2 can get its energy supply for heating and hot water in December by this method.

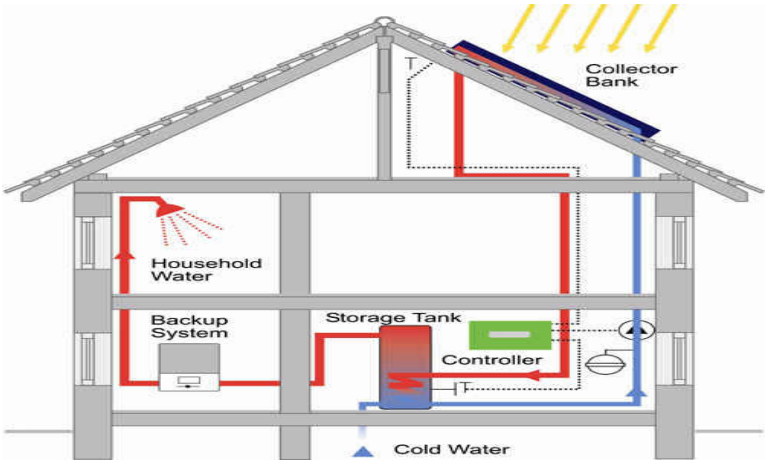


Fig1: Heating system in solar heated system (Reference: 10)

The utilization of solar powered vitality is a totally benevolent activity. Solar-light based vitality can be utilized as solar oriented warmth by a few contraptions, for example, solar based cooker, solar based dryer, solar powered water radiator, solar based refining, space melding, green house innovation, and solar based air craft's. Solar powered vitality can likewise be utilized as solar-light based power by PVC or solar based cells. Solar powered photovoltaic cells can be introduced in remote territories in backwoods and deserts where setting up of electric links is cost-restrictive.

1. Solar oriented vitality being non-dirtying and non-tasty is estimated as sustainable power source and fits into the guideline of maintainability.

2. Solar-light based cells are broadly utilized in electronic watches, adding machines, traffic sign and fake satellites. Due to their non polluting characteristic world, solar oriented cells are known as spotless and green cells. Solar Water Heating Component

a. Collector b. Flat Plate c. Evacuated Tube

LITERATURE REVIEW

A comprehensive review on solar water heater, solar water heating system proves to be an efficient technology for converting solar energy into thermal energy. The proficiency of sun oriented warm transformation is around 55%when contrasted with sun

