*Research Journal of Chemical Sciences* _____E-ISSN 2231-606X
Vol. **6(3),** 8-15, March **(2016)** *Res. J. Chem. Sci.*

# Effect of different Concentrations on Mechanical Properties of Polymer Composites

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**Available online at: www.isca.in, www.isca.me**
Received 8th September 2015, revised 14th December 2015, accepted 10th March 2016

## Abstract

*Fiberglass is widely used in the preparation of materials such as bus bodies, aero planes, chairs, tables, in the preparation of various instruments etc. The reason for such important applications of fiberglass is that it is hard like steel and iron materials but have advantage over these that it is not rusted. It has also low weight like plastic materials. It can also be recycled and reused. In our current study we have prepared various samples of Fiberglass by hand lay –up operation method and studied the mechanical properties of these samples using Universal Test Machine. The effect of changing concentrations of various constituents is studied.*

**Keywords**: Fiberglass, Universal Testing Machine, Concentration.

## Introduction

Fiber Glass is a composite material. Composite materials are widely used from ancient times due to their outstanding properties such as low density and cost. These materials are applied widely in automotive and aerospace industries such as bushes, seals, gears, cams, and shaft etc.[1,2]. Fiber Glass is also widely used in bus, car bodies, in preparation of various instruments, tables and chairs etc.

Fiber glass, also known as glass fiber-reinforced plastic (GFRP)[3] or glass-reinforced plastic (GRP)[4] is a fiber reinforced polymer made of a plastic matrix reinforced by fine fibers made of glass.

The Glass fibers are composed of silica. In its pure form it is in the form of polymer $(SiO_2)$ n. It has no sharp melting point, but starts softening at $2000^0$C ($3632^0$F). At this temperature, it also starts degradation and most of its molecules become free moving particles. After this, if it is cooled quickly, then the molecule will not be able to get an ordered structure[5]. In the polymeric form, it forms $SiO_4$ groups, which attain tetrahedral structures with silicon in center and the four oxygen atoms at the four corners of a tetrahedron.

The silica usually needs a high temperature to be worked with it, which is a drawback of silica. Usually impurities in the form of different materials are added to the glass to lower the temperature needed for its working. These materials also impart other properties to the glass, which are beneficial in some applications. The first type of glass used for fiber was soda lime glass or A-glass. This does not show resistance to alkalis. A new type E-glass was formed; this is an alumino borosilicate glass that is Alkalis free[6]. As this type of glass is mostly affected by chemicals, such as acids, so a new type known as C-glass was introduced, this overcomes this deficiency. Glass fibers have high ratio of their surface area to their weight and this high surface area makes them more susceptible to chemical attacks. By producing air spaces between them, thermal insulation can be produced with a good thermal conductivity of 0.05w/ (m. k)[7].

Now a day E-glass is mainly used for fiberglass production all over the world. For making the glass Reinforced Plastic (GRP) or Fiber Reinforced Plastic (fiberglass), the glass is used in the form of a chopped strand mat (CSM) or a woven fabric[8]. The unsaturated polyester (using 2-butanone peroxide along with MEKP as catalyst) and Vinyl ester or epoxide compounds are used for GRP. In Fiber Glass making, the glass fiber is usually treated with a monomer or polymer and the resin, which make the material able to resist both compressive and tensile forces well[9].

The fiberglass made utensils appears just like materials made from ceramics and plastics. However the difference can be noted upon using these materials. These are stronger than plastic materials. The color of these materials is not affected by weather. It is not damaged by cold or hot weather. Upon breaking these materials can be repaired easily. These materials are less dense than other materials. These are not rusted like Iron.

The use of fiberglass made materials have also an advantage from environmental point of view. These materials can be recycled and are again used for making fiber glass materials. The recycling of fiberglass materials started at Kansas in 2009. Now a day, the Owens-Corning Corporation is using almost

40% of recycled glass as a raw material for fiberglass production[10,11]. The materials used in fiber glass production are; MEKP, PVA (solution), Resin, Cobalt / Naphthenate, Fiber mat (chopped strand mat)

## Materials and Methods

All the materials used in the fiber glass production, e.g. PVA, resin, cobalt/Naphthenate, MEKP and fiber mat, were purchased from a local Fiber glass shop named "Khyber Fiber Glass" which purchased these materials from "Al Kher Chemicals Industry, Lahore, Pakistan".

**Preparation of Composites:** Different samples will be prepared by changing the weight of different constituents of fiber glass. The general methodology used is given in the following:

First a known amount of PVA solution, Resin, Co/ Naphthenate and MEKP is taken and mixed well. The prepared solution is placed on a certain mold or a clean glass sheet. Fiber mat is placed on this mixture. Then it is compressed to make it homogenous and the sample is allowed to become dry.

A 2% PVA aqueous Solution was prepared and that was kept free from contact with air and light, so that it can be used again and again for sample preparation. The fiber mat used was mat-450 and in each sample of fiberglass composite, the fiber mat with 90mm length and 25mm width were used. The cobalt naphthenate was added to resin in a ratio of 6g/100g. The constitution of the following three materials was changed regularly for each sample of fiberglass. i. PVA solution (2% aqueous). ii. Resin and Co/ naphthenate solution. iii. MEKP.

**Instrument:** The instrument used was Universal test machine; Model no 250-25CT, Serial no 250-7046, Testometric Company Limited, Lanchashire, England. The instrument was run at the maximum sensitivity of 9, with a rate of 20mm/ minute.

