DESIGN, FABRICATION &EXPERIMENTAL INVESTIGATION OF

THERMAL STORAGE SYSTEM USING ZEOLITE PELLETS

A Project report submitted in partial fulfillment of the requirements for the award of the degree of

BACHELOR OF TECHNOLOGY IN

MECHANICAL ENGINEERING

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2018-2022

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CERTIFICATE

This is to certify that this project report "**Design , fabrication & experimental investigation of thermal storage systems using zeolite pellets**" submitted by **N. Lokesh (319126520L36),U.Ranjith kumar (318126520203) ,Ch.Vamsi(318126520177) , P. Yogendra (319126520L39), R. Vidya sagar (316126520160)** of IV/IV MECHANICAL in partial fulfillment of the requirements for the award of the degree of Bachelor of Technology in Mechanical Engineering of Anil Neerukonda Institute of technology and sciences (A), Visakhapatnam is a record of bonafide work carried out under my guidance and supervision

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ACKNOWLEDGMENT

An endeavor over a long period can be successful with the advice and support of many well-wishers. We take this opportunity to express our gratitude and appreciation to all of them. We owe our tributes to Dr. B. NAGARAJU, Head of the Department, MECHANICAL Engineering, ANITS, for her valuable support and guidance during the period of project implementation. We wish to express our sincere thanks and gratitude to our project guides Mr. I. Pavan kumar, Assistant Professor, Department of mechanical Engineering, ANITS, for the simulating discussions, in analyzing problems associated with our project work and for guiding us throughout the project. Project meetings were highly informative. We express our warm and sincere thanks for the encouragement, untiring guidance and the confidence they had shown in us. We are immensely indebted for their valuable guidance throughout our project. We also thank all the staff members of Mechanical department for their valuable advices. We also thank supporting staff for providing resources as and when required.

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ABSTRACT

With depleting reserves of traditional fuels, there is a worldwide demand for alternative energy solutions. One of the most promising developing technologies is energy storage, as it provides the benefit of capturing available energy for use at a later time .In this analysis we are going to use zeolite pellets as thermal storage material, which has storage capacity 4 times more than water.

The zeolite pellets are exposed to halogen light source for a period of 3 hours and the radiation intensity is measured with solar power meter and the zeolite pellets are kept under supervision for 3 hours, 250grams of zeolite are kept under super vision and the amount of input is 2255KJ and after the duration we get a real time output of 50.16KJ where the efficiency is surrounded to 2.7%. The energy stored in the zeolite often increases with the increase in the zeolite added to the procedure the efficiency revolves around the weight and the radiation constraints.

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CHAPTER 1

1. INTRODUCTION

The increasing use of renewable energy sources during the last two decades has increased the importance of research and development of energy storage systems. Intermittent sources such as wind, solar or tide do not always generate energy at the same rate as the energy in cities is consumed. This switch, from energy systems governed by traditional fossil fuels to systems with high penetration of renewable energies, introduces load imbalances between supply and demand.

1.01 THERMAL STORAGE SYSTEM:

Thermal storage systems are used to store heat or cold to be used later where ever we intend to use it ,at different conditions where heat is required where natural heat is not available

Thermal energy systems are divided into 3 types

1) sensible heat

2) latent heat

3) sorption

Thermal energy storage (TES) systems are much preferred in many engineering applications, which have the ability to bridge the gap between energy supply and energy demand. Cooling or heating energy redistribution requirements can be effectively met using TES systems.

Thermal energy storage systems are a suitable storage method for large buildings. Thermal energy storage systems are generally used in small-scale applications for hot water and heating. It is also used in the field of electrical energy generation in large-scale applications.

The idea behind TES is changing the way users generate the vast amount of heating and cooling capacity that eats up so much conventional energy from the grid. The problem is that much of the grid power used for heating and cooling buildings is generated by energy from fossil fuels such as coal, oil and natural gas. This can be addressed using TES, which can provide heating and cooling solutions simply by evening out the distributed heat in a natural landscape or cycle, for example, by applying heat stored in solar collectors or by distributing cold water or air from

fig 1.1 zeolite pellets

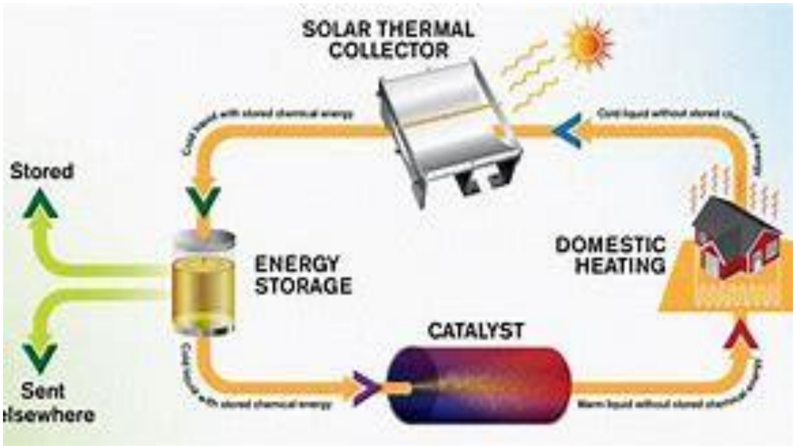

fig1.2 thermal storage system

underground to cool a building space. Scientists and engineers are hard at work on new thermal energy storage solutions to replace fossil fuel-driven HVAC systems.