based electrical direct change framework which has an effectiveness of scarcely 15%. **Loucas Georgiou .et.al. (2021)** This dataset presents the warm execution of building coordinates level sun oriented collectors with a uniform and multiple riser structure . The input information of the numerical show were gotten with the utilize of the PVGIS device. Sun based radiation and encompassing temperature values at slants °, 45 °, and 90 °were extricated and utilized as boundary conditions. Numerical calculations were carried utilizing Limited Component (FE) examination. Three-dimensional temporal models were created to calculate the explored configurations' warm execution based on the natural temperature , the sun based radiation, and the slant point. The numerical show was approved with the utilize of an exploratory information set appearing a great assertion between the two models with RMSE of 5%. Information of hourly warm flux through the building brick work with the building-integrated sun powered collector and the normal liquid temperature of each framework is displayed. **Mohamed R.Gomma.et.al. (2020)** Against the background of he ever developing logical and open Intrigued in finding elective sources of clean vitality, adapted toward the overarching objective of relieving the hurtful suggestions of greenhouse impacts on the environment, this paper proposes one such elective . In capturing the environmental benefits to be picked up from squander warm recuperated amid a cement mechanical prepare , this paper illustrates how an Natural Rankine Cycle (ORC) can be a reasonable source of control production. This owes to its capacity to use both medium and high – grade temperature warm sources. In the process of plan and experimentation, this consider received a crossover arrangement utilizing squander warm recovery (WHR) that was combined with a sun oriented field, to convert control within the ORC through a warm oil loop and create power. The WHR was taken from vent gasses of a rotating furnace found in cement industrial forms but that too has the advantage of working over a extend of temperatures. These ranged from 250 ◦C to 380 ◦C. The sun powered space consolidated a Parabolic-Trough 250 ◦C to 380 ◦C. The sun powered space consolidated a Parabolic-Trough Sun based Collector (PTSC), with the working liquid R245fa. The execution of each component was at that point analyzed and optimized. The concluding comes about of this think about confirmations that ORC can eventually be of noteworthy advantage to industry both financially and ecologically , by creating up to 323 to 360 kW of power that is required to control a cement plant, whereas giving for a payback time period inside the run of 3.75 a long time and a net sparing of 280,000 $/year.**Kaminski.et.al. (2019)** The article presents comes about of the test examination of the flat - plate sun based collector with polyisocyanurate (PIR) foam thermal cover. The comes about of EN/ISO 9806:2017 warm effectiveness test, amid which the sun oriented collectors with shake fleece and PIR froth were utilized , are displayed . Also, the lodging temperature conveyance , at the same working conditions , were measured with infrared camera and compared for shack wood and PIR froth sun oriented collectors. **Walaa Mousa Hashim.et.al. (2018)** author describes the performance of solar water heating for flat plate collector. The system is designed in such a way that the fluid can flow from inlet to outlet through pipe which has length of 15.9m , designed as a pattern of lope square. The results of this experiment shows that the heating of water at flow rate of 5.3 L/min is More than the flow rate of water at6.51L/min which causes higher efficiency and effectiveness of the collector . So, the maximum temperature obtained was 51.4◦C at 5.3 L/min and 49◦C at 6.51 L/min respectively. The main conclusion of this experiment is that by using this system for heating the water and then it can be used in house, building and other purposes. **V Ramachandra Raju .et.al. (2018)** this research paper introduces the effect of active solar still for Indian coastal climatic condition. This experiment has been conducted for 24

hours during the summer months for active solar distillation system. An effective collector inclination of 5◦ angle is used. This experiments were conducted at Kakinada, A.P , India which has coastal climatic conditions. The main aim of this research is to demonstrates the effect of flat plate collector connected in series on the yield and distillation efficiency of an active solar still for selected location. This results shows that the solar still, with two flat plate collectors which is connected in series, provides 41% more distillate yield as compared to still with single FPC and has efficiency is 0.47% more with two flat plate collectors connected in series . By using their FPCs which is connected in series produced 89% more distillate yield as compared to still having single FPC. Though, the still efficiency is 0.48% less with three collectors in series due to increase in area for radiation.

RESEARCH METHODOLOGY

The experiments were conducted at LNCT COLLEGE OF ENGINEERING AND TECHNOLOGY, Bhopal (Madhya Pradesh) India on the month of October and November 2021. The gatherer was looked toward the sun and changed its circumstances with time or the circumstance of sun. Be that because it may, the framework was attempting in some times within the day and the gatherer was changed its circumstance with the situations of the sun in multi day. The test was coordinated to think approximately the introduction of the sun based warm gatherer with the reflector.

A sun arranged imperativeness specialist is utilized to assemble coordinate brilliant essentialness having parallel ways and diffused brilliant essentialness from sun. The foremost extraordinary groupings of sun fueled imperativeness gatherers assemble diffuse and coordinate sun based radiation. A reflector concentrates coordinate radiation onto a to begin with or versatile gatherer and mirrors a noteworthy bit of the diffused radiation onto the Flat plate specialist position near to a focal point of reflector. The Flat plate gathered was situated so that it gets both the immediate radiation during the day time.

Practical Experiment and Design strategy:

To total a test examination, the Flat plate sun based warm gatherer utilizing Hexagonal sort reflector as showed up in fig.2. The Flat plate daylight based warm specialist was comprised of iron plate .Here, the casing is utilized which include of Hexagonal reflector having Five bit of mercury or mercury glass that were Mounted all around the edge as showed up in fig2.6.The reflector was mounted in such a way, that it can alter its circumstance with the circumstance of the sun. In Truth ,the earth moves one change approximately its center in each 24h, gives a insurgency of around 15 degree in 1 hour that suggests the sun based bar goes wrong around 2.5 degree in 10min. Here, three glasses are of rectangular shape and two glasses are of triangular shape. One rectangular shape glass whose dimension is 66cm x 45cm is mounted on the middle of the edge. Another two rectangular shape glasses and two triangular kind of glasses are mounted in an edge which seen as a Hexagonal kind reflector as showed up in fig.2.5.Here, the two rectangular shape glasses of dimensions 71cm x 29cm are as shown in fig.2.4 . and two equilateral triangular shape glasses of dimensions 43 cm is shown in figure 2.5. The defend plate of the gatherer was set at a stature of 74cm with the help of stand .The frame has a structure which has height of 74cm , width of 50.5cm and length of 71.5cm as shown in figure 4.

Fig:-2. Image of Temperature measurements with the Digital thermocouple

Fig:-3. Image of maximum temperature shown by thermocouple

Fig:-4 -Image of Dimensions of Flat Plate Solar Collector

Fig:–5 -Image of working of all five reflector mirrors

The defend plate of the specialist was painted dull. Within the examination whereas taking five reflected mirror utilized, these reflected mirror are set physically with changing the position of the sun. Here within the day time , the time between 10 am to 12 pm the four reflected glass is working out of which triangular plate1 is set at an angle of 15°, rectangular plate4 is set at an angle of 60°,triangular plate3 is set at an angle of 68° and rectangular plate5 is set at an angle of 51°. At that time, container is placed near to plate1.Here the ambient temperature varies between 22 to 27°C. Therefore water temp. Obtained by focusing the reflected mirror varies between 21.1to 41.8°C. Whereas the time between 12 pm to2 pm there's moreover four glass working whose focuses are ; two rectangular reflector glasses set at an angle of 50 °and one triangular reflector

glass set at an angle of 68° as shown in fig.5**.** Here the container is placed at centre and maximum temp. of water obtained is51.4°C at 2pm as shown in fig. 3 when ambient temp is 31°C. Another while the time between 2 pm to 4 pm there are five reflected glass which was working and seen as a Hexagonal sort reflector as appeared in figure 2. The point of these reflected glasses which was set physically by taking after the sun position are; two rectangular reflected glass is set at an angle of 50° and 47 °and two triangular reflected glass is set at an angle of 15and 64 degree as shown in fig.3 .Here, the container is placed near to plate5 and the temp of water obtained varies from 49.8 to 43.3°Cwhen ambient temp. is 29°C, whereas working these Hexagonal sort reflector , comes about illustrated that at this point most extraordinary considered light can drop the specialist that prompts growing the trade of warmth to the water that are accessible within the specialist. In Truth, the propensity point impact immovably on the warmth move pace of level plate sun powered authority. It also taken note that in winter the propensity edge of the reflector was kept up at 50° degree with respect to the horizontal axis. The reflectivity of mirror glass was taken as 90% and anticipates that the event radiation on the specialist surface was around 50 to 55 %.