**Experimental:** The fourteen samples of fiber glass sheets were prepared by the same standard technique used for the preparation of fiber glass sheets. The amounts of these three main constituents were varied according to the table given above. The chopped strand mat used in the preparation of these samples is commonly known as, by its trade name mat-450. The mat was cut into samples of length 90 mm and width 25mm, with a weight of 1 gram each. For each sample the amount of constituents were varied as shown in figures below

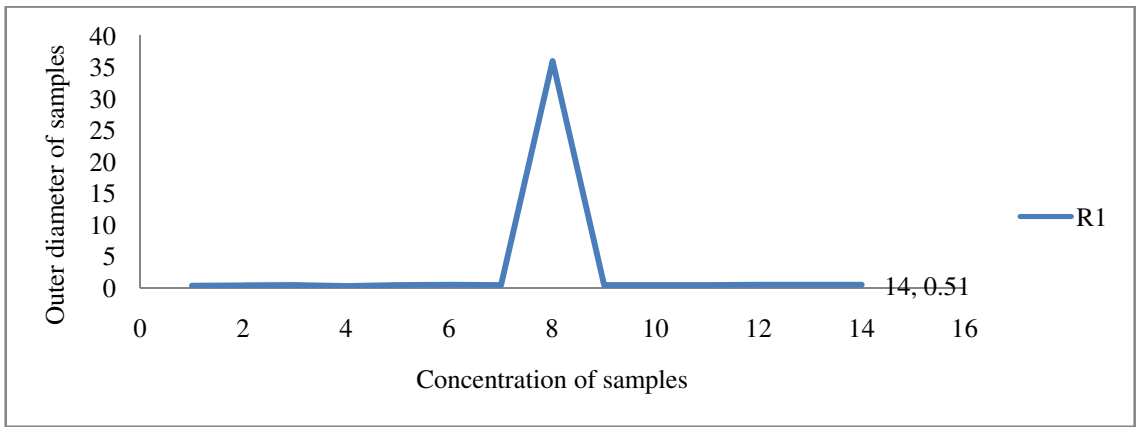


**Figure-1**
**Effect of 0 .20 grams of resin and Cobalt-nephthanate at constant MEKP (0.13 grams) and PVA (0.6 to 2.0 grams) solution**

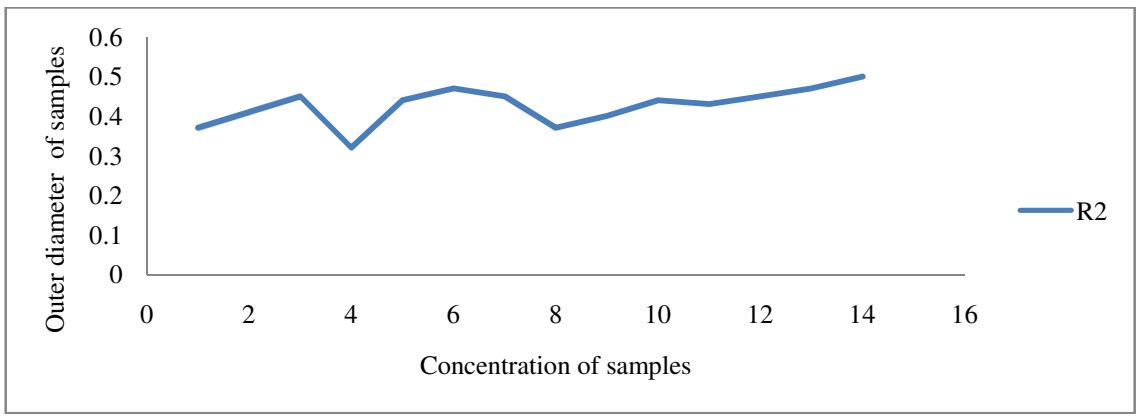


**Figure-2**
**Effect of 0 .23 grams of resin and Cobalt-nephthanate at constant MEKP (0.13 grams) and PVA (0.6 to 2.0 grams) solution**

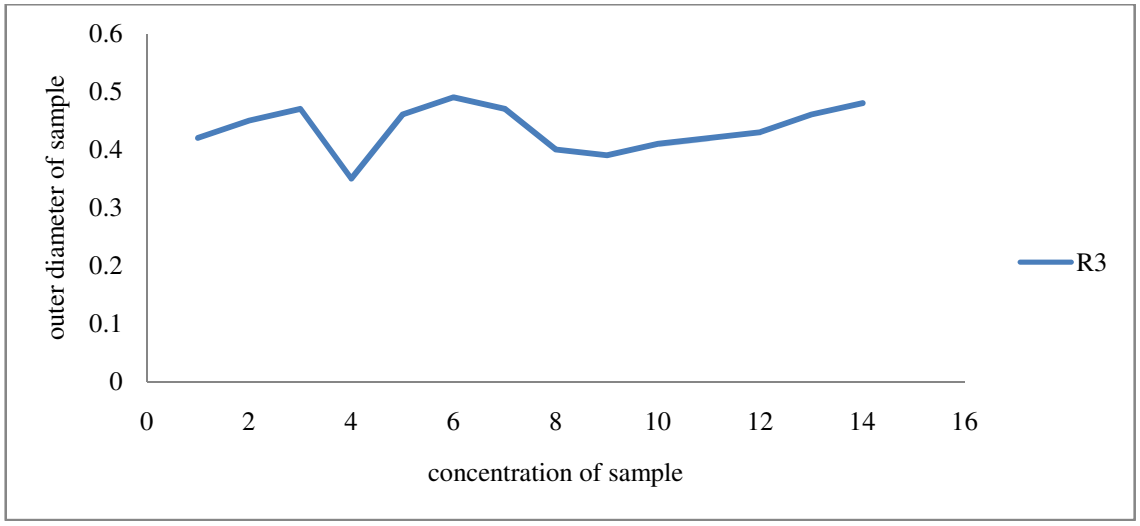


**Figure-3**
**Effect of 0 .26 grams of resin and Cobalt-nephthanate at constant MEKP (0.13 grams) and PVA (0.6 to 2.0 grams) solution**