1.02 THERMAL ENERGY

Thermal energy refers to the energy contained within a system that is responsible for its temperature. Heat is the flow of thermal energy.

Some examples of thermal energy:

Good thermal energy examples are the burning of wood and coal. Solar energy: Solar energy comes under the best sources of thermal energy. It is the cleanest and readily

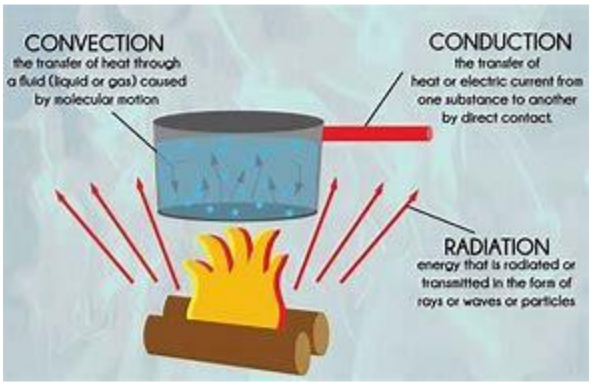

fig 1.3 different types of energy transfer

available source of energy. Mechanical energy: We can convert mechanical energy to thermal energy. An excellent thermal energy example is the energy released due to friction.

1.03 SOURCES

- Chemical energy: We can convert chemical energy to thermal energy. Some good thermal energy examples are the burning of wood and coal.
- Solar energy: Solar energy comes under the best sources of thermal energy. It is the cleanest and readily available source of energy.
- Mechanical energy: We can convert mechanical energy to thermal energy. An excellent thermal energy example is the energy released due to friction.
- Fossil fuels: Fossil fuels are burnt to produce thermal energy.
- Geothermal energy: We can convert geothermal energy to thermal energy. A good thermal energy example is the energy released due to volcanoes, hot springs, and geysers.

1.04 THERMAL ENERGY GENERATION

Everything around us is made up of molecules and atoms. These molecules and atoms are always in motion; they will either move back and forth or will bump into each other. When they are in motion, they produce heat or better known as thermal energy. Thermal energy is the heat energy that is produced when there is a rise in temperature. This rise in temperature causes the atoms and molecules in a material to vibrate at a higher frequency. It will eventually collide with each other. As a result, energy is dissipated from them, which is called thermal energy. As these atoms and molecules keep moving faster, the temperature will keep rising.

Although energy harvesting is a nascent technology that is being used as an alternative powering approach, there are concerns for medical applications, such as reliability, manufacturing, efficiency of energy generation for small devices, low-energy density, rectification, energy storage, and management.

fig 1.4 thermal storage plant

1.05 THERMAL ENERGY STORAGE

Thermal energy storage is defined as a technology that allows the transfer and storage of heat energy or energy from ice or water or cold air. This method is built into new technologies that complement energy solutions like solar and hydro.

The thermal energy is produced in the periods of off-peak electrical demand or utilization and collected in a thermal energy storage tank, then withdrawn and distributed to the facility during peak periods.

Example for thermal storage:

Suppose there is a party and you are not likely to make ice when people arrive. You would buy ice, store it in a freezer and use it when required. The process of thermal energy is very much similar. The electricity you utilize to make that ice is less expensive at night than during the daytime.

