Manufacturing of foam pipe using space holder techniques for solar parabolic trough collector

[1]Pranav B Patel
Research Scholar
Mechanical Department, Parul University of Baroda, Vadodara, India

[2]Bhupesh Goyal
Research Scholar,
The Maharaja sayajirao University Vadodara
Assistant Professor,
Parul University,Vadodara, Gujarat, India

[3]Dhaval Sodha
Assistant Professor
Mechanical Department, Parul University of Baroda, Vadodara, India

Abstract- **Porosity is considered in two ways in the manufacturing industry. Regular casting processes view porosity as a product flaw, however metal foam structures view pores and porosity as the most desirable characteristics due to the final object's improved physical and thermo-mechanical characteristics [2]. In this article, manufacturing methods for creating metal foams are covered, along with the benefits of the solid space holder technique over other ones already in use. The primary factors that determine how well a metal foam structure performs are the minimum pore size and the orientation of the pores, and achieving these factors is the toughest hurdle for both researchers and businesses. So, using the traditional casting procedure, specimens were created as part of the tests. Various tests are also conducted for accurate and proper analysis. On specimens, several tests were performed. Based on a survey of the literature, aluminum is chosen as the best casting material [13]. There are many ways that metal foam can be made that yield high porosity[22][26]. The space holder approach is chosen among those because it enables pores to have the ideal position and orientation. Additionally, it expands the metal foam structure's surface area. Open-cell structures do not have a bigger surface area than close-cell structures. Because aluminum works best for casting under high-temperature conditions, casting is a good way to create metal foam structures with close-packed cells [20][21].**

Keywords: **Space holder techniques, Porous materials, Casting Process.**

1. INTRODUCTION

Metal Foam: -

In the field of materials science, a metal foam is a substance or structure that is made of a solid metal with vast amounts of gas-filled pores [6]. The pores may be linked or sealed. High porosity is what distinguishes metal foamsfrom other materials[7][14].

Types of Metal Foam: - 1) Open Cell Foam and 2) Closed Cell Foam [8]

1) Open Cell Foam: -

Foundry or power metallurgy are the production methods for open cell foams. As their name implies, "space holders" are used in the powder method to fill pore spaces and channels [11]. A polyurethane foam skeleton made ofopen cells is used to cast foam.

2) Closed Cell Foam: -

A gas or foaming ingredient is frequently injected into molten metal to create foams. By injecting gas bubbles intothe substance, melts can be foamed. In a high-density liquid, molten metal bubbles are often very buoyant and risefast to the surface[9][10]. Its rise can be reduced by adding ceramic powders or alloying elements to the melt to create stabilizing particles, increasing the viscosity of the molten metal, or by other techniques.

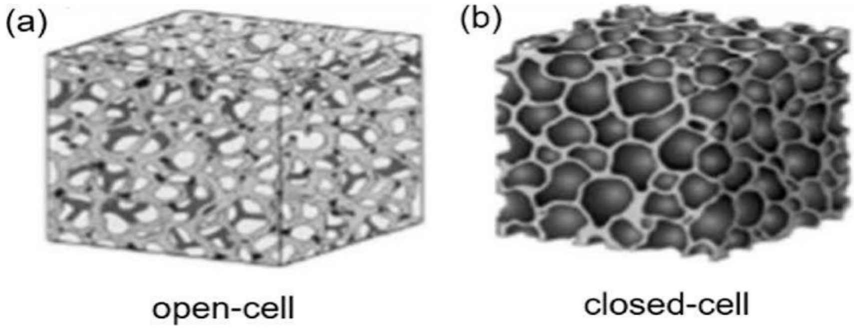

Fig.1 Open cell and closed cell

Casting Mold: -

Pouring liquid substance into a mold's cavity is the process of casting. This liquid will eventually heal by a chemicalreaction or cooling. A casting, which is the term for the solidified component, is ejected or broken out of the mould to complete the procedure.

