Formations of Silicon Carbide and Epoxy Matrix Radiator: An Experimental Design, Dimension and Formulations

S Ramu, K Krishnakumar, A Shanmugasundaram, BR RameshBapu

Abstract: The greatest dealon the article have to approach the experimental design, dimensions and formulations in Silicon Carbide and Epoxy Matrix Radiator. The experiment prepared as per the fabrication chart behind that known about the characterization of material and proposal layout of fabrication work. Among the research work, concentrated the formation of silicon carbide epoxy matrix radiator in the given configuration and composition prepared as a high thermal conductive Epoxy resin is mixed at the ratio of 20wt% of epoxy resin 80% of Silicon Carbide. As silicon carbide has higher thermal conductivity and lowerthermal expansion than Aluminium and then the experimented result determined by the rate of heat transfer analysis such as the mode of heat transfer like Conduction, Convection and Radiation of the materials (Aluminium 6061 and Sic + Epoxy Resin). The following heat transfer characteristics formulated and calculated as per the given design, dimension and configuration of the materials.

Keywords: Aluminium 6061, Silicon Carbide Epoxy Matrix, Radiator, Thermal Conductivity.

I. INTRODUCTION

A. Silicon carbide

Silicon carbide can prepare as a structural member and characteristic are low thermal expansion, high thermal conductivity, hardness, resistance to abrasive and corrosion and most important to withstand of elastic resistance at the temperature maintained up to 1650°C have led to the suitable applications.Most probable techniques were handled and composed of tetrahedral carbon and silicon atoms preparation to build strong bond in the formation of crystalline lattice structure. The suited material properties tested about the heat conduction in electric material, electric furnace and thermistor for temperature variable offered in resistance.

Formations of Silicon Carbide and Technology
There are some classified structures availed to prepare the structural silicon carbide member:
a) Sintered
b) Bonded
c) Liquid Phase
d) Sintered solid state

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Mostly SiC bonded by the reaction of compound arrange as a continue matrix of SiC having 5% to 20%. As know that the powder coal containing and added or decomposes of resin maintained imitate temperature 1500°C.

When the process of sintered structure can arrange the continue matrix formation where the silicon reacted to perform a structure of bridge and remaining silica has residual pore give complete dense in uncovered area or non-reacted silicon area. The structural integrated on that point noted temperature 1370°C and melted 1410°C. The literature and characteristic can able to identify the group of composite materials are silicon carbide make perfect suit of ceramics and its applications.

But the strong character of the silicon carbide are elastic modulus, thermal expansion like conductivity and diffusivity of material. Best suit for rapid changes in temperature can preference identifiable materials are $Si3N_4$ over SiC. To avoid furnace resistance and over lead the suitable application and uses are in combustion engine such as turbine rotor.

Application are:
a) Sand blasting injector
b) Automotive water pump seals
c) Bearings
d) Pump components
e) Extrusion die

B. Epoxy Resin

In general composition should have charted the alloying techniques to meet the required properties of material such as thermal properties and mechanical properties. Fiber reinforced polymer epoxy method hold most efficient fiber content in the formation of the structures built in resin matrix.

II. LITERATURE SURVEY

A. Reinforced Polymer Composites

The main objective of the paper involved fabrication and technology of the work composing of epoxy and polyester resin composite using materials are aluminium oxide and silicon carbide with various proportionality composed as a alloying composite reinforcement. The proportional made with GFRP contain extremely five fibers of glass. The epoxy resin given binding properties of fibres layers and hardener executed to improve adhesion and strength of the composite ratio 10:1 and in term as Hy 951 obtained as matrix composition.

They were done experimental work as per the standard setup and processes handled to preparing the hardening in the formations of solid matrix like liquid monomer polymerizes into the polymer.

Compositions were executed ranges in four different samples:

Sic (3%) + Al_2O_3 (3%) + Epoxy

Sic (2%) + Al_2O_3 (2%) + Epoxy

Sic (3%) + Al_2O_3 (3%) + Polyester

Sic (2%) + Al_2O_3 (2%) + Polyester

With this test sample experimented the mechanical characteristics like Tensile Strength, Shear Strength, Impact Test, Hardness Test and Biaxial Strength completed successfully by this article. Maximum tensile strength reached 36.53 MPa, Shear Strength 6.45 kN, Biaxial Stress 40.7 MPa, Good Stiffness and Shrinkage reduced.[1]

