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OPTIMIZATION OF FRP MOULDING PROCESS

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Abstract : *Fibre-reinforced polymer is a composite material made of a polymer matrix reinforced with Fibres. Factor which are mostly affecting resin bonding are Gel time and peak exothermic temperature which are different for different compounds. Since in Fibre reinforced glass plastic moulding all the raw material such as Fibre glass mat, resin, gel coat, catalyst, accelerator and pigment which are required for the production are constant. Since resin is the binder in Fibre reinforced glass plastic, resin can be considered as the key of the Fibre reinforced glass plastic moulding process. The factors on which resin depends are curing time, gel time, peak exothermic temperature and pot life. The main factors are curing time, gel time and peak exothermic temperature. Curing time, gel time, and peak exothermic temperature are different for different compound. Hence the only parameters that can be changed is catalyst and accelerator. Using different catalyst and accelerator may help in proper binding of resin and hence it may result in a smaller number of unwanted defects which will ultimately lead to decrease the cost. Hence certain experiments have to be perform for getting the idea of effect of different catalyst, accelerator on resin.*

Keywords *- Accelerator, Catalyst, Gel time, Peak exothermic temperature, Resin.*

I. INTRODUCTION

The FRP which is known as Fibre reinforced polymer composites are becoming more preferable day by day as a substitute for infrastructure components that are used in traditional civil engineering materials which are concrete and steel. Fibre reinforced polymer composites are more popular because of certain characteristic like light in weight, no corrosive, exhibit high specific strength and specific stiffness. Because of these advantageous characteristic, Fibre reinforced polymer composites are being used in new construction, rehabilitation of structures, reinforcement in concrete, decks, modular structures, formwork, and external reinforcement for strengthening & seismic upgrade. Composite materials are artificial or it can be natural. Composite materials are made up of two or more constituent materials which have significantly different physical or chemical properties which remain separate and distinct throughout within the finished structure. Most composites materials are having strong stiffness fibres in a matrix which is weaker or it can have less stiffness. The objective behind using composite it to make a component which is stronger and having high stiffness and it should have low density.

II. LITERATURE REVIEW

[3] Sachin Waigaonkar, B J C Babu & Amit Rajput "Curing studies of unsaturated polyester resin used in FRP products",Indian Journal of Engineering & Materials Sciences Vol. . 18, et. al, 2011 presented study on FRP.Fiber for reinforced plastics (FRP) items being solid and light in weight, find broad applications in cars, marine, basic and family unit segments. Unsaturated polyester (UP) gum is a rule fastener material utilized in FRP items. Relieving of Unsaturated polyester pitch is a key for fruitful FRP preparing. Gel time (tgel) and top exothermic temperature (θpeak) are basic proportions of relieving of gum. tgel demonstrates beginning of polymer cross-connecting (setting) while θpeak controls shrinkage and breaking of polymer. This paper means to foresee the tgel and θpeak during fix of Unsaturated polyester gum. The weight percent of methyl ethyl ketone peroxide (MEKP) as impetus, cobalt octoate (Coct) as a quickening agent, calcium carbonate (CaCO3) as filler and glass strands as

fortifications are utilized as cycle factors. The varieties in tgel and θpeak are approximated by relapse conditions. Solid associations are found between the cycle factors. The cycle improvement is made to accomplish an ideal mix of tgel and θpeak inside the system of experimentation. Corroborative investigations are performed to approve the anticipated outcomes.

[18] Nasr E S & Azim A A, Polym Adv Technol, et. al, 1992, conducted experiment onthe curing behavior of unsaturated polyester resin was investigated. In the present study, styrene, methyl ethyl ketone peroxide (MEKP) and cobalt octoate (CO) have been selected as solvent (monomer), catalyst and accelerator, respectively. The effect of the concentration of both MEKP and CO on the curing exotherm, curing time, hardness and compressive strength of the prepared copolymers was investigated.

[14] Ling Li, Xia Cao, L James Lee et. al, 2004, conducted experiment on gel time. In low temperature composite manufacturing processes, a major concern is how to control the resin gel time and cure time and how to achieve a high resin conversion with low residual Vol. atile organic chemicals. In this study, a cobalt promoter catalyzed dual-initiator system was used to control the reaction rate and resin conversion of unsaturated polyester resins. A mechanistic kinetic model was developed to predict the reaction kinetics with dual initiators. This model can be used to simulate the isothermal and dynamic reaction rate and conversion profiles. It can also be utilized to predict the effect of promoter concentration on UP resin cured at low temperatures. The dual-initiator system was applied in the vacuum-assisted resin transfer molding process at room temperature. The kinetic model, in conjunction with the heat transfer analysis, was able to successfully predict the temperature profiles during the molding processes.

III. PROBLEM DEFINITION

There are numbers of defects which company faces during production which is mainly due to resin bonding. Factor which are mostly affecting resin bonding are Gel time and peak exothermic temperature. Gel time and peak exothermic temperature are different for different compounds. Changing the parameter may help in overcoming the defects.

IV. METHODOLOGY

Existing Process The process of Fibre reinforced glass plastic start with preparation of moulds and mixture of gel coat,resin, catalyst, accelerator and pigments. The polyester resin is used as a resin, FG250 is used as a catalyst, cobalt is used as a accelerator pigment is selected according to the color required. The shape and size of die mould is chosen according to the product requirement. The die mould is different for different slides for example for Thunder Bowl Water Slide will have one die mouldcavity, Hotel & Resort Slides will have its die mould cavity and so on. Thus, the product which have to be manufactured will depend on the slide requirement. After selection of mould the selected mould on which moulding is to be done is clean before manufacturing so that there will be no dust, dirt and impurities. Presence of any dust, dirt and impurities will lead to defects in product and thus lead to wastage of time as well as money. After cleaning of mould next step is applying a coating of releasing agent. The coating of releasing agent is done so that as pigment and resin are sticky in nature it will stick to mould and it will become difficult to remove the finished product after moulding. Thus, it will lead in defect in die cavity. Hence for easy removal of finished product coating of releasing agent is applied. After completion all the above process a layer of Fibreglass mat is applied on the die cavity. The first layer of Fibreglass mat is applied properly so that there should be no gap between the die having coating of releasing agent and Fibreglass mat. If there will be presence of gap between the die cavity and mat then it would lead to waviness and shrinkage defects. After the first layer of Fibreglass mat mixture of pigment, gelcoat, resin, catalyst and accelerator is applied with help of brush