Types of Metal Foam: - 1) Open Mold Casting and 2) Closed Mold Casting

1) Open Mold Casting: -

An open mold is a container, like a cup, that has only the shape of the desired part. **The molten material is poured directly into the mold cavity which is exposed to the open environment**. This type of mold is rarely used in manufacturing production, particularly for metal castings of any level of quality [3].

2) Closed Mold Casting: -

In closed-molding, **raw materials (fibers and resin) cure inside a two-sided mold or within a vacuum bag (shut off from air) [27]**. Closed-molding processes are usually automated and require special equipment, so they'remainly used in large plants that produce huge volumes of material—up to 500,000 parts a year.

Space Holder Technique: -

Space holder technique was **used for production of Aluminum foam and NaCl was taken as space holdermaterial**.[4] [18]

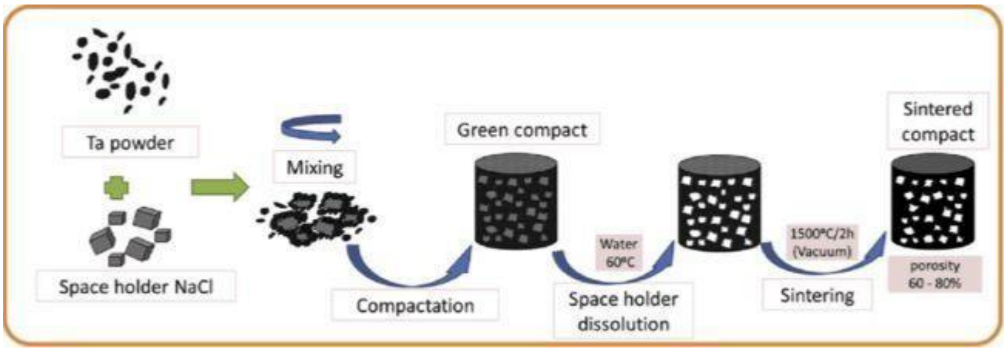

Fig.2 Space Holder Technique

2. LITERATURE REVIEW

Tan Koon Tatt, [1]Metal foams possess excellent physical and mechanical properties. This paper reviews the common manufacturing process of metal foams. Various ways used to produce metal foams based on metal properties are described. The manufacturing process follows four primary routes: liquid state, solid state, ion or vapour processing. Liquid-state processing produces porosity to liquid or semi-liquid metals, and solid-state foaming produces metal foams with metal powder as starting material. For ion and vapour processing methods, metals are electro-deposited onto a polymer precursor. The polymer precursor is removed by chemical or heat treatment to produce metal foams. The advantages and limitations of each manufacturing process are also described.

H. Javaniyan Jouybari,[2]The thermal performance of a nano fluid flow through a flat platesolar collector with the metal porous foam filled channel is experimentally investigated. For this purpose, the SiO2/deionized water nano fluids are prepared with volume fractions of 0.2%, 0.4% and 0.6% then their thermal behaviour is examined on the porous channel collector based on the ASHRAE standard. Based on the experimental results, the thermal efficiency is improved up to 8.1% in the nano fluid flow. using the porous media and nano fluid causes an undesirable increase in the pressure drop. To take both the heat transfer enhancement and pressure drop into consideration, a Performance Evaluation Criterion (PEC) has been used for nano fluid and porous media, separately. It is observed that as the nano particle volume fraction increases from 0.2% to 0.6%, the performance of nano fluid flow, PEC*nf* 21 , is enhanced from 1.07 to 1.34 in the lowest flow rate (0.5 lit⁄min). Also, the performance evaluation of the porous media, PEC*p* shows that the solar collector.

Manuel F. Azamar,[3]Open-cell Al foams were produced by the replication casting technique in three different pore sizes. All produced foams were physically characterized, determining their relative density, porosity, and pores per inch, as well as their mean pore surface area and diameter. Permeability tests were carried out by means of the injection of a highly pressurized gasoline additive at room temperature and 200 °C, at pressures of up to 25,000 psi. The structural capacity of the studied specimens to conduct fluids at these critical experimental conditions was assessed by means of compression tests in order to determine their mechanical properties after the permeability tests, e.g., energy absorption capacity, young's modulus, and plateau stress. It was found that the produced open-cell Al foams were able of conducting the gasoline additive at critical flow conditions of pressure and temperature, without suffering important physical nor structural damage.