B. Heat Transfer Process of Internal and External Flow in Radiators

Illustrated the general contribution of the heat exchanger used to exchange the heat from hot fluid to cold fluid to achieve the maximum thermal and overall efficiency of the radiator. Accompanied of the project discussed about the mode of heat transfer (Conduction, Convection and Radiation), including the part of internal and external fluid flow with the annulus dimension to found the effectiveness of the heat exchanger. Mainly it has determined and investigated the characteristics of heat transfer, when the observation of the project proposed the character of heat exchanger expressed the analysis of internal fluid flow, fluid non-circular tube section, yield heat transfer coefficient in water corresponding the similarity of air flow to heat exchanger tube where observed in external flow direction across in the radiator tube and protruded number of fins along the circumferences on the area to increase the rate of heat transfer. These method of work were executed as numerous assumption technique in heat exchanger.[2]

C. Modern and Conventional Radiators

This article have studied different factor the influence the performance of the radiator along with reviews of conventional and modern enhancement in improving the performance of the radiator. And the factors that affected by the engine cooling system such fuel consumption and thermal efficiency.[3]

D. Change in Heat Exchanger Material

Explained in the dealt that to apply the graphite foam content over the radiator to found the potential matter of material in heat exchanger. The structure of heat exchanger were designed as a corrugated model and extended surface designed louver strips model using materials were aluminium to withstand maximum rate of temperature to exchanges. Especially design of heat exchanger and applied foam techniques contributed light weight model of radiator to achieve the performance of the heat exchanger. Where the experimental result compared with the aluminium and copper material, resulting achieved expected COP value than the other methods. Selection of graphite material enumerated before the fabrication by the case study, Similarity of the graphite reached high pressure drop, low Coefficient of Performance value to performed the higher rate of heat transfer in the radiator.[4]

III. MATERIALS AND METHODOLOGY

A. Software used for Designing

The design was done by using AUTOCAD software. The design was done in 2D. The radiator is drawn in first angle projection and the tube is drawn in isometric view.
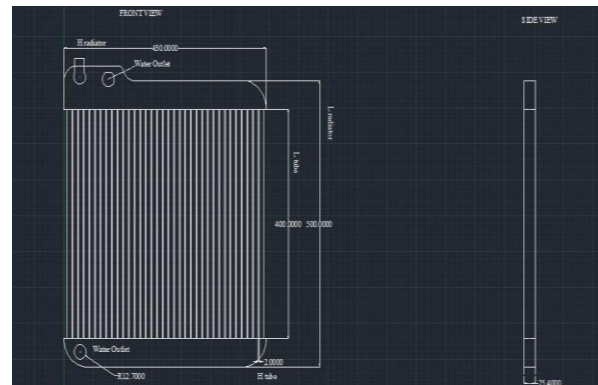

Fig: 1 Radiator design front and side view in AUTOCAD Software

B. Silicon Carbide

Silicon carbide of 50μm about 500gm was bought from Vazirbun Trading, Broadway, Chennai.

C. Radiator

The radiator used in this project is a Universal Aluminum Radiator. Model belong to Hyundai Santro along with the fan was purchased in Raja Car Parts at Pudupet.
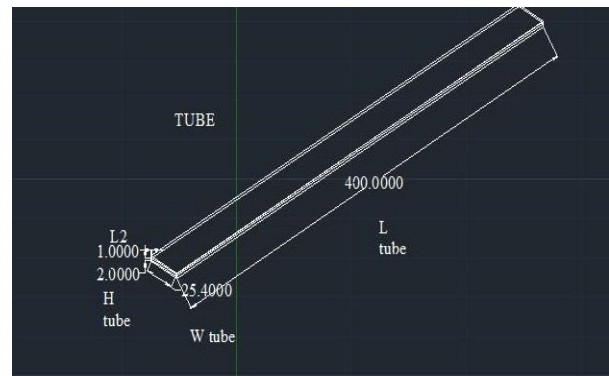

Fig: 2 Radiator Fin Dimensions in AutoCAD Software

Fig: 3 Silicon Carbide

D. Epoxy Resin

An epoxy resin Araldite AW106 Resin and HV 953 U Hardener of 500ml each is purchased at Universal Machine Tools, Broadway, Chennai.
The resin is diglycidyl ether of

bisphenol-A and hardener is 2-ethyl-4-Methylimidazole.

Table 1: Material Properties

Properties	Resin	Hardener
Colour / Appearance	Colourless Liquid	Amber Liquid
Specific Gravity	1.17	0.92
Viscosity	50000	35000
Thermal Conductivity	0.39 W/m2K	

E. Fabrication Technology

Ripping of Fins

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Formation of Sic and Epoxy Matrix
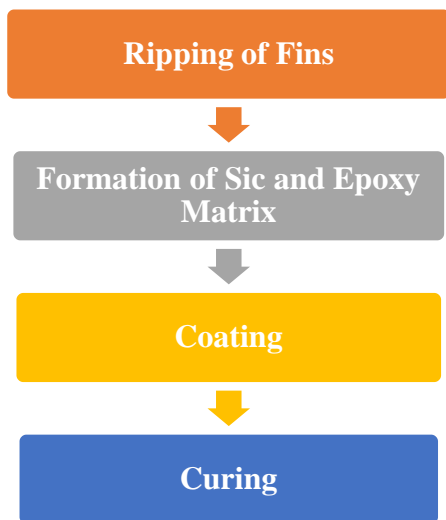
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Coating