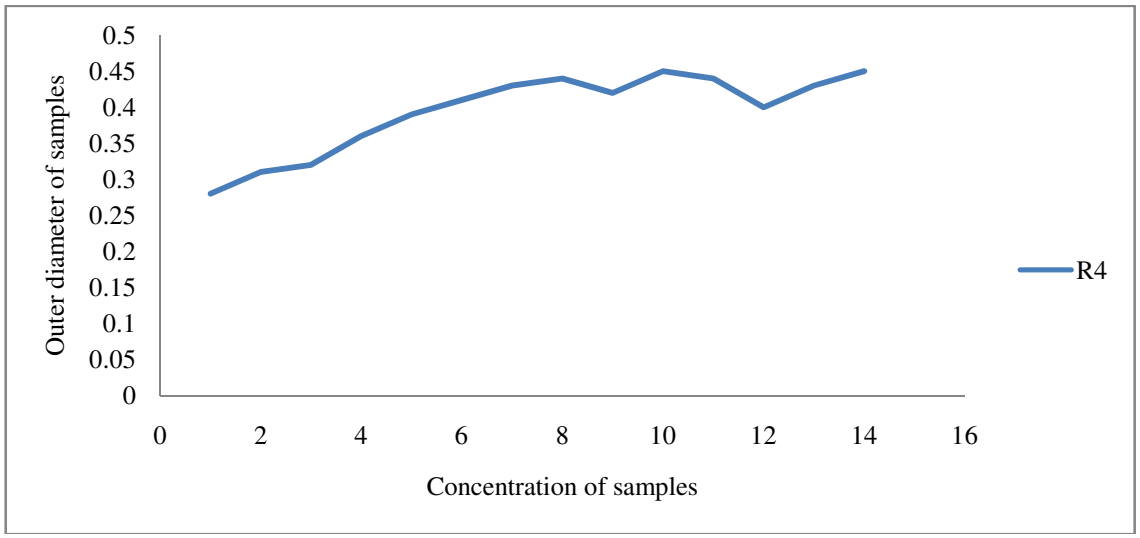


**Figure-4**
**Effect of 0 .30 grams of resin and Cobalt-nephthanate at constant MEKP (0.13 grams) and PVA (0.6 to 2.0 grams) solution**

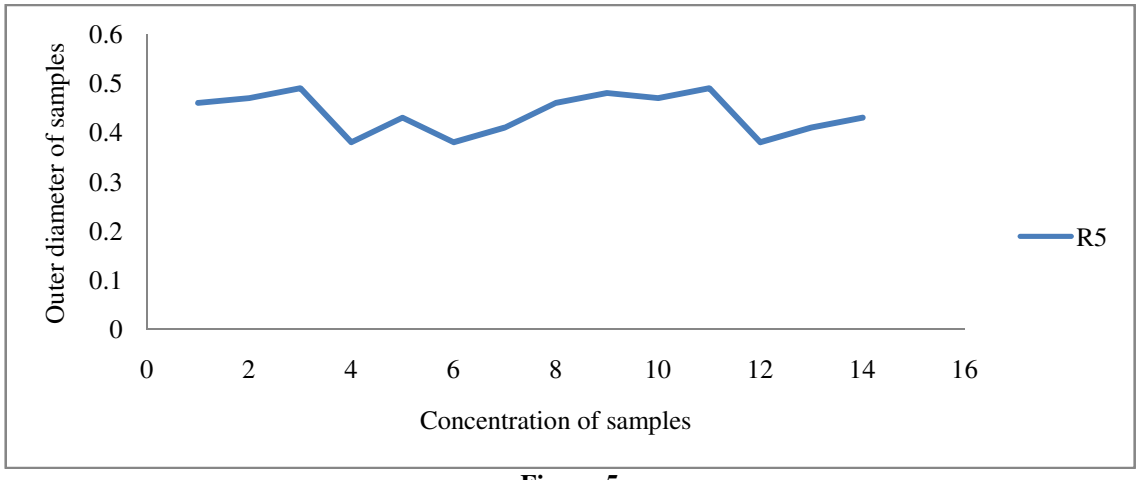


**Figure-5**
**Effect of 0 .33 grams of resin and Cobalt-nephthanate at constant MEKP (0.13 grams) and PVA (0.6 to 2.0 grams) solution**