Tan wan,[4]In this study, we found that porous CaCl2 granules can be easily deformed undercertain pressure and temperature conditions. Based on this finding, a new infiltration process that employs CaCl2 granu lesas space-holders was developed to prepare aluminium(Al) foam with high porosity. In this process, porousCaCl2 granule preforms were first subjected to hot-pressing deformation, which provided two benefits:1) the density of the preform was increased, thereby increasing the porosity of the final preparedopen-cell Al foam (over 80%)
and 2) the contact surface of the neighbouring CaCl2 granules was increased. After hot- pressing, the sizes of the dissolution and removal channels of CaCl2 increased. Consequently, the space-holder particles could be completely removed, which is just the most difficult bottleneck problemin the traditional infiltration process applying salt particles as space- holders in which the saltremoval is not enough and the porosity is lower than 65%.

Bhupesh Goyal, [5]Generally, porosity is not a desirable characteristic of any material. In today's Industrial scenario, this parameter becomes necessity of materials for different applications like structural, solar absorbers, and sound absorption as well as biomedical applications. Metal foams are cellular structures contain porosity which increases mechanical, thermal and other physical properties of conventional materials. There are manufacturing issues concern with these materials like homogeneity and location of pores, controlling of parameters. In this article, the techniques of manufacturing of porous materials are discussed with their limiting parameters and pros & cons. Powder metallurgy is found suitable for better porosity but the cost for this process constrain its usage among the researchers and Industry as well. Space holder method is one of the found appropriate among all other used for the manufacturing of open and closed cell foam in perspective of cost as well porosity. The orientation of space holder plays a crucial role for the development of better porous object. This article reviews the different methods of manufacturing and their properties for the better future perspective in terms of cost, structure and application of porous foams.

Prakash H. jadhav, [7]In this contemporary research, a parametric analysis of partially filled high porosity metallic foams in a horizontal conduit is performed to augment heat transfer with reasonable pressure drop. The investigation includes six different models filledpartly with aluminum foam by varying internal diameter of foams from the wall side and external diameter of foam from the core of the tube. The pore density of the foam ranges from 10 to 45 PPI and their porosity varies from 0.90 to 0.95. Flow dynamics are captured using Darcy Extended For chheimer model for the porous filled region and two-equation turbulence k-ω model employed in clear region of the fluid. The local thermal non- equilibrium assumption is incorporated in porous filled region of the conduit to compute the heat transport characteristics. The results showed that the thermal performance factor of 10 PPI aluminum foam performs close to the 10 PPI expensive copper foam. The performance factor is found to be higher for 30 PPI aluminum foam amongst the PPIs of the foam considered. However, the performance factor is found to be 2.93, 2.22 and 1.73 for 30PPI, 45 PPI and 20PPI with their porosities of 0.92, 0.90 and 0.90, respectively for the model 1, model 2 and model 3 at lower Reynolds number of 4500 and then it decreases progressively with increasing flow rates of the fluid. The results of average wall temperature, average Nusselt number and Colburn j factor are also evaluated to obtain best possible performance.

R. karuppasamy,[8]in recent years, developments of new materials are finding more importance in various engineering applications the reason for this development is attributedto the needed for the lighter and strong ermaterials. The major advantage of lighterand stronger materials is that, it improves the efficiency of the parts made of materials without compromising on the strength of the part. Most of the researchers are investing the development of aluminium foam production methods and its characters and properties. In this paper discuss the production methods and applications of aluminium foam. Different types of aluminium foams are closed and open cell structure. This can be produced through stir casting, infiltration, powder metallurgy and sand-casting methods are used.