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Curing

Fig: 4 Layout diagram for fabrication methodology

Table: 2 Radiator Dimensions and Parameters

L radiator	H radiator	W radiator	L tube	H tube	W tube	N tube
m	M	m	m	m	m	No Unit
0.5	0.43	0.0254	0.40	0.002	0.0254	35

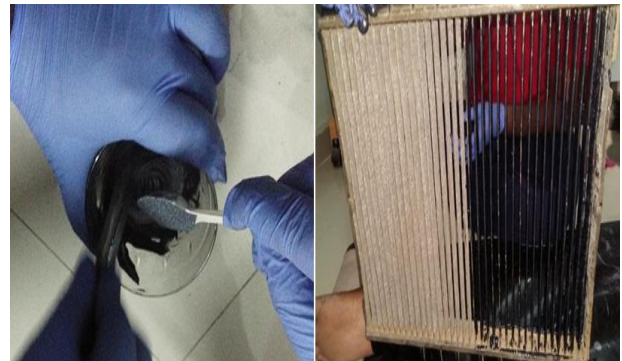**Fig. 5 Ripping of fins and Soldering Tool**

Fig:6 Silicon Carbide Surface Coating in Radiator

IV. CALCULATION & DISCUSSION

A. Internal Flow of Water

While experimenting the hot water flows from the engine through the radiator tube, the heat exchanger basic dimensions are observed non-circular cross section in hydraulic diameter. The flow of water content observed the rate of flow and determined the Reynolds number. When exposed the calculated dimensions of the wetted perimeter are negligible. Similarly the air flow across the bundle of the radiator tubes, where flow opposes the direction as crossed flow manner. Flow of air across the bundle one by one is complicated and in dimensions, its difficulty to observe the reading and calculation of the characteristic of heat transfer. As well the part of dimension ratio height to width very small and it has considerably assumption should be required as per the standard data.

$$D_{hydraulic} = \frac{4 \times A_{tube}}{P_{tube}}$$

$$D_{hydraulic} = 3.968 \times 10^{-5} \text{ m}^2$$

$$T_{mean\ water} = \frac{T_1 + T_2}{2}$$

$$T_{mean\ water} = 63.6\ °C$$

$$V_{water} = \frac{Q_{water}}{N_{tube} \times A_{tube}}$$

$$V_{water} = 1.12 \times 10^{-5} \text{ m/sec}$$

$$Re_{water} = \frac{V_{water} \times D_{hydraulic}}{\nu_{water}}$$

$$Re_{water} = 927.866 < 2300$$

Nusselt Number

$$Nu = 3.96$$

$$h_{water} = \frac{Nu_{water} \times k_{water}}{\nu_{water}}$$

$$h_{water} = 649.98 \text{ W/m}^2 \text{ K}$$

B. External Flow of Air

$$T_{mean\,air} = \frac{T_1 + T_2}{2}$$

$$T_{mean\,air} = 40.835° \text{ C}$$

$$V_{air} = \frac{\text{Speed of the fan} \times \text{Area of the fan}}{A_{radiator} - [N_{tube} \times H_{tube} \times L_{radiator}]}$$

$$V_{air} = 10.1 \text{ m/sec}$$

$$Re = \frac{V_{air} \times W_{tube}}{\nu_{air}}$$

$$Re = 6.3125 \times 10^3 < 5 \times 10^5$$

$$Nu_{air} = 1.1 C1 \, Re_{air} \, n \, Pr^{0.33}$$

For non-circular section, assumed rectangular section. C1 =

0.205, n = 0.731

Nu = 119.22

$$h_{air} = \frac{Nu_{air} \times air}{W_{tube}}$$

$$h_{air} = 45.13 \text{ W/m}^2 \text{ K}$$

$$Q = -k \, A \frac{dT}{dx}$$

$$R = \frac{1}{A_{radiator}}[\frac{1}{h_{water}} + \frac{L_1}{K_1} + \frac{L_2}{K_2} + \frac{1}{h_{air}}]$$

$$R = 3.1814 \times 10^{-4}$$

$$Q = \frac{\Delta T}{R}$$

$$Q = 23.67 \times 10^3 \text{ Watts}$$

V. CONCLUSION

The main conclusion of the paper have dealt about the heat transfer characteristics such as Reynold number, Nusselt number and Thermal resistance in the silicon carbide epoxy matrix radiator and the sufficient data collection of the project i.e. to find the material for exchange, binder, fabrication, inlet and outlet temperature and finally the overall heat transfer coefficient were accomplished successfully.

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