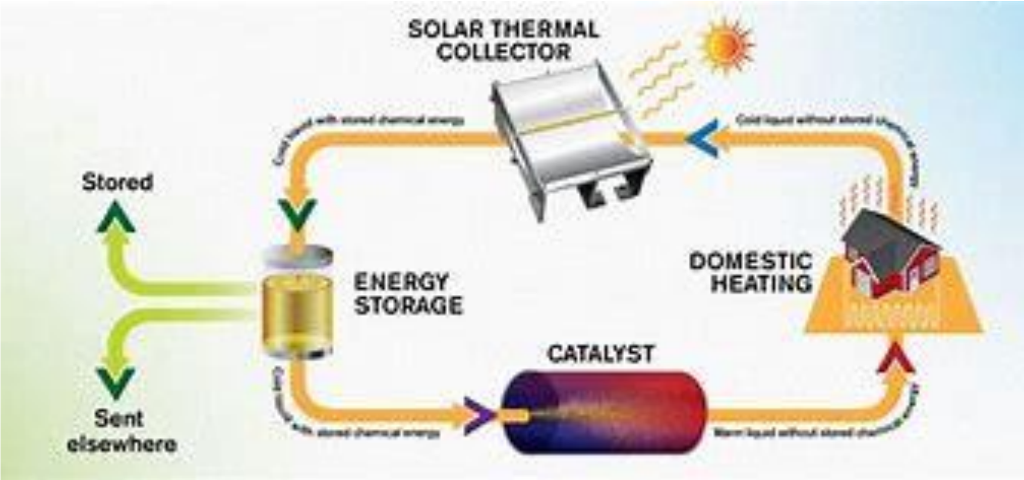

fig 1.05 Example for solar thermal energy storage

1.06 ZEOLITE

Zeolites are microporous , three-dimensional crystalline solids of aluminium silicate. Zeolites have small openings of fixed size in them which allow small molecules to pass through them easily but larger molecules cannot pass through them; that is why they are sometimes called molecular sieves

fig 1.06 zeolite pellets

Formula for zeolite:

$Na2Al2Si2O8.xH2O$

1.07 ABOUT ZEOLITE

Zeolite has a very high adsorption capacity ,when water comes in contact with the zeolite the adsorption process commences and an exothermic reaction takes place the heat is released in large amounts , in a recent scientific study it is stated that zeolite has absorption capacity four times greater than that of water. Also the zeolite are more affordable products ,their most use is in the winter season where they are replaced for the room heaters ,this is the best application for the thermal storage process .

Zeolites can also be used to thermochemically store solar heat harvested from solar thermal collectors as it was first demonstrated by Guerra in 1978 and for the adsorption refrigeration, as first shown by Tchernev in 1974. In these applications, their high heat of adsorption and ability to hydrate and dehydrate while maintaining the structural stability is being exploited.

This hygroscopic property coupled with an inherent exothermic (energy releasing) reaction when transitioning from a dehydrated form to a hydrated form make natural zeolites useful in harvesting waste heat and solar heat energy. The hygroscopic property for zeolite is high and while having the high heat absorbing capacity makes the zeolite best for making the good thermal system for the release of heat without having any electrical means.

The hygroscopic property of any material refers to material's ability to attract and hold water molecules. This is achieved by the process of adsorption or absorption of water from the surrounding environment. The hygroscopic property of substances makes them capable of causing corrosion in metals and other materials. A zeolite mineral is a crystalline material with a structure consisting of connected tetrahedra, each of which contains four O atoms surrounding a cation. Open cavities in the form of channels and cages can be found in this system. These are normally occupied by H_2O molecules and typically exchangeable extra-framework cations. Guest organisms can move through the channels because they are wide enough. Dehydration occurs in the hydrated phases at temperatures predominantly below 400 °C and is essentially reversible. (OH, F) groups will break the structure by occupying a tetrahedron apex that is not shared with neighboring tetrahedra.

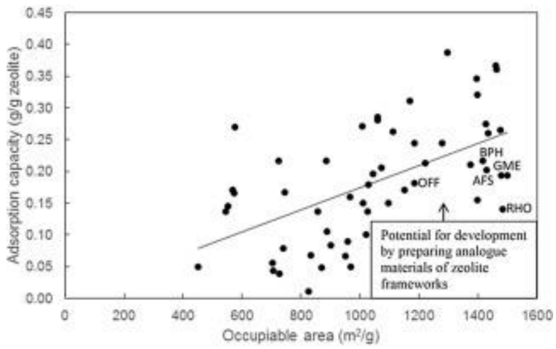

fig 1.01 graph of adsorption

Image taken from paper on :

Relation of water adsorption capacities of zeolites with their structural properties.

By melkon tatleir , Gunther munz , Stefan k henninger

a

1.08 CHEMICAL COMPOSITION AND STRUCTURE IF ZEOLITES

All zeolites are made up of the aluminosilicate framework where silicon and aluminium are tetrahedrally coordinated. Silicon cation and aluminium cations are enclosed by four oxygen anions (O2-). The tetrahedral structure of $Si0_4$ and $Al0_4$ forms the building block of zeolite.

Zeolite formula is often given as;

$\mathbf{M_{x/n}[AlO_2]_x.(SiO_2)_y.mH_2O}$

However, zeolites tend to have different chemical elements in their composition. The formula for zeolite is given in the ratio where,

M = any one metal that could be magnesium, sodium, potassium, lithium, or calcium.

n = valence of the metal cation.

y = number of water molecules in the structure of the zeolite.

y/x = Atomic Si/Al ratio

1.09 STRUCTURE

The crystalline structure of zeolite is very different as compared to other crystalline solids. Zeolite can be considered as a special crystalline solid having a characteristic framework structure with cavities occupied by ions and water molecules that have considerable freedom of movement