Haitao Hu, [9]Hydrophobic metal foam has a great potential for improving the boiling characteristics. In the present study, the nucleate pool boiling heat transfer characteristics of water on the hydrophobic metal foam covers were experiment ally investigated. The experimental conditions cover the metal foam pore density of 5–40 PPI (pores perinch), the porosity of 85%-95%, and the heat flux of 0–2 × 106 W/m2. The experimental results show that, at heat flux smaller than 1.3 × 106 W/m2, the pool boiling heat transfer coefficient is increased maximally by 36%and the incipient boiling superheated degree is decreased by 0.4–1.4 K through hydrophobic modification on metal fibres; with the increasing heat flux, the increment of heat transfer coefficient decreases; at high heat flux, the heat transfer coefficient of hydrophobic metal foams is smaller than that of uncoated ones. The hydrophobic modification effect factor EFHy varies within 0.88–1.36. A new correlation forpool boiling on uncoated and hydrophobic metal foam covers was developed with an average deviation of 10.2%.

Xiaohu yang,[10]Thermal energy storage technology has attracted extensive attentionsdue to its remarkable energy-saving benefits. However, the low thermal conductivity of phase change materials seriously limits the energy storage efficiency, which put forward more stringent requirements for heat transfer enhancement. In this study, a two-dimensional axi symmetric simulation model with natural convection was established for the shell-and- tube thermal energy storage unit. Open-cell metal foam with a porosity of 0.94 and pore density of15 pore per inch was employed to be arranged in either heat transfer fluid or phasechange materials domains. The effects of the metal foam location and the metal foam porosity on the heat storage performance were studied. The numerical method was verified by experimental measurement, achieving good agreement. Results demonstrated that metal foam can significantly enhance heat transfer due mainly to the reduction of thermal resistance in heat transfer fluid. The case that both domains for heat transfer fluid and phase change materials were embedded in porous media can provide the best heat transfer enhancement. Compared with smooth tube without metal foam, the full melting time for thiscase was reduced by 88.548%; meanwhile, temperature response rate, heat flux and j-fact or were increased by 834.27%, 774.90%, 5186.91% respectively. Besides, embedding metal foam into phase change materials can improve the temperature uniformity of phase change materials.

Bernardo Buonomo, [11]foam. LTNE condition are assumed. The purpose of the investigation is to find the heat exchanger dimensions to evaluate a compromise between theheat transfer improvement and the increase in pressure drop. The results are showed in terms of heat and mechanism transfer improvement and the increase in pressure drop. The results are showed in terms of heat and mechanical power ratio. It is found an optimal foam thickness in terms of tube diameter equal to 5. At the end, the Energy Performance Ratio (EPR) is evaluated to determine the efficiency of the metal foam and the best value is obtained for Re=800.

Y. Vazifeshenas,[12]Conventional cooling channel flow fields of Polymer Electrolyte Membrane Fuel Cells (PEMFCs) introduce some challenges that would reduce the cell total performance. So, presenting novel ideas to improve the cooling flow fields is fully appreciable. The more common conventional flow fields include the serpentine, parallel and Multichannel would be precisely studied in this paper. In order to see the effect of porous materials in heat transfer, metal foams were introduced to the channels. Unlike continuous long flow passages in conventional channels, metal foams provide randomly interrupted flow passages. Re-circulation of fluid, due to randomly distributed tortuous ligaments, enhances the heat transfer in these new channels. Moreover, to assess the features of utilizing metal foams in cooling channels, different parameters like metal type, porosity percentage and also, the cooling media were investigated. Since both thermal and hydraulic points of view are important in cooling engineering, the heat transfer and pressure drop for all three channel typeswere verified. The results showed that enhancing the porosity of the metal foam would decrease both heat transfer and pressure drop. Also, the multi-channel type revealed the best heat transfer behaviour in presence of metal foams.