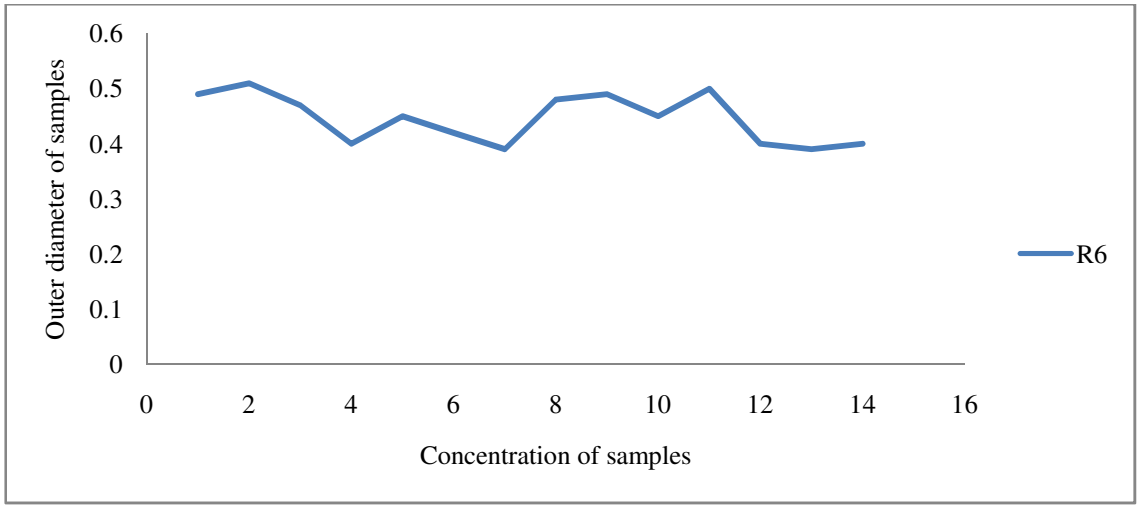


**Figure-6**
**Effect of 0 .36 grams of resin and Cobalt-nephthanate at constant MEKP (0.13 grams) and PVA (0.6 to 2.0 grams) solution**

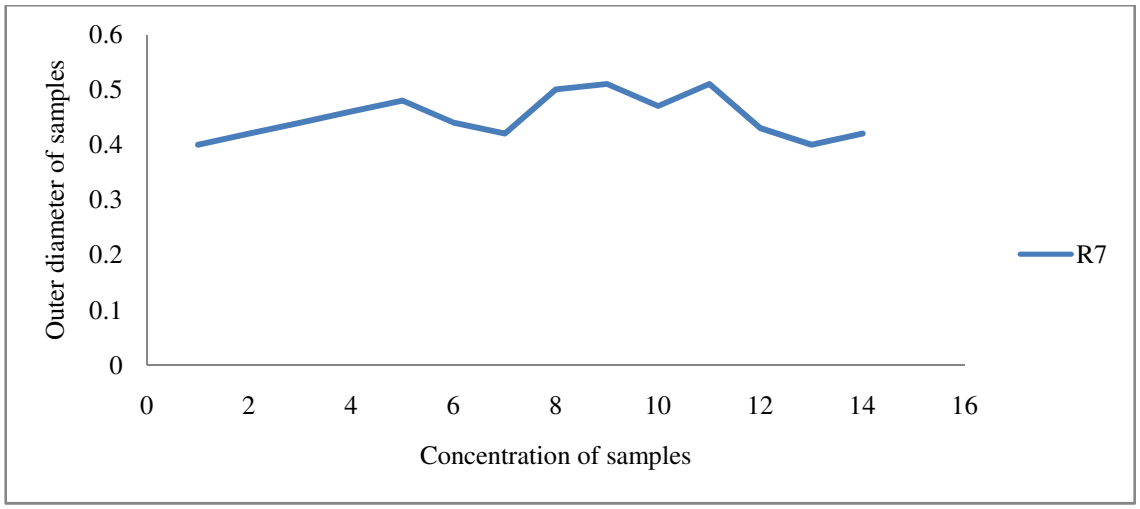


**Figure-7**
**Effect of 0 .40 grams of resin and Cobalt-nephthanate at constant MEKP (0.13 grams) and PVA (0.6 to 2.0 grams) solution**

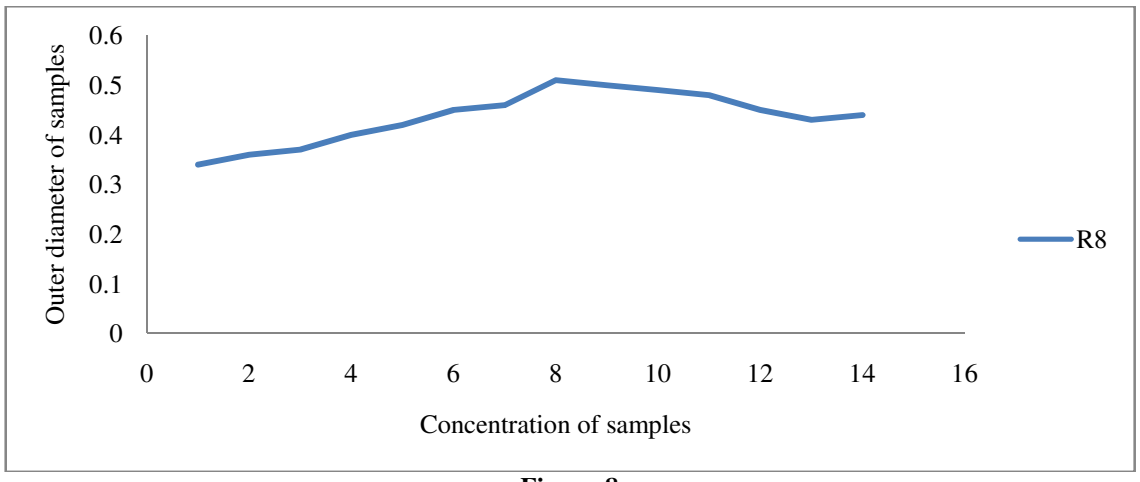


**Figure-8**
**Effect of 0 .46 grams of resin and Cobalt-nephthanate at constant MEKP (0.13 grams) and PVA (0.6 to 2.0 grams) solution**

