International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056
Volume: 02 Issue: 03 | June-2015 www.irjet.net p-ISSN: 2395-0072

EXAMINATION OF MECHANICAL AND TRIBOLOGICAL PROPERTIES OF FIBER REINFORCED HYBRID COMPOSITES: A Review

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Abstract-*In the field of composite materials the fiber reinforced composite consisting of single fiber is used for long time. In this type of process the properties of single fiber is used for the whole material. The results would have appeared for limited area. This is because use of single fiber consisting of certain property. To overcome this problem the use of another fiber is made. This resulted in the form of hybrid composite. In this paper the hybrid composite are in the form of aramid and glass fiber. The properties of both the materials are discussed here. For this hybrid composite the epoxy resin is used as a binder. Epoxy resin in the hybrid composite will result in the strong bond for the materials.By adding the filler to the composite material we can further improve the performance of composites. The filler use in this paper is the tungsten carbide. The tungsten carbide is known for its low density. Hybrid composite s now a days used in the high level applications. This has become the backbone of the composite world today.*

Key Words: Composite materials, Hybrid composite, Tungsten carbide, Aramid fibers, Glass fibers.

1. INTRODUCTION

Composite are materials consist of two or more chemically distinct constituents on a macro-scale, having a distinct interface separating them, and which cannot be obtained by any constituent working individually. They consist of five different types. Among them polymer matrix composite (PMC) and metal matrix composite (MMC) are the commonly used in large scale. In the industries application of fibre place an important role in both type of composite matrix. Because the type of fibre used should possess required amount of strength to form the strong bond. The glass fibreis the most used and easy available fibre.

1.1 Fiber

In fibre, Aramid fibre and carbon fibre are the strong fibres compared to glass fibre. Aramid fibre is also called as Kevlar fibre. The aramid fibre can be introduced as a strong reinforcing agent in the composite material field. It will increase the mechanical properties such as tensile strength, ,flexibility and hardness. The hard materials such as bullet proof jackets are made from aramid fibres. Glass fibre/epoxy resin is the vastly used combination in the industries. It is available easily and it can be economical compares to other fibres. Aramidfibre has the structure of chain molecule which results in the formation of the strong bond in the matrix. Even at high temperature aramid fibres will not melt instead they will degrade. They were initially used for the car tyre reinforcement. Glass fibre and aramid fibre has high strength /weight ratio.

1.2 Resin

There are three commonly used resin in the composite material industry i.e Epoxy resin, polyester resin and vinyl ester resin. Among these three epoxy resin is used in wide application and purposes. It has high viscosity even at room temperature. Physical and mechanical properties of the composite materials can be increased by increasing the molecular weight. Epoxy is most costlier than the other two resin but his has got the better properties than them, like stiffness, strength etc.

1.3 Filler

Filler forms the addition strength to the mechanical properties of the composite materials. In this fillers tungsten carbide is one of the best fillers available. Tungsten carbide got low density, whereas nano tungsten carbide fillers got much more low density compared to normal tungsten carbide. The tungsten carbide when used as reinforcement it will increase the properties like tensile strength, Young's modulus, ultimate tensile strength, hardness of the entire composite material. Tungsten carbide can be reinforced to the composite material by many processes such as powder metallurgy, Arc welding etc.

2. LITERATURE REVIEW

The use of hybrid fibers is increasing due to their unique property of increasing the strength in the composite material. They are easily available and but cost

is higher compares to that of natural fibers. But the properties of the synthetic fibers are far better than the natural fibers. Natural fibers are available in large scale and at low cost. But they lack the quality of the synthetic fibers.

Density of the aramid fiber in composites were investigated byRogeriolagomazur ,Michelleleali costa et al[1], The work is concentrated on the low density of the aramid fiber. The property can be enhanced by adding epoxy resin to the system. They even tried to repair the broken composite material with the help of the epoxy mixed with aramid fiber.

A research has been carried by Zahra riahi and farizadfshin[2] they also tried to repair the composite material. So that it gives high performance with the minimum effort. There advantages over the natural fibers were investigated. When the mechanical properties were checked it showed higher result than the other fibers. Aramid or Kevlar fiber is analyzed in this paper .