RESULT AND DISCUSSION

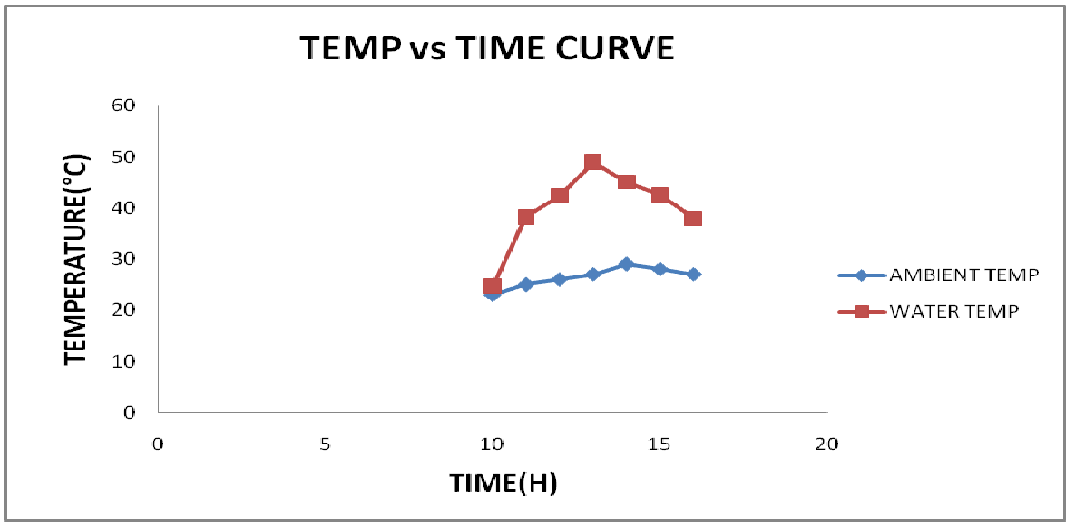
The system was attempted in commonly within the day and position of a gatherer was altering with position of the sun in multi day. As the sun situated pillars reliably strikes it inverse, the sun fueled radiation mishaps or impression of imperativeness from a gatherer surface will be extend. The gatherer was painted with dark shading for which radiation transmitted by protect plate of the specialist can't get absent. Along these lines, extending its temperature. The Hexagonal kind reflector at that point once more made of a planar mirror/sun oriented mirror utilized here to achieve the centered sun based warmth on to the specialist surface. Each one of these gets most astonishing daylight based water warming on the gatherer surface. This heat was consumed by water which show within the gatherer. The foremost extraordinary water temperature was recorded at around 1 pm as appear in graph 1-. Illustrates the hourly temperature assortment in multi day of 26 October 2021. The figure illustrates the assortment of gatherer water. In graph 1- demonstrates the hourly temperature variation with time in multi day of 26th October 2021. Here just four reflecting mirror glass is working within 10am to 12 pm and each one of the five hexagonal reflector mirrors is working within the centre of 1pm to 4 pm which is utilized to reflect the sun radiation and

concentrate to the specialist. At the time of morning 10 am the ambient temperature is 23°C and water temperature is 24.7°C with working of four reflector glass mirrors in which two of the triangular plate was set at an angle of 35° and75° and two of the rectangular mirror was set at an angle of 45° and 48°. The foremost extraordinary temperature of water within the specialist at 1 pm is 49°C with working of five reflection of hexagonal reflector when the container is placed in between plate1 and plate5 where the ambient temperature obtained is 27° C.

Table 1- Data's of 26th October 2021

SN.	TIME (H)	AMBIENT TEMP(°C)	T1 (°C)	T2 (°C)	T3 (°C)	T4 (°C)	T5 (°C)	WATER TEMP(°C)
1	10	23	30.3	27.6	28.9	28.8	26.8	24.7
2	11	25	38.6	31.8	38.3	37.5	36.6	38.3
3	12	26	38.9	31.4	37.9	37.1	36.5	42.5
4	13	27	39.4	32.9	35.8	35.0	34.4	49.0

5	14	29	41.9	33.2	37.4	35.8	37.1	45.1
6	15	28	37.3	32.6	35.6	34.0	35.1	42.6
7	16	27	34.1	28.9	30.7	30.7	31.4	38.0