Gholamreza Bamorovat Abadi,[13]Heat transfer in small tubes is of particular interest in the heat exchanger industry for manufacturing shell-and-tube or concentric-tube heat exchangers. Metal-foam-filled tubes enhance the heat transfer mechanism by providing a high surface-area-to-volume ratio. This experimental study investigates the heat transfer andpressure drop in such tubes. Single-phase experiments were performed using copper tubes with an inner diameter of 4 mm and filled with copper metal foam. R245fa refrigerant was used as the working fluid with mass flux ranging from 200 to 1000 kg/m2 s. The heat transfercoefficient and pressure drop data are reported and compared to a tube without metalfoam. The experimental data are also compared to well-known correlations from the literature. Most of the correlations are unable to capture any data point since they were developed for much bigger channels. New correlations are proposed to predict the heat transfer coefficient and pressure drop in such small tubes with metal foam in side.

J. Kadkhodapour,[14]In this study, experimental procedure and numerical methods were utilized to evaluate the effect of regular and irregular pore distribution as well as loading direction on compressive properties and deformation mechanism of hollow sphere aluminium foams. In order to study scaling laws, different volume fractions of the regular samples were produced and loaded in horizontal and vertical directions to address the loading conditions effects. For this purpose, expanded polystyrene (EPS) grains were expanded to a designed diameter size and positioned in different configurations. Compression test results showed higher elastic properties for irregular sample due to the thicker cell walls while energy absorption capability at high strains was found to be reduced due to the non-uniform deformation in comparison with regular foams. In regular samples, anonlinear behaviour in the elastic regime was observed since the imperfections during casting procedure. Furthermore, similar deformation mechanisms were found for the set of samples with similar pore configurations indicating the feasibility of controlling deformation mechanism by manipulating morphological characteristics. Finite element results well predicted deformationmechanism of structures and plastic properties of regular hollow sphere samples especially for plateau stress with less than 12% relative error.

Roman Dyga,[15]the paper reports the current state of the art and results obtained from research into heat transfer through metal foams filled with fluid. The impact of the fluid on the value of so-called effective thermal conductivity of foam and the heat transfer mechanismin a foam–fluid system is described. The experimental research was conducted using three aluminium foams with cells that were filled with air, water and oil. A substantialimpact of fluid on the effective thermal conductivity value of metal foams was found. This impact is particularly remarkable in the case of fluid circulations in cellular structure of the foam. A correlation that describes effective thermal conductivity of foam–fluid system was developed. The proposed model also finds its application for convective heat transfer in the intercellular area of foams.

Mohsen Nazari,[16]the interaction of nano fluids with extended surfaces in the form of porous structures and its effect on the thermal performance of the heat exchanger is not well documented. In this study, the forced convective heat transfer due to flow of

Al2O3/Water nano fluid through a circular tube filled with a metal foam is investigated experimentally. An isothermal boundary condition is created and the pressure drop and the heat transfer rate are measured over a range of flow rates. The results are compared with values for water flowing through a similar tube without the metal foam insert. The experimental data indicatea significant improvement in the heat transfer rate at the cost of a pressure drop increase. Our experimental data also show a direct relationship between the Nusselt number and the volumefraction of Al2O3.

K. NAWAZ,[17]High-porosity metal foams, with novel thermal, mechanical, electrical, andacoustic properties, are being more widely used in various industrial applications. In this paper, open-cell aluminium foam is considered as a highly compact replacement for conventional louver fins in brazed aluminium heat exchangers. A model based on the ε- NTU method is developed to compare the flat-tube, serpentine louver-fin heat exchanger to the flat-tube metal-foam heat exchanger. The two heat exchangers are subjected to identical thermal-hydraulic requirements, and volume, mass, and cost of the metal-foam and louver- findesigns are compared. The results show that the same performance is achieved using the metal-foam heat exchanger but a lighter and smaller heat exchanger is required. However, thecost of the metal-foam heat exchanger is currently much higher than that of the louver-fin heat exchanger, because of the high price of metal foams. If the price of metal foam falls to equal that of louver-fin stock (per unit mass), then the metal-foam heat exchanger will be lessexpensive, smaller, and lighter than the louver-fin heat exchanger, with identical thermalperformance.