Further when the tensile properties were compared the synthetic fiber showed higher tensile strength at certain load compared to natural fibers.Arpitha G R, Sanjay M R, B Yogesha[3] said that the natural fibers can decompose in the soil. As a result they can become environmental friendly. The synthetic fiber lack this quality of the natural fiber. But when we take application wise natural fiber cannot match with the synthetic fiber.
(e.g. bullet proof jackets ,hard tolls, For drilling purpose). Natural fibers cannot be used in this type of application.

Manoj single and Vikaschawla[4]made the experimental on the marine industry, especially on the surface of the ships. Here the surface of the ship is exposed to the mine blast that take place in the sea when the battle break downs. Lot of life were dependent on this surface of the ship to observe theblast from the bottom of the sea. So the author made use of glass fiber in large scale in order to provide the protection from the blast. Fly ash and epoxy resin in different proportion were varied and the results were tabulated. The better composition known is further used as the base composition for the battle ships,

Critiane M. Becker,TeoA.Dick et al[5]has studied effect of epoxy resin in the composite material. The epoxy resin might have good mechanical properties but they lack the thermal properties. Under high temperature they will catch fire easily. This may result in the complete failure of the composite material. So it is mixed with the LDH. This LDH will act as fire resistant in the epoxy resin. By this the fire problem of the epoxy cab be controlled.

Another research conducted by M.M. Raj, L.M.Raj, P.N. Dave[6] made an effort to change the property of the epoxy resin. Here he used the blending technique to make the modification. Phenolic urea oligomers with four different groups were used for the blending technique. It was noted that the stability of the epoxy is increased and the phenolic groups acted as an curing agent in the process. By using this kind of technique the property of the epoxy can be increased. The impact strength of the final composite material can be decreased.

GaoGuangfa, Li Youngchi, Jing Zheng, Yuan Shujie[7] choose the glass fiber as the base material for the whole process. Their aim was to find out the ultimate body of the aircraft using the glass fiber. The glass fiber may have low density but it lacks the mechanical property to be the ultimate surface body of the aircraft. So they decided to add the epoxy resin to the glass fiber. The epoxy resin was introduced at the high temperature. At the high temperature the glass/epoxy combination was found to yield the better mechanical properties than before.

Yu-Chung Tseng, Chih Yu Kuo[8] as other authors they didn't tried to increase the mechanical properties of the glass/epoxy composite material. They tried to find out the new method to improve the properties of the matrix. Initially they decided to find out fabrication process for glass epoxy composite material for the use of turbine. Their idea was to find out the best structure for the low power turbine, so that it can perform at high level. The turbines are usually made out of aluminum. Adding glass fiber/epoxy to the system will increase the properties.

Rim Ben Toumi, Jacques Renard et al[9], Carriedout the non-destructive testing initially for the composite material. This test makes sure the component is defect free. Then the remaining test were done including static and fatigue test. E- Glass fiber is used in the process. Under different loading condition the material was analyzed. The effect of static and fatigue were discussed.

R. Murugan, R. Ramesh, K. Padmanbhan[10] Studied the effect of hybrid composite in the aircraft industry. The aerospace industry depends on the composite material to a certain extent. The research here is taken place to improve the property of the fiber by adding another fiber of different property to it, finally forming the hybrid composite material. The application of the hybrid composite material is huge in the aerospace industry.

Another research has been successfully carried out by Ramesh K. Nayak, Alim Dash, B.C. Ray[11] to improve the efficiency of the composite material. Here three different fillers were used to find out the best property of the fiber glass/epoxy. Al_2O_3, TiO_2, SiO_2 are the three different fillers used in the fabrication process. The size of the SiO_2 is smaller compared to others. So it gives better mechanical properties than the aluminum. The aluminum has as larger size than compared to silica, so it gives the better hardness. So silica can be used to improve the properties of glass/epoxy composite material.

