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SOLAR HEAT COLLECTOR BASED FURNACE

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ABSTRACT:

Human life is mainly dependant on metals, or, to be precise, on the various tools made out of metals. On the same lines, metal tools and materials are mostly being made in furnaces, where, metal is melted and then re-solidified into finished commodities. But, the adverse factor that lies here is that furnaces use non-renewable sources of energy. These are not only getting depleted day by day but are also creating bad effects on environment due to their by-products formed on burning them.

If we can direct solar energy into furnaces, we would not only arrest the use of non-renewable fuels but also help in reducing pollution. Moreover, availability of solar energy is continuous and needs minimal cost. .

We receive very intense sun's heat for 300 days in a year. So, using optics and some engineering skills, we can design a solar collector which can provide energy that would be enough to melt metals.

Harvesting renewable energy is the requirement of present time. This paper mainly focuses on construction of solar collector which concentrates heat at a single point, thereby, creating a source of heat to be used for numerous applications.

KEYWORDS: optics, concave, focal point, tensile strength, mylar, pivot.

I. INTRODUCTION:

Solar Furnace is an optical system in which the solar radiations received by the collector are concentrated into a small area. If this highly concentrated radiant energy is received into a cavity, heat is generated and very high temperatures can be attained. This cavity, which is the actual furnace, is a minor part of the whole assembly which totally depends on the proper working of solar collector.

Solar energy is a combination of heat and light energy and therefore has a tendency to get reflected. Hence, if numerous reflective surfaces are arranged in a manner such that all solar energy incident on them would get reflected back at some area, the intensities of heat and light energies in that vicinity would increase.

The effects obtained from reflective surfaces of different type are different. If concave mirror is used instead of flat mirror, the energy that was incident in some area would get more concentrated and accumulate at a single point, thereby, creating a better heat source. This point in the science of optics is known as focal point and the length from the mirror surface to the point is known as focal length.

II. REFLECTIVE SURFACES:

The collector is a reflective surface of concave shape. Various reflective surfaces can be used for its construction; which include mirrors, aluminium foil and mylar sheet.

A. MIRRORS:

A concave reflective surface can be made from mirrors by two methods. The first method is use of numerous flat mirrors arranged on a concave surface. The second method is use of an originally concave shaped mirror. Of these two methods, the second method is more effective because if flat mirrors are used, a focal area is obtained and attaining a focal point is difficult. On the contrary, if concave shaped mirror is used, a sharp focal point can easily be obtained. But use of mirrors make the system costly.

B. ALUMINIUM FOIL:

Aluminium acts as a highly reflective material. Aluminium foils are cost effective as compared to mirrors and also easily available. But creating concave surface becomes difficult from aluminium foil because of low tensile strength.

C. MYLAR SHEET:

Mylar sheets make use of BoPET (Biaxially-oriented polyethylene terephthalate). Vaporized aluminium is deposited to form a film on BoPET. Mylar sheets have high reflectivity. Other properties are high tensile strength, chemical and dimensional stability. Moreover, they are also

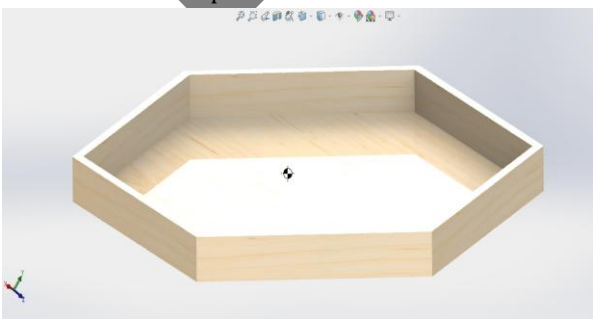
cheap and easily available. Hence, they overcome all the limitations of mirrors and aluminium foil.

III. CONSTRUCTION OF MODEL:

Various subparts of the complete model include collector dish, clamp, crucible and base structure.