M. Odabaee,[18]A numerical study has been conducted to examine the heat transfer from a metal foam-wrapped tube bundle. Effects of key parameters, including the free stream velocity, longitudinal and transversal tube pitch, metal foam thickness and characteristics of the foam (such as porosity, permeability, and form drag coefficient) on heat and fluid flow are examined. It can be observed that the performance of the metal foam heat exchangers, measured in terms of area goodness factor, can noticeably be better than that of the conventional design of finned-tube heat exchangers. It is also found that even a very thin layer of metal foam, when wrapped around a bare tube bundle, can significantly improve thearea goodness factor. Finally, it is shown that while friction factor is more sensitive to the metal foam permeability than its porosity, the converse is true when it comes to the Colburn factor.

R. Surace,[19]the interesting properties of metal foams as light weight, good energy absorption, low thermal conductivity, recyclability have spurred new process developments with the goal to obtain materials with a good relation between properties and costs. The different manufacturing methods are classified according to the starting metal state: liquid, powdered or ionized. The aim of this study is to evaluate the morphological and mechanical foam properties and to optimise the process parameters of a space holder method starting from powders: the Sintering and Dissolution Process (SDP).During the experimental work the samples have been realised following the principles of Design of Experiment (DOE). The analysed parameters are: the composition, the pressure and the sintering time. The final evaluations of the most important features (relative density and plateau stress) have been made by ANOVA statistical analysis to identify the most influencing variables onfoam quality.

Kolli Harish Kumar,[20]Energy demand in the present scenario is rising to meet the increasing demands of energy usage. On the other hand, the use for renewable energy sourcesnow becomes essential to mitigate the climate change as well as to reduce gradual depletion of fossil fuels. Among these renewable energy sources, solar energy particularly solar thermalsystems have phenomenal scope in present and future research. In solar thermal systems,concentrators are used to extract the energy from solar irradiation and convert it into usefulform. Among different types of solar concentrators, the parabolic dishsolar concentrator ispreferred as it has high efficiency, high power density, low maintenance, and potential forlong durability. In this paper, a detailed review has been carried out on the design parameterslike focal length, concentration ratio, and rim angle ofthe parabolic dish solar concentratorsystem for achieving higher overall efficiency. The effects of different geometrical shapes of receivers on the overall heat transfer rates are discussed in this paper. Conical shaped receiveris having high overall optical and thermal efficiency comparing with other shapes ofreceivers. This study also shows that how thethermal performance of the receiver getsenhanced by 10–13% using nano fluids in place of general heat transfer fluids. The paperhighlights different models using ray- tracing method for estimation and evaluation of thesolar irradiation distribution on the receiver surface. The empirical relations for the design ofparabolic dish solar concentrator system are derived for estimating overall concentratorefficiency and heat available at the receiver are given in this review. From the literature, thethermal performance of the receiver affecting the overall performance of the system isobserved. Thermal losses due togeometrical properties and ordination of the receiver areexplained in the observation section.

J. Subramani,[21]the present work investigated thermal performance and heat transfer characteristics of a solar parabolic trough collector usingAl2O3/DI-H2O nano fluids. Nano fluids of varying concentrations(0.05% / _ 0.5%) with mass flows (0.0083–0.05 kg/s) were considered for turbulent regime (2401 _ Re_7202) analysis. Experiments were carried out asper ASHRAE 93(2010) standards. By thermal performance analysis using Al2O3 nano fluid, it wasunder stood that the collector efficiency improved up to 56% at a maximum volume concentration of / 5 0.5% and flow rate of0.05 kg/s. The heat transfer study comparing Al2O3 nano fluid with pure water showed appreciable reduction in temperature gradient and surface temperature of the absorber. The heat transfer characteristics such as Nusselt number and friction factor relating to Reynolds number fits the experimental and predicted data and found within the limits of 65.35% and 69.61% for Nusselt number and friction factor respectively. Moreover, a similar empirical correlation was developed for collector efficiency, which was identified to be within the limit of 61.02%. VC 2017.