S.K.Singh, S.Singh, S.Sharma and V.Sharma[12]made the same effort as the other authors to improve the efficiency of the epoxy resin in the glass

fiber. He made use of montmorilloniteclosite 30B nanoclay to modify the epoxy resin. The different composition of nano clay is used such as 1%, 3%,5%. The results were analyzed. The nano clay of 3% showed better properties than the 1% and 5%.

In this work experimental investigation is carried out by .B.M.Girish, Basawaraj B.R, B.M.Satish and D.R.Somashekar[13]they added the filler to the composite material. The addition of filler especially tungsten carbide will increase the mechanical properties of the material. By liquid metallurgy process the copper is mixed with tungsten carbide to enhance the property.

The investigation carried on mechanical properties byMahaniyusoff and ZuhailawatiHussain[14] showed that the addition of filler to the composite material will increase the mechanical properties. The tungsten carbide is of low density which place an important role in property enhancement of the material.

Zhenguri Yao, Jacob J, Stiglich and T.S. Sudarshan[15]made a research on the tungsten carbide as a filler material. The powder metallurgy process is used here, the tungsten carbide is undergone all the process. Finally when added to the material, as expected all the mechanical properties were increased.

Leonard choi, Tonya Wolfe, Matthew Yarmuch and Adrian Gerlich[16] Studies the wear property of the composite material. The wear takes place where the rubbing of material takes place. The wear problem can be solved by the wear resistant material. The Tungsten Carbide is used a wear reducing agent here.

HariPrasadaRaoPydi, BalamuruganAdithan, A.SyedBavaBakrudeen[17] made use of tungsten carbide for the single fiber that is used in the matrix. Along with the aluminum, tungsten carbide is added. Aluminum consists of a low weight and the tungsten carbide is of low density. Combining these two they yield a product which is more efficient than the aluminum used alone in the composite material. They work as a hybrid composite in the matrix to improve the mechanical properties.

As we know that filler places an important role in the composite material A.R.K.Swamy, A.Ramesha, G.B. Veeresh Kumar and J.N. Prakash[18] compared the two filler materials, to get the better properties. Tungsten and graphite fiber were compared. Both almost had the same properties with slight changes. Tungsten carbide has high hardness, whereas the graphite had ductility.

The addition of nanoWC increased the tensile, flexural strength and hardness of glass epoxy composite as investigated by T.Danny Xiao, Xinglong Tan, Maozhong Yi et a[19]. The chemical water soluble treatment is done to the nano tungsten carbide. It formed a large bulk structure which is rich in hardness. Even the cobalt is also added to the tungsten carbide. Then both are treated with chemical water soluble solution. At last getting the property enhanced.

A research carried is out by J.M.Amando, M.J.Tobar, A.Yanez et al[20].To determine the crack free tungsten carbide. Every composite material should possess good quality in order to be crack free. Tungsten carbide at certain level remains crack free. There will be three stages in the composite materials. One is when the properties of the tungsten carbide will start to increase. Second it becomes maximum. Third it will star to decrease. The suitable phase is decided ad used as a basic for the composite materials.

3. CONCLUSIONS

The above review showed that the synthetic fibers will be the future of the composite materials. The following may be concluded based on this review.

- Synthetic fibers have good specificmechanical properties than natural fibers which are used in applications.
- Aramid fiber or Kevlar fiber has the best stiffness and hardness compared to the natural fibers such as jute.
- Compared to glass/epoxy composite, aramid/epoxy or the glass/aramid/epoxy was proven to be better in mechanical properties.
- Epoxy resin can be preferred first among the polyester resin and vinyl ester resin.
- Tungsten carbide when used as a filler material will improve the mechanical characters such as tensile, ultimate tensile strength, Young's modulus and hardness.
- Epoxy resin can be treated to enhance the properties of it. It can be heat treatment or any other means. Finally the total material property will be increased.
- Even the tungsten Carbide can also increase its mechanical properties. This can be achieved by the powder metallurgic process.
- The chemical treatment i.e the chemical water solution is also prepared to improve the present tungsten carbide properties.
- By the montmorilloniteclosite 30B nanoclay we can modify the property of the epoxy resin.
- Tungsten Carbide can be used as a wear resistant material. So total wear of the composite material will decrease. The results due to the no or less wear will be good.

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