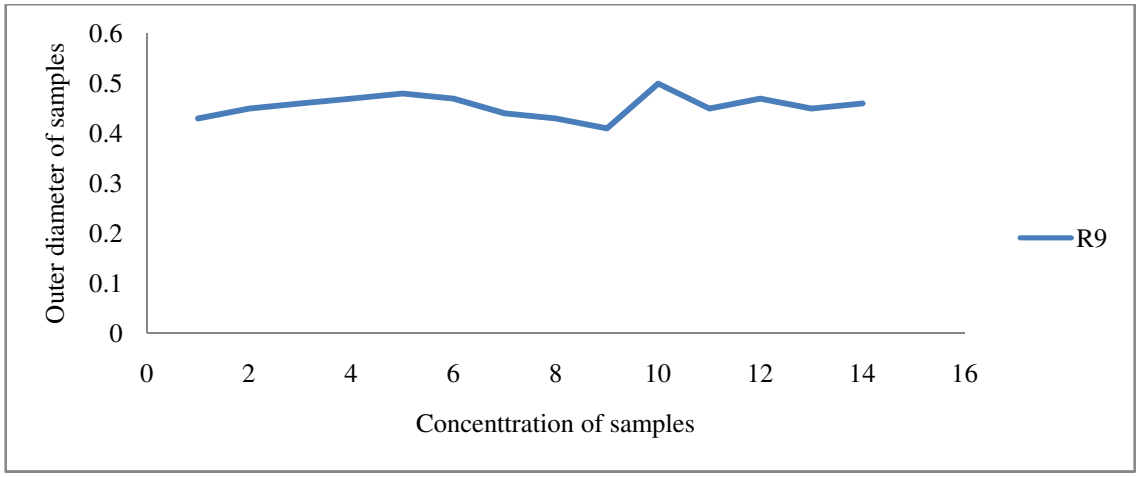


**Figure-9**

**Effect of 0 .50 grams of resin and Cobalt-nephthanate at constant MEKP (0.13 grams) and PVA (0.6 to 2.0 grams) solution**

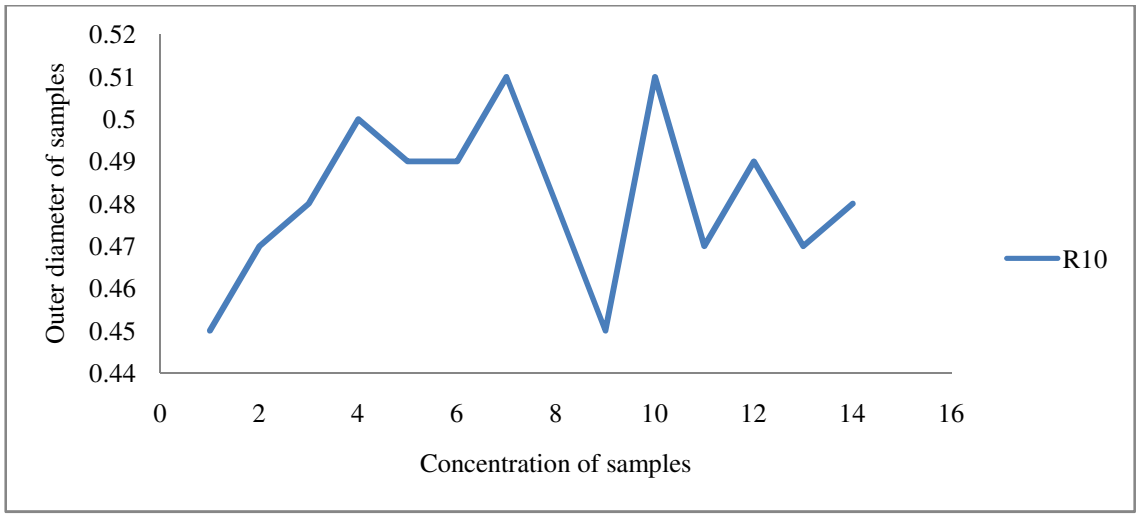


**Figure-10**

**Effect of 0 .53 grams of resin and Cobalt-nephthanate at constant MEKP (0.13 grams) and PVA (0.6 to 2.0 grams) solution**

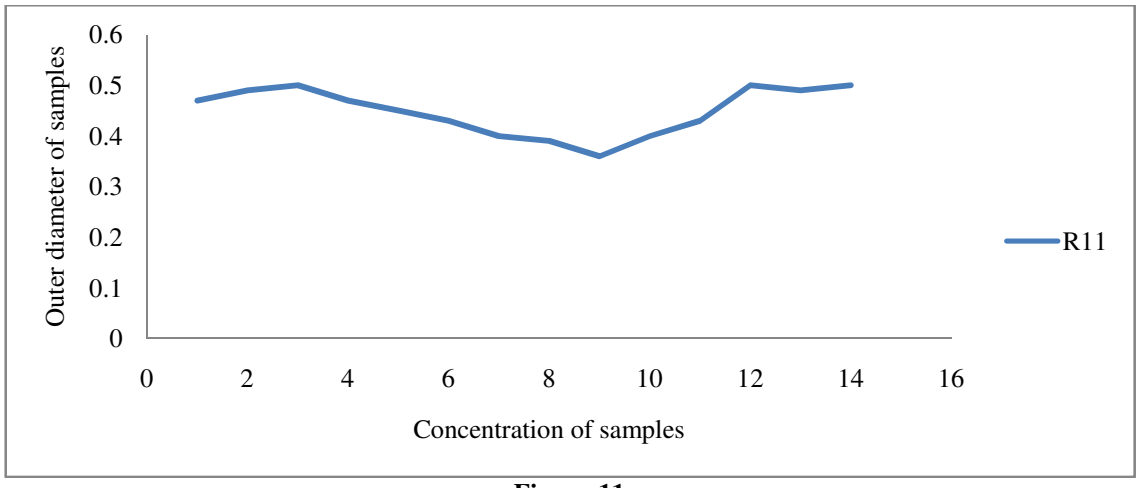


**Figure-11**

**Effect of 0 .56 grams of resin and Cobalt-nephthanate at constant MEKP (0.13 grams) and PVA (0.6 to 2.0 grams) solution**