Alka Bharti,[22]in this paper, the design stages of a solar parabolic trough collector is presented. The design of prototype was done using Creo parametric 2.0 software. The design parameters are decided on the basis of analysis and its effects due to variations in the parameters. This design process will be useful in fabrication of solar parabolic trough collector.

Mostafa Alizadeh,[23]in this study, open cell Al–Al2O3 composite foams having different volume fractions of Al2O3 (0–10 vol.%)were synthesized by using the space-holder technique. Various amounts of spherical carbamide particles with mean size of 1.2 mm wereused for producing porosity fractions of 50, 60 and 70 vol.%. Compression test was performed on the foam samples for evaluating the compressive properties and energy absorption behaviour of them. The results showed that the compressive properties and energy absorption behaviour depend on the volume fraction of Al2O3 and porosity fraction. Generally, by decreasing the porosity fraction, the energy absorption capacity and compressive properties were raised. The composite foams containing 2 vol.% Al2O3 showed superior compressive properties and energy absorption behaviour in contrast to other foams studied in this work. Also, it was found, as the strain during the compression test is increased, the energy absorption capacity is increased too. It is noticeable that, the slope of energy absorption capacity–strain curves decrease by increasing the porosity fraction.

A. Şakir BOR,[24]the present study was undertaken to investigate the production of a highporosity, biocompatible Ti-6Al-4V alloy by space holder technique using spherical carbamide particles, and to characterize the produced samples by compression tests and SEM images. The technique includes the following steps: mixing of100-600 μm diameter spherical carbamide particles with irregular Ti-6Al-4V alloy powder of <78 μm size, compaction of the mixture of carbamide particles and Ti-6Al-4V powders by cold uniaxial die pressing, removal of carbamide by melting and dissociation, and sintering of the compact. Optimum compaction pressure, which preserves carbamide sphericity while providing the required packing of Ti alloy powders, was found to be 450 MPa. Ti-6Al-4V alloy foams of porosities between 60% and 75% with mean pore sizes of ~400 μm and mean sphericity values of 0.65 were successfully produced. Yield strength was observed to exponentially decrease with porosity, which is typical of cellular metals, reaching significantly low values at around 65% porosity, which was thought to be a result of pore coalescence.

Ghariya Hanshrajkumar Bhupendrasinha, [24]Research and new innovative technologies have started a new revolution in the area of energy development with storage capacity. One or other issues is that researchers are lacking with the conservation or storage of this energy. Porous Materials could be the concept which can be used to conserve energy in the solar sector. Metal foam or porous material which results in an increase in surface area can be taken as a source for energy conservation or storage received from the energy source. Solar Parabolic Trough Collector which is solar operated device can be an approach of the energy conversion. In this research article, performance and working of solar parabolic trough collector is been observed utilization of porous material as receiver of solarenergy. The temperature of water flowing through the system was increased with the use of porous material in the solar parabolic trough collector. Finally, the efficiency of the systemis improved.