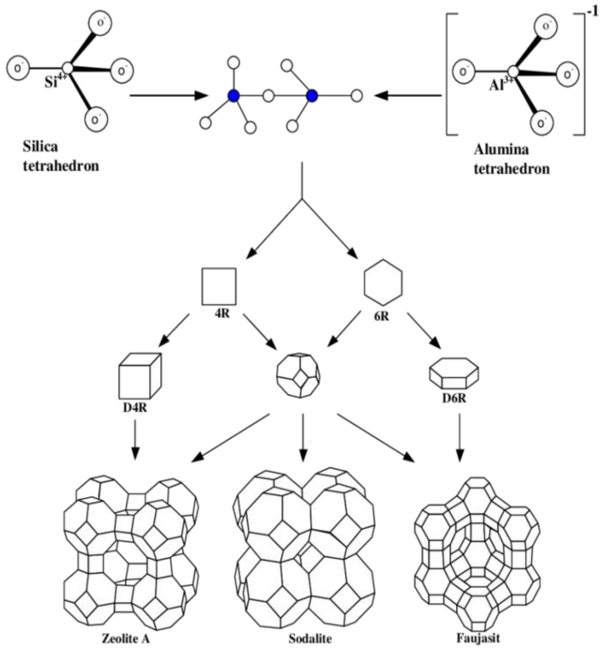

fig 1.07 zeolite structure

1.10 PROPERTIES OF ZEOLITE

- Zeolites are stable solids under various environmental conditions. The melting point of zeolite is very much high, i.e.1000^{o}C.
- They are insoluble in water or other inorganic solvents.
- They do not undergo oxidation in the presence of air.
- The characteristic property of zeolite is its open cage-like framework structure that helps zeolite trap water and ions of potassium and calcium.
- The natural form of zeolite occurs in very random forms and pore sizes are not uniform whereas synthetic zeolites are synthesized in a precise manner with uniform pore size.
- Zeolites that are rich in alumina are attracted to polar molecules like water whereas zeolite rich in silica are attracted towards nonpolar molecules.
- Since zeolites are not reactive and are obtained from naturally occurring minerals, therefore, they do not have any harmful environmental effects; although skin contact or inhalation may have a carcinogenic effect.

1.11 ADSORPTION

Adsorption is often described as a surface phenomenon where particles are attached to the top layer of material. It normally involves the molecules, atoms or even ions of a gas, liquid or a solid in a dissolved state that is attached to the surface. Adsorption is mainly a consequence of surface energy.

Physical adsorption:

This type of adsorption is also known as physisorption. It is due to weak Van der Waals forces between adsorbate and adsorbent.

1.12 APPLICATION OF ZEOLITES

ION EXCHANGE:

The cage-like structure of zeolites makes them very useful in the exchange of ions. For example, hard water is passed through a column filled with sodium-containing zeolites. In this process, calcium and magnesium get trapped by zeolites and sodium ions get release which results in softening of water making water rich in sodium. Nowadays zeolites are also being used in detergent for the removal of magnesium and calcium thereby making the water softer and increasing the effectiveness of the detergent.

AS CATALYST:

Zeolites are used as a catalyst in several important reactions such as cracking, isomerization and hydrocarbon synthesis. The porous structure of zeolite makes it a highly effective catalyst. Moreover, pores in a particular zeolite are of fixed shape and size making zeolite selective on certain molecules, therefore zeolite is sometimes referred to as shape-selective catalysis.

ADSORBENT:

Zeolites have a very high adsorbing capacity and are used to adsorb a variety of materials. They have a wide range of applications in the field of purification, drying and separation.

2. LITERATURE SURVEY

2.1Experimental study on double pass solar air heater with thermal energy storage

S.S. Krishnananth, K. Kalidasa Murugavel

*Aldabbagh et al.2010) investigated that the single and double pass solar air heaters With wire mesh as packed bed achieved 45.93% efficiency for single pass solar air heater and 83.65% for double pass solar air heater. Omojaro and Aldabbagh (2010) invest-gated the single and double pass solar air heaters with wire mesh as packed bed and observed that efficiency increases with an increasing air mass flow rate. For the same flow rate, the effi-ciency of the double pass was -19.4% higher than that of the single pass.

2.2 Thermal energy storage using phase change material: Analysis of partial tank charging and discharging on system performance in a building cooling application

P. McKenna , W.J.N. Turner , D.P. Finn

A PCM is a material that releases or stores thermal energy during a phase change, i.e., from solid to liquid, or liquid to solid. This property of PCMs means that electrical energy used for powering HVAC systems can be stored as latent thermal energy in a TES tank – a tank filled with PCM and a heat transfer fluid (HTF). The TES tank allows buildings to participate in demand-side management (DSM) programs . Energy storage provides a mechanism for the temporal decoupling of energy generation with energy use. If the phase change material thermal energy storage tank is not required to operate at maximum capacity (i.e., maximum charge), energy savings are possible by only partially charging the tankGenerally, higher charging loop flow rates and lower discharge loop flow rates produce better energy performance. Charging a phase change material thermal energy storage tank above 90% is not recommended, as at very high charge fractions, the energy performance decreases considerably, while the charging time increases significantly.