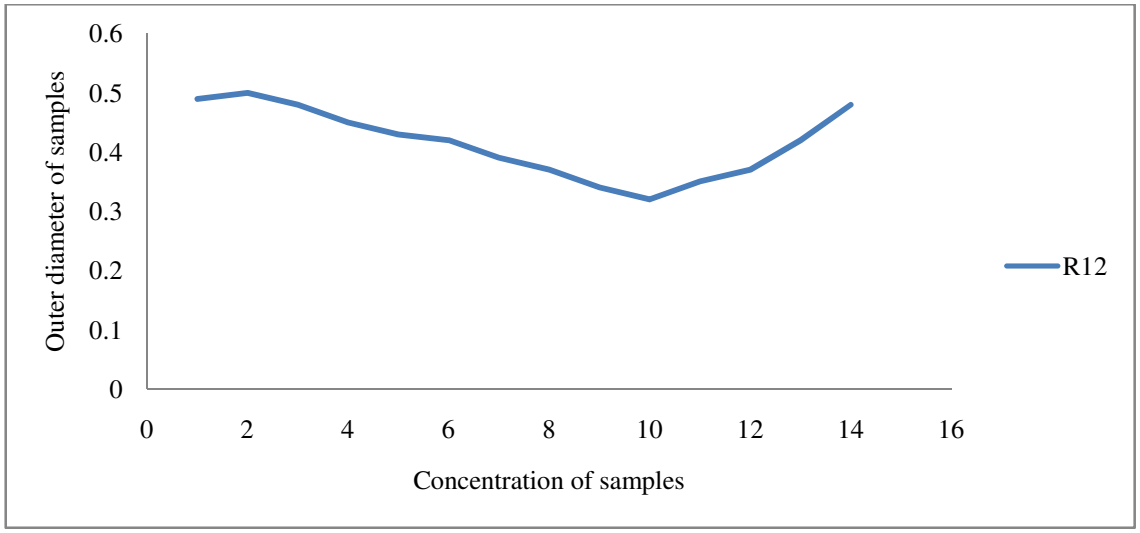


**Figure-12**

**Effect of 0 .60 grams of resin and Cobalt-nephthanate at constant MEKP (0.13 grams) and PVA (0.6 to 2.0 grams) solution**

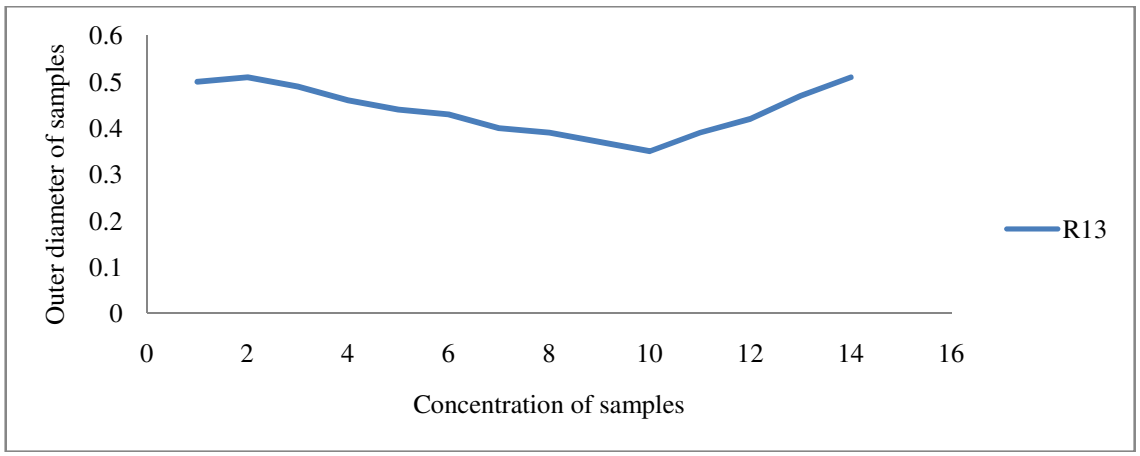


**Figure-13**

**Effect of 0 .63 grams of resin and Cobalt-nephthanate at constant MEKP (0.13 grams) and PVA (0.6 to 2.0 grams) solution**