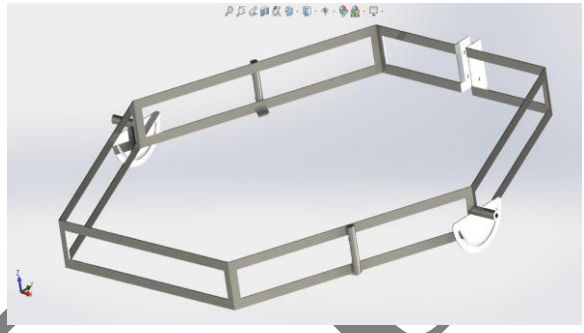
A. CONSTRUCTION OF COLLECTOR DISH:

- The first consideration is the material to be used for collector dish. Since collector dish would have the concave reflective surface mounted into it, it should possess properties like high rigidity and low weight. Hence, wood is chosen.
- The second consideration is shape of collector dish. Circular shape can provide better concave results but is difficult to be made from wood. Moreover, when such systems are manufactured on larger scale, circular shape can prove less efficient because when many circular shapes are joined together, the area between them becomes ineffective. Hexagonal shape overcomes all these limitations. Hence, hexagonal shape is chosen.
- The mylar sheet is stretched on the collector dish which forms its front part.
- The rear part is covered using plywood. The whole assembly is sealed using silicone and adhesive tape. Then, the rear panel is drilled and a Poly Vinyl Chloride (PVC) pipe fitting is used to attach a ball valve assembly.
- Air leaks in the chamber are checked. A vacuum pump is used to suck out the air inside the chamber. The mylar sheet gets stretched and a pure concave reflective surface is formed. When required depth is achieved, vacuum pump is shut down and valve is closed to maintain low pressure inside the chamber.
- This collector can adjust its focal length as per requirement by adjusting pressure.
- This method is effective to create perfect concave shape without the use of any precision tool. It also avoids costly machining to create concave surface.
- Also this method is cost effective since all materials are cheap and cost effective.



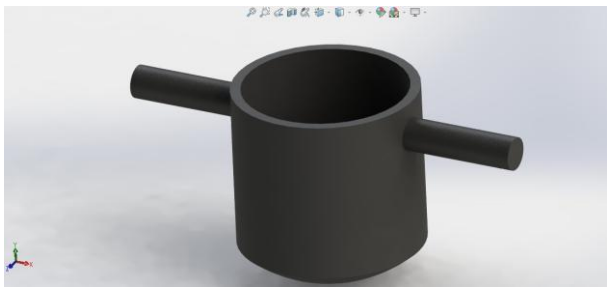
B. CONSTRUCTION OF CLAMP:

- As sun changes its position throughout the day, so the entire collector dish is provided with such degree of freedom so as to track the movement of sun.
- Below shown is a clamp for wooden frame that has pivot on two ends to provide a rotary motion when rested on base structure.



C. CRUCIBLE:

- The focal point of concave surface is the point where entire heat gets concentrated. When metal is held at this point, it would be exposed to maximum heat and get melted.
- There has to be a container to hold metal pieces for them to melt.
- A ceramic or metal container in which material can be melted or subjected to very high temperature is a crucible.
- Basically, this container would be working as the actual furnace in the entire setup.
- Various metal containers are available. But the properties that crucible should possess are sustaining high temperature and good conduction of heat.
- Hence, copper container is used as a crucible in actual model.



D. CONSTRUCTION OF BASE STRUCTURE:

- Base structure is made of tubular mild steel members, designed to be sturdy and light weight.
- The structure provides 100° pivot rotation and 360° base swivel which results in total coverage of sun's position throughout the day.

E. FINAL ASSEMBLY:

IV. ADVANTAGES:

A solar heat collector can be used in numerous other ways. A source of heat energy is a boon to the field of engineering.

Solar energy is a very economic source of energy. It only needs to be installed. It does not have maintenance problems and has long life. Therefore, solar energy is only a one time investment and later free for nearly twenty years. So, the awareness for the use of solar energy needs to be increased. These renewable sources of energy have the potential to overcome the crisis of fossil fuels. These are not only environment friendly but also economically efficient.

V. FUTURE SCOPE:

A heat source is of great importance to the field of engineering. Heat has numerous applications if it can be directed properly.

The solar collector creates a heat source at focal point. One of the applications is creating a furnace at that point as described in this article. A few other applications are as follows:

A. STIRLING ENGINE:

Stirling engine is a type of external combustion engine. It has a sealed cylinder with one part hot and other cold. The working gas inside the engine is moved by mechanism from the hot side to cold side.

To create such heat differences, a source of heat is required. The focal point of solar collector can be used in this case.

B. CREMATION:

In many religions, a person's body is burned after death. Lot of wood is used in the process. Along with wood, various oil and fuel is also poured for continuous burning of wood till the body turns into ashes.

The heat source created by solar collector can come into picture here. Instead of using various fuels for wood burning, constant supply of heat by solar means can be provided.

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