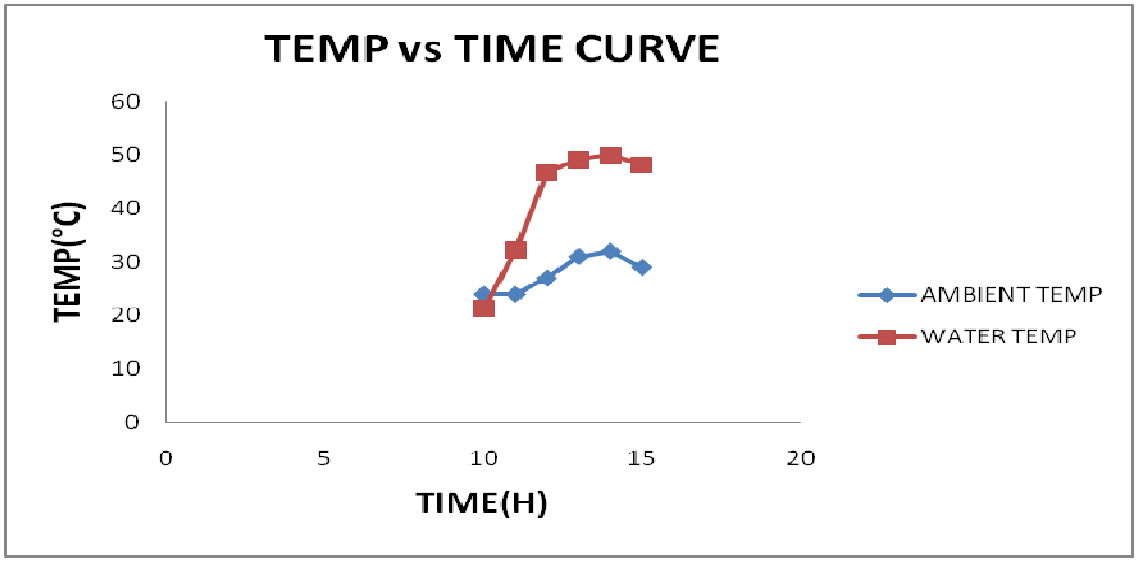
Graph1- The variation of Water and Ambient temperature with time on 26 th October 2021.

In graph 2- demonstrates the hourly temperature variation with time in multi day of 06th November 2021. Here just four reflecting mirror glass is working within 10am to2 pm and each one of the five hexagonal reflector mirrors is working within the centre of 1pm to 4 pm which is utilized to reflect the sun radiation and concentrate to the specialist. At the time of morning 10 am the ambient temperature is 24°C and water temperature is 21.3°C with working of four reflector glass mirrors in which two of the triangular plate was set at an angle of 15° and 70° and two of the rectangular mirror was set at an angle of 50° and 51°. The foremost extraordinary temperature of water within the specialist at 2 pm is 50.0°C with working of five reflection of hexagonal reflector when the container is placed in between plate1 and plate5 where the ambient temperature obtained is 32° C. The temperature of base plate 2 is 37.3°C and the temp. of both of the triangular plate1 and plate2 is 39.5°C and 38.3°C .Another , the temperature of both of rectangular plate4 and plate5 is 36.6°C and 37.5°C . The direction of sun is 228° South-West. The height of stand is 101cm and length of stand which is used for holding the container is 62cm.

Table 2- Data's of 06th November 2021

S NO.	TIME (H)	AMBIENT TEMP(°C)	T1 (°C)	T2 (°C)	T3 (°C)	T4 (°C)	T5 (°C)	WATER TEMP(°C)
1	10	24	31.5	29.3	36.6	36.7	35.8	21.3
2	11	24	36.8	34.3	38.3	37.9	39.5	32.2
3	12	27	35.8	36.6	39.0	37.9	38.5	46.8

4	13	31	39.8	36.6	38.9	37.8	39.4	49.1
5	14	32	39.5	37.3	38.3	36.6	37.5	50.0
6	15	29	39.8	33.3	35.3	34.1	35.8	48.2



Graph 2- The variation of Water and Ambient temperature with time on 06th November 2021

CONCLUSION

A model of a Flat plate collector with Hexagonal sort reflector was developed and tried has been conducted at LNCT Campus between 26th October to 6th November 2021. Here the Hexagonal sort reflector has been utilized for conducting the all tests. It is observed here that the ambient temperature is 25 ℃ to 30℃ at that point the demonstrate temperature has been gotten between 43.3 ℃ to 51.4 ℃. It is gotten within the month of October 2021. The heat exchange rate and a collector productivity is unequivocally depends on sun oriented radiation. In Reality, the radiation radiated by the safeguard plate of the collector cannot elude through a glass and the reflectors, on the other hand utilized to concentrate sun based warm on a collector surface. Although it is observed that in typical day's and at morning hours within the temperature extend 22 ℃ to 29 ℃ the show temperature has been shifted to 45 ℃ to 51 ℃ that will produce a heat water that will be utilized within the household purposes and commercial purposes moreover. That can be reducing the load on electricity also. Here, on an average there is an increment of 20℃ temperature in winter season.

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