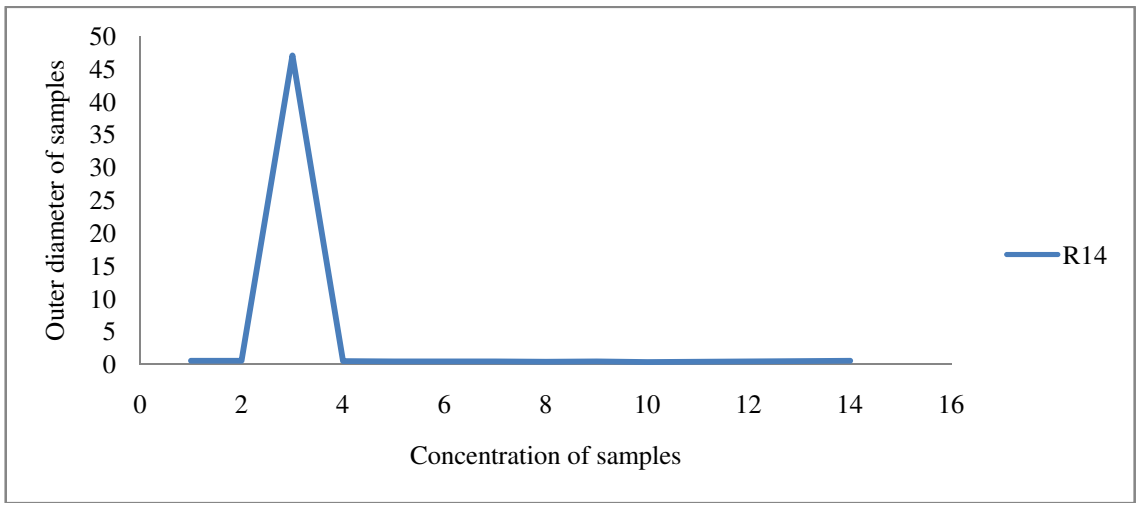


**Figure-14**

**Effect of 0 .66 grams of resin and Cobalt-nephthanate at constant MEKP (0.13 grams) and PVA (0.6 to 2.0 grams) solution**

The samples after preparation were allowed to become dry in open air. After getting dry, the samples were analyzed by Universal testing machine to calculate the properties of each sample as shown in figure below

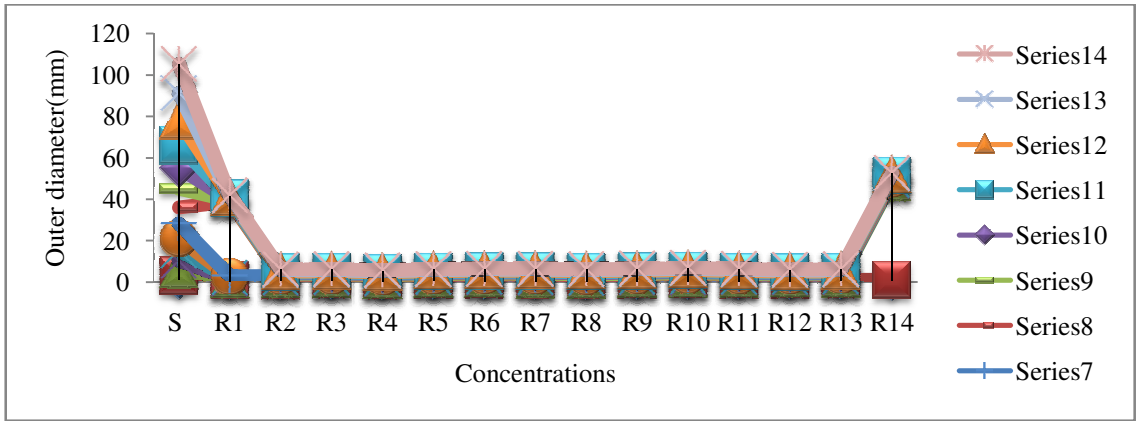


**Figure-15**
**Outer diameter against concentration**

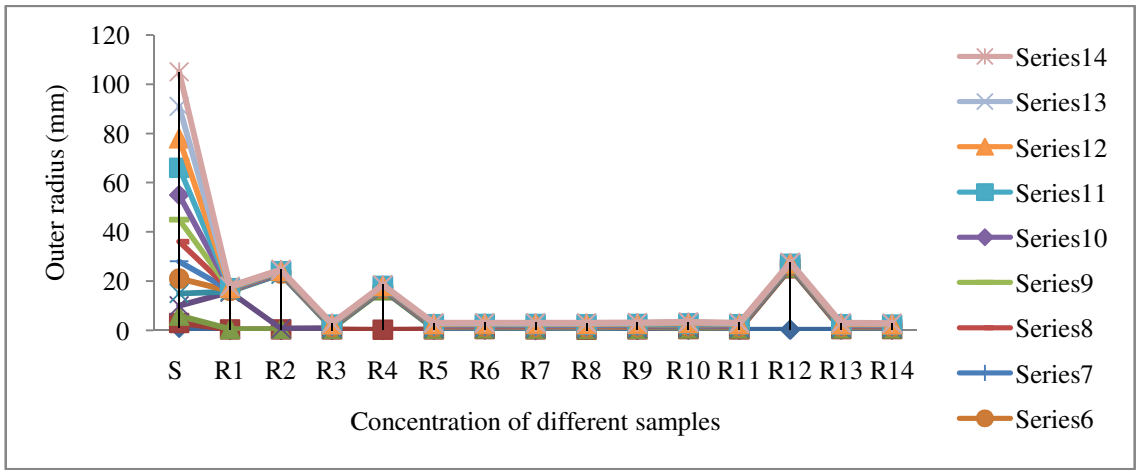


**Figure-16**
**Outer radius vs. concentration of different samples**

## Results and Discussion

The mechanical properties of fiber glass (polymer composites) can easily be understood and known from this research and results. Here 14 different samples were taken. In which the concentration of PVA (poly vinyl alcohol) is taken from 0.6ml to 2.0ml, means the concentrations were taken in the increasing order. Secondly we have taken the Resin and co- nephthenate combined, and at last we have taken the catalyst known as MEKP (Methylethyl ketone per oxide). The 14 different samples are prepared in such a way that the concentration of Fiber mate is taken 1g (constant for each sample), the concentration of PVA is changed from sample to sample (0.6ml to 2.0ml), the concentration of Resin/ Co -nephthenate is also changed from table to table and that of catalyst MEKP is taken constant. Now we have got the results from every table and graph also. From this we noted that as the concentration of the PVA changed than it gives different results. From the results we noted that as the concentration increases the outer diameter and radius also slightly increases. But when the concentration of catalyst is constant than it required a lot of time for completion the reaction and also have high activation energy. But when we increase the concentration of the catalyst than the reaction was completed very quickly and save our time and decrease the activation energy also (future plan). The effect of Resin concentration plays a pivotal role in dryness and also increase of the outer diameter and outer radius. With the increase of concentration of Resin the dryness, diameter and radius of the sample effect in a positive direction also. Same is the case for the co-nephthenate also because it is also used in different concentration. It act as catalyst also and its concentration also effect on the diameter and radius, means that the increase of concentration increases the diameter and radius.