3. EXPERIMENTAL WORK

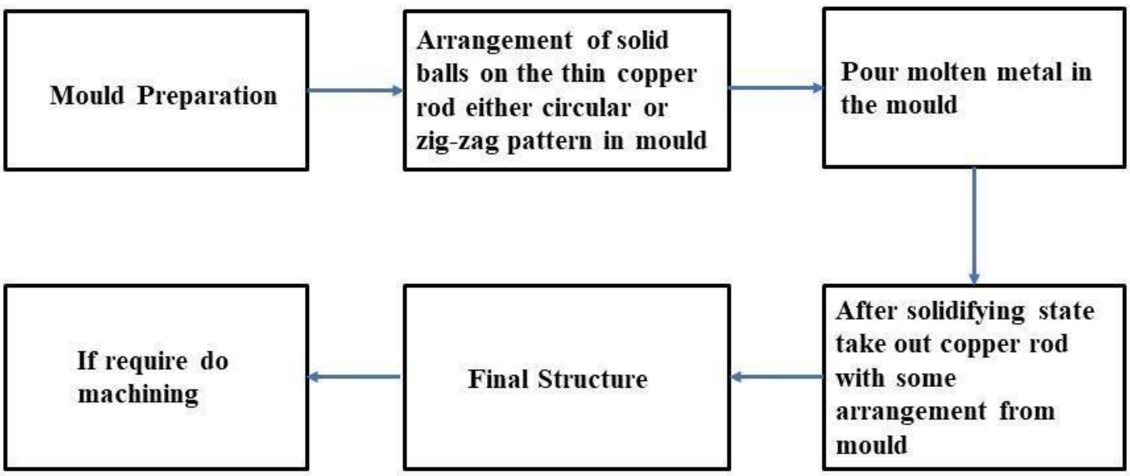

Fig 3: - Line Diagram of space holder method

This method almost follows the traditional casting method with some modification to make porous structure.[5] Solid balls like sand balls, “Kushal Kanthil” goli, NACL (Sodium chloride) are the options to get the pores inside the structure. In mould solid balls are insert on the thin copper rod one by one on another in vertical direction according to the requirement of porosity in the structure. Now number of thin copper rods with solid balls are arrange either circular or zig-zag pattern in the mould. Molten metal pours in the mould and certain time are required to solidify molten metal then after solidifying thin copper rods are pluck out from the mould carefully by some arrangement. Finally, it comes out as the porous structure from mould and for some application if required do machining on that casted porous structure. Proper location or uniformdistribution of pores and orientation of pores is solved by this method compare to above mentioned methods.[1]

1st casting: -

Casting material: - Aluminum

Structure: -
- Fiber plastic ball (2mm),
- Copper wire (Dia- 1mm, Length- 100mm)

Results: - fail

Casting method: - Open die casting

Fig 4: - structure (1st casting)

Fig 5: - casting

Fig 6: - element 1st casting

2nd casting :-
Casting material :- Aluminum

Structure:-

- Kusal kanthil (3mm),
- Copper wire (Dia- 1mm, Length- 100mm)

Casting method :- Open die casting

Results :-
Object cylindrical bar shape Dimension :-L - 53mm
D - 65mm

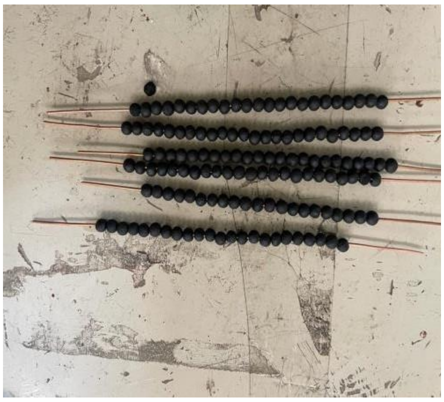

Fig 7: - structure (2nd casting) **Fig.8:** - setup of structure **Fig 9**: - casting

3rd casting: -
Casting material: - Aluminum

Structure: -

- Kusal kanthil (3mm),
- Copper wire (Dia- 1mm, Length- 100mm)

Casting method: - Open die casting

Results: -
Object cylindrical bar shape Dimension :-
L- 51mm
D - 60mm

Fig 10: - structure (3rd casting) **Fig 11**: - setup of structure **Fig 12**: - element 3rd casting

4. RESULTS AND DISCUSION

1) In 1st casting process fiber plastic balls are used to create porosity in the pipe but it's fails becauseit can't resist the molten temperature of aluminum alloy 6061 and it melts inside the mould cavity.So from this process porous structure is not obtained at the end of experiment.

2) In 3rd casting process kusal kanthil balls are used to create porosity in the pipe and it can resist the molten temperature of aluminum 6061 alloy. At the end of the process porous structure is obtained in the metal foam pipe through out the length of pipe.

5. CONCLUSION

From the experiment it is concluded that as the contact surface area increases in the pipe heat transfer rate also increases. Metal foam pipe manufactured by space holder technique gives minimum pore size inside the structure. Space holder technique gives better porosity in the structure in terms of size and orientation compare to other existing techniques.

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