2.3 Cost-effective Electro-Thermal Energy Storage to balance small scale renewable energy systems

SampsonTettehMaryam RozaYazdani Annukka Santasalo-Aarnio

Thermal Energy Storage (TES) can store thermal energy directly and at a large capacity. The most common TES systems are direct sensible, latent heat, and thermo-chemical storages. Their energy source is either solar thermal or industrial waste heat, where the end-use of these systems is for heating, drying and cooling purposes . There are some examples of TES systems that provide electricity output, such as some sensible heat storages and thermo-chemical storages .Latent heat with a comparatively low storage volume and low medium temperatures can be used for seasonal storage.

2.4 Comparative environmental life cycle assessment of conventional energy storage system and innovative thermal energy storage system

Borbala Rebeka David a SeanSpencera JeremyMillera SulaimanAlmahmouda HussamJouhara

The current technologies for electrochemical storage are split into two main branches: capacitors and batteries. Capacitors are a suitable alternative to batteries, by offering high efficiencies and an increased lifespan. The downfall of the capacitor lies within the capacity, as batteries can store 30 times more charge per unit per mass in comparison to a capacitor [16]. Although unsuitable for large scale applications, the application of capacitors has been applied in small-scale energy recovery such as nano generators , energy harvesting via vibrations and piezoelectric technology.

2.5 Prototype design and experimental study of a metal alloy-based thermal energy storage system for heat supply in electric vehicles

In cold climates, a large portion of the battery power in an electric vehicle is used to provide heat to the cabin, which can result in a significant reduction in mileage. In order to address this issue, a compact thermal energy storage system based on aluminum silicon alloy was proposed, and expected to be used in electric vehicles as the heat supplier, in which the output temperature and heat power are fully adjustable according to the heat demand. The charge/discharge characteristics and thermal insulation performance of the system have been studied. The energy density of the heat storage tank is 225 Wh/kg or 179 Wh/L. It can supply heat for more than 3 h under the discharge power of 1.5 kW, and the heat utilization rate is higher than 80%.

3.EXPERIMENTAL CALCULATION

Water = 3 liters

Zeolite pellets temperature = 60℃

Water initial temperature = 23℃

Sun radiation = 1164 w/m^2

Zeolite pellets weight =254 grams

Water final temperature = 28℃

Q_{in} =1164 W/m^2 = 1164 $J/m^2.S$ $S=3 \times 60 \times 60$

= 25,056,000 J/m^2

= 25,056 KJ/m^2

= $25{,}056 \times 30 \times 30 \times 10^{-4}$ KJ/m^2

= 2255KJ

$Q_w = 4.18 \times 3 \times 10^{-3} \times 10^{3} \times 5$

Q_w = 62.7KJ

The total amount of energy acquired by the water from zeolite pellets is 62.7KJ

The effectiveness of the zeolite pellets is 2.7%

fig 3.1 liters of water in a container

fig 3.2 temperature of water rising

4. METHODOLOGY

At first, a closed entity is taken which has a very low thermal conductivity, so that the heat which is being absorbed by the zeolite pellets should not leak on to the outside surface and could maintain in the zeolite pellets itself

A closed entity taken as wood material

The area of the material is 30*30 cm^2. Using weighing machine, we have taken only 250grms of zeolite pellets.

We used a light source which emits radiation as the input & heat supplied to the zeolite pellets. The zeolite pellets have been kept over the light source to absorb the heat. The heat input over a time period of 3hrs in a day to the zeolite pellets

During the heating process, we measure the solar radiation using solar power meter as 1160w/m^2. After completion of 3hrs we stopped the heat input source. We have taken 3liters of water, whose initial temperature of water is 23°c measured using temperature indicator.

The zeolite pellets are dropped in the 3 liters of water, where one end of thermocouples are in water and other end of thermocouples are connected to temperature indicator. We used the k- type thermocouples.

Dropping the zeolite pellets in water, makes the temperature rise in water up to 28°c. We took the temperature readings using temperature indicator connected to it.

After all calculations, we got an effective temperature rise for amount of zeolites provided and a thermal storage capacity in zeolite pellets which efficiency is around 3.6%.

4.1 THERMOCOUPLES:

A thermocouple measures temperature, so technically, a thermocouple is a type of thermometer. Of course, not all thermometers are the same. Two different metal make up a thermocouple. Generally, in the form of two wires twisted, welded, or crimped together. Temperature is sensed by measuring the voltage. Heating a metal wire will cause electrons within the wire to get excited and want to move. We can measure this potential for electrons to move with a multimeter. With this measurement, we can calculate the temperature.

In short, a thermocouple translates temperature energy into an electrical signal. This signal can be acted upon, perhaps directly by a person who is monitoring the thermocouple. But more likely by an automated system that observes, records, or uses the data to perform an action.

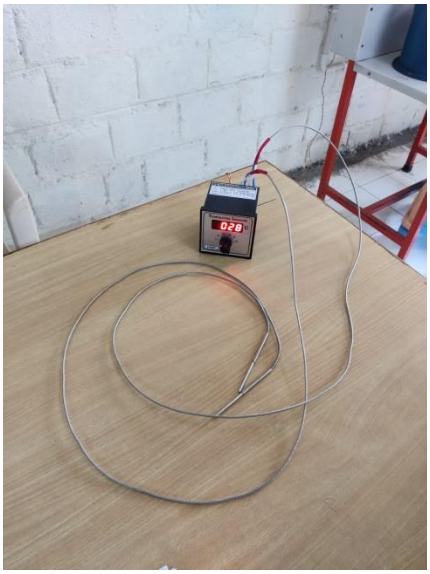

fig 4.1 k -type thermocoupple

4.2 Different types of thermocouples

Each type of thermocouple has its unique characteristics that differ in durability, chemical resistance, application compatibility and vibration resistance.

We have type R, S and B thermocouples which are noble metal thermocouples used in high-temperature applications. We also have type K thermocouple, J, T and E, the most common ones, base metals .Thermocouples are usually protected in a special wrapper that isolates them from the normal atmosphere. The sheath ensures that when in use, the thermocouple will give the correct temperature readings. It also offers protection against corrosion.

Each type of thermocouple is classified by an alloy. When two metals join together at two junctions, they create an emf.

1. Type R Thermocouple

This type of thermocouple is used to measure high temperatures in different applications. It is costly because it has a higher percentage of Rhodium. When compare it to type S, their performance is similar, but what distinguishes them is the amount of Rhodium they both contain.

We can use this appliance in lower temperature applications since it is stable and very accurate. Its output is slightly higher and it is also more stable if we compare it to type S.

2. Type S Thermocouple

This thermocouple type contains high thermoelectric voltages; therefore, it is used in high-temperature appliances. This characteristic gives it the advantage of being used in medical fields, for example, in pharmaceutical industries. It will create a voltage when the temperatures on either side are different.

3. Type B Thermocouple

What distinguishes type B from all the other thermocouple types is that it has the highest temperature limit. It works well in extremely high-temperature applications. Even at extremely high temperatures, it still maintains accuracy and stability.

4. Type J Thermocouple

Of all types of thermocouple, type J has a short lifespan; it is common and has a smaller temperature range. You can compare it to type K in terms of expense and reliability.

5. Type K Thermocouple

This type of application is commonly used since it's affordable, reliable, and offers accurate temperature readings. Type K is mostly used in nuclear applications due to its radiation hardness. The see beck coefficients of this thermocouple range between 0- 1000 degrees Celsius.

6. Type T Thermocouple

It used mainly in deficient temperature application due to its stability. It is used in low freezers or laboratories.

The type we used in the experiment is K-TYPE thermocouple

fig 4.2 k type thermocouple

4.3 TEMPERATURE INDICATOR

A temperature indicator is a very easy to use and cost-effective control device that helps to determine and display, e. g., the duration of exposure to excessive temperatures. A temperature indicator can be used in fridges, dryers, furnaces and other technical equipment and many models are also suitable for the measurement and indication of various other physical parameters like weight, pressure, humidity, etc.

It is useful in many different sectors, for instance in laboratories and in production processes where it is crucial to be aware of changes in temperature. It plays a particularly important role in quality control. A temperature indicator is frequently used to control the quality of raw materials and semi-finished products and to control finished products during storage and transportation.

It easily detect products that may be spoilt, to reduce the risk of manufacturing low-quality, defective products, to name only a few of the numerous possibilities to benefit from a temperature indicator. The use of an indicator even helps staff to be more careful with the products and to follow the relevant rules.

A temperature indicator is often equipped with an interface for data transfer and can be configured via the PC or with the help of the keys situated directly on the front panel. Measurement results can easily be read out from large LED displays or transferred to a PC for further analysis. A temperature indicator stands out by its high accuracy.

In the experiment the temperature indicator is connected with the k type thermocouple to get the required temperature the temperature of the water is obtained.

Temperature indicators are installation instruments which can process signals from temperature sensors and show them on the display. Temperature indicators enable easy and economic valuation of resistance sensors

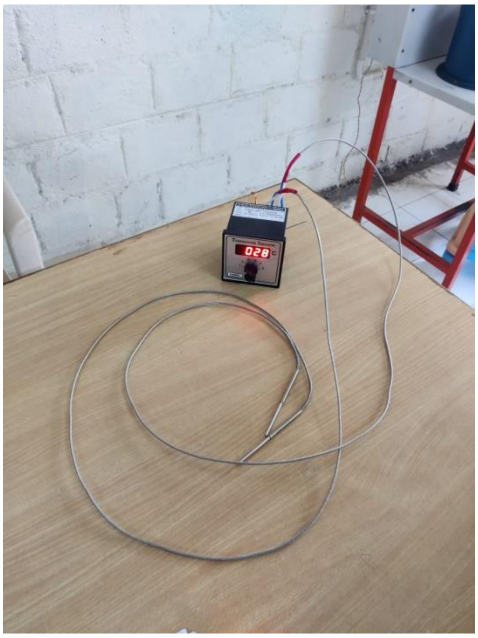

fig 4.3 temperature indicator with thermocouples

4.4 WOODEN BOX

A wooden box is taken so that there may not be any heat losses, wood material is chosen because of the ability to sustain heat (not upto high temperatures but into a medium range of temperature), the wood capacity of not dissipating heat to outside environment is high.

The wooden box is clamped with two edges and space is kept other each the sides so that if we want to increase the intensity of the heat we can place mirrors on either sides of the wooden clampings which is kept on the both the sides of the box

The clearance is given to the wooden box in reference to the dimensions where the box is 30 x 30 in centimeters

fig 4.4 The wooden box

fig 4.4 (a)wooden box

4.5 ZEOLITE

Zeolites are micro porous, three-dimensional crystalline solids of aluminium silicate. Zeolites have small openings of fixed size in them which allow small molecules to pass through them easily but larger molecules cannot pass through them; that is why they are sometimes called molecular sieves.

Zeolite has a very high adsorption capacity, when water comes in contact with the zeolite the adsorption process commences and an exothermic reaction takes place the heat is released in large amounts, in a recent scientific study it is stated that zeolite has absorption capacity four times greater than that of water. Also the zeolite are more affordable products, their most use is in the winter season where they are replaced for the room heaters, this is the best application for the thermal storage process.

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4.7 EXOTHERMIC REACTION

An exothermic reaction is a reaction in which energy is released in the form of light or heat. Thus in an exothermic reaction, energy is transferred into the surroundings rather than taking energy from the surroundings as in an endothermic reaction. In an exothermic reaction, change in enthalpy (ΔH) will be negative.

Therefore, it can be understood that the net amount of energy required to initiate an exothermic reaction is less than the net amount of energy released by the reaction. When a calorimeter, a device used to measure the heat released by a chemical reaction, the net amount of heat energy that flows through the device is equal to the negative of the total energy change of the system.

However, it is extremely difficult to measure or even calculate the absolute total of energy in a given chemical system. Therefore, the energy change (or the enthalpy

change, denoted by ΔH) is measured instead. The relation between the value of ΔH and the bond energies of the reaction can be given by the following equation.

ΔH = (energy used in the bond formation that yields products) – (energy released when the reactant bonds are broken)

Therefore, it can be understood that an exothermic reaction will always have a negative value for the change in enthalpy, i.e. $\Delta H < 0$.

For the measurement of the enthalpy change of combustion reactions bomb calorimeters are very suitable devices

fig 4.5 initial temperature of water

fig 4.6 final temperature of water

Due to the exothermic reaction happening between the water and the zeolite pellets the temperature of the water rising and the difference in the temperature is being shown in the figures.

The amount of zeolite pellets taken into the experimental procedure is 250grams

fig 4.7 weight of zeolite pellets

The total weight (including zeolite and the plastic wrapper) is 253grams.

A weighing machine is used to know the weight of the zeolite, to perform the experiment we took a 250grams of zeolite and placed it under the light source and observed for 3 hours & the resultant energy is supplied to the zeolite and it is measured by a radiation measuring sensor, the amount of energy stored in the zeolite is calculated.

4.8 HALOGEN LAMP SETUP

Halogen lamp setup consists of a stand with halogen lamps attached to it and it is focused on the wooden box where the zeolite pellets are kept.

Halogen lamps are used because of their high emission of heat.

Halogen is a type of lighting technology that is essentially an enhanced version of incandescent. Just like with incandescent light bulbs, the electrical current enters the socket and travels up to the tungsten filament, heating up the filament to incandescence. Halogen light bulbs have tungsten filaments housed in a quartz capsule and filled with iodine and bromine gases.

Electrical current flows from the socket and makes contact with the base of the light bulb. Just like with incandescent light bulbs, the electrical current enters the socket and travels up to the tungsten filament, heating up the filament to incandescence. The enhancement with halogen lamps is that the filament is enclosed in a quartz capsule filled with halogen gas. This gas is inert and made up of iodine and bromine.

The flow of electrical current starts the “halogen cycle,” where the particles burning off the tungsten filament are then re-deposited back onto the filament by the halogen inside the quartz capsule, allowing for these particles to be “reused.” Reusing the particles gives the lamp a higher luminous efficacy and a longer life than incandescent lamps. So halogens can last up to 2,500 hours while incandescents have an average life of 800-1,200 hours.

Halogen lamps can also operate at a higher temperature than incandescent lamps. This is why you often see small halogen quartz light bulbs with a 250-300 wattage rating.

A quartz capsule is made up of the purest form of glass. Whereas most traditional glass contains other diluting materials, quartz is pure and allows for the glass to operate at a higher resistance.

The caution with a quartz capsule is that the oils from our fingers break it down. So if you consistently touch a quartz capsule inside a halogen light bulb, your fingers will affect the life of the product.

HALOGEN LAMP SETUP

Fig 4.8 halogen lamp setup

fig 4.9 halogen lamp setup

4.9 SOLAR POWER METER

A solar power meter is a device that can measure solar power or sunlight in units of W/m2, either through windows to verify their efficiency or when installing solar power devices.

Solar meters accumulate PV yield production and local energy consumption to monitor and analyze PV plant performance.

It often comes with a monitoring function to alert plant owners of PV plant performance issues, letting them quickly resolve problems and maximize return on investment

Traditional electricity meters can only measure the electricity that flows one way. That is, from the grid into the house. Solar meters, however, are bi-directional, which means they can also measure the electricity that the home exports to the grid.

Solar energy systems usually reach highest electricity production during the afternoon. This is when many people aren't home or lights aren't used. In contrast, home electricity use is typically higher in the mornings and evenings. Solar energy meters help to account for these ups and downs in day-to-day electricity production and usage.

With the solar meter, excess electricity is fed into the electric utility's grid when it produces more than needed. When this happens, the meter runs in reverse.

This "back-and-forth" between the system and the grid ensures that the excess production will still be used and there will not be any shortages. With solar meters, the excess electricity produced covers the times when there isn't enough produced.

When the solar power system produces more electricity than used for a month, the utility bill will receive credits based on the net number of kilowatt-hours given back to the grid. If the solar power system generates less electricity than used in a given month, there is a need to buy electricity from the utility to make up the difference. In these instances, users would pay for the electricity they use, minus any excess electricity the solar panels generate.

SOLAR POWER METERS

Fig 4.10 solar power meter

Fig 4.11 solar power meter (readings)

5. REAL TIME INPUT & OUTPUT

5.1 INPUT:

The zeolite pellets are exposed to halogen light source for a period of 3 hours and the radiation intensity is measured with solar power meter and the zeolite pellets are kept under supervision for 3 hours, 250grams of zeolite are kept under super vision and the amount of input given is 2255KJ (calculated).

The initial temperature of the water before adding the zeolites to it is 23ºC.

Fig 5.1 Initial temperature of water

5.2 OUTPUT:

After the duration of 3 hours completed under the halogen light source, the zeolites absorb the energy from the light source & store the energy within it the energy total stored in the zeolite obtained through calculation is 8.668KJ, the efficiency is rounded off to 2.7%

Fig 5.2 Final temperature of water after adding zeolite pellets

6. RESULT

In this paper, thermal storage is a promising technology to reduce energy costs. The thermal storage can have high impact on energy consumption, demand and total energy cost.

In this experiment we have introduced the zeolite pellets as the heat storage material of solar energy, for the continuous heat input, we used the halogen lamp equipment, which consists of halogen lamp setup and solar power meter for measuring the radiation emitted by the halogen lamp setup. The process is done for the duration of 3 hours & finally we got an effective increase in temperature from 23ºC to 28ºC and the heat has been stored by the zeolite pellets for the 3 hours there was an effective increase of temperature of 5ºC, upon calculating with values obtained we have got an effectiveness of 2.7% ,

The future scope of this procedure is when we increase the weight of zeolite then we will get a rapid increase in storing energy which can be later used wherever it is necessary, this zeolite can also be used for cooling purposes also the zeolite has an wonderful heat absorbing capacity which can also be used for industrial purposes

7. CONCLUSION

As the technology are blooming with emerging trends the availability so we have developed a new efficient energy storage system that the energy storage is much more efficient and the storage capacity of the zeolite pellets are about 4 time greater than that of water, using this feature we have developed a storage system and the necessary calculations are done for the energy storage in the zeolites.

The energy input is given from the halogen lamp and the energy that has been radiated from the halogen lamp is calculated with the help of the solar power meter and is calculated. After a duration of 3 hours the heat retained is transferred to water so that to know that the zeolite is storing the heat or not.

From the results obtained the heat energy is being stored in the zeolite pellets and the heat energy is being released to the water when the zeolite is kept in water.

Scope for future work

The heat storing capacity is high in the case of zeolite and the zeolite can be used for the heat storing applications and also for the cooling processes, the heat absorbing capacity is high so that it can used in manufacturing industries so that the heat could not be wasted.

Finally an effective & a efficient way of storage of energy has been developed

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