If we increase the concentration of MEKP, which is used as initiative and as catalyst also then the reaction is completed in a

very soon. From this study if we compare the two values with each other such as concentration vs. time, we can easily calculate that by increasing concentration, the time required for reaction reduces respectively. So it means that these are inversely proportion to each other.

## Conclusion

From all this work the mechanical properties showed that by using different chemicals such as fiber mate, Co-naphthenate and MEKP (methyl ethyl ketone per oxide), we conclude that the different samples have increased outer diameter withincrease of concentration of co-naphthenate and also the outer radius of the samples has been increased by increase of concentration of the given materials. But here we will take the concentration of the MEKP constant. So it requires a lot of time for the dryness. In this work, a low concentration of MEKP were used in order to get dry quickly in a short time but there is no efficient effect on the outer diameter and outer radius. So it means that by increasing the concentration of MEKP decreases the time required for dryness of the samples, while the concentration increase of co-naphthenate increases the two parameters (diameter and outer radius). So it means that MEKP is a good initiator for a chemical reaction i.e. a good catalyst and it will decrease the activation energy so as the reaction completes very quickly.

## References

**1.** Pithily H. (2009). An experimental investigation of wear of glass of fiber epoxy resin and glass fiber polyester composite materials. *J. European polymer*, 45, 149-154.

**2.** Edwards K.L. (1998). An overview of the technology of fiber reinforced plastics for design purposes. *Material and Design.* 19(1-2), 1-10.

**3.** Nawy Edward. G. (2001). Fundamentals of high-performance concrete (2nd.). *John Wiley and Sons*, 310, ISBN 9780471385554.

**4.** Mayer Rayner M. (1993). Design with reinforced plastics. *Springer*, 7, ISBN 9780850722949.

**5.** Gupta V.B. and Kothari V.K. (1997). Manufactured Fiber Technology. Chapman and Hall publishing London, 544-546.

**6.** Milos V.B. (1990). Technical approach to glass. New York, Elsevier.

**7.** Frank P.I. and David P.D. (1990). Fundamental of heat and mass transfer (3rd Ed). John Wiley and sons, A 11-12.

**8.** Ilschner B. et al. (2000). Composite materials, Ullmann's Encyclopedia of Industrial chemistry Weinheim, Germany. Wiley-VCH Verlag GmbH and Co.KGaA.

**9.** Erhard G. (2006). Designing with plastics Trans. Martin Thompson. Munich: Hanser publishers.

**10.** New recycling effort (2009). Aims to push KC to go green with its glass. Kansas City, star, posted on Kansas city.com.

**11.** North American Insulation Manufacturers Association (2009). FAQ.

**12.** Pastureau P. (1907). Le Superoxyde de la methylethylcelone, Comptes Rendus, 144, 90-93.

**13.** Milas N.A. and Goluboric (2012). Studies in Organic Peroxide. XXV. Preparation, Separation and Identification of Peroxides derived from Methyl Ethyl Ketone and Hydrogen peroxide. *J. Amer. Chem. Soc*, 81, 5824-26.

**14.** Yuan M.H., Shu C.M. and Kossoy A.A. (2005). Kinetics and hazards of thermal decomposition methyl ethyl ketone peroxide by DSC. *Thermochemica acta*, 430, 67-71

**15.** Martin J.L. (1999). Kinetic analysis of an asymmetrical DSC peak in the curing of an unsaturated polyester resin catalysed with MEKP and cobalt octoate. *Polymer,* 40, 3451.

**16.** Martin J.S., Laza J.M. and Morras M.L. (2000). Study of the curing process of a vinyl ester resin by means of TSR and DMTA. *Polymer,* 41, 4203.

**17.** Liaw H.J., Chen C.J. and Yar C.C. (2001). The multiple runaway-reaction behavior prediction of MEK–oxidation reactions. *J. loss Pre. Process Ind*. 14, 371.

**18.** Yeh P.Y., Shu C.M. and Duh Y.S. (2003). Thermal hazard analysis of methyl ethyl ketone peroxide. *Ind. Eng. Chem. Res.,* 42, 1.

**19.** Rhim J.W., Park H.B., Lee C.S., Jun J.H., Kim D.S. and Lee Y.M. (2004). Crosslinked poly (vinyl alcohol) membranes containing sulfonic acid group: proton and methanol transport through membranes. *J. Memb. Sci.*, 238, 143.

**20.** Kumar G.G., Uthirakumar P., Nahm K.S. and Elizabeth R.N. (2009). Fabrication and electrochemical properties of PVA /Para Toluene Sulphonic acid membranes for the applications of DMFC. *Solid State Ionics.* 180, 282-287.

**21.** Bill Meyer F.W. (2007). Text book of polymer Science, 3rdEdition, John Wiley and sons. New York.

**22.** Langenheim J. (2003). Plant Resins. Chemistry, evolution, ecology, and ethno botany, Timber Press, Portland.

**23.** Ulrich Poth. (2002). Drying Oils and Related Products. Ullmann's Encyclopedia of Industrial Chemistry, Wiley-VCH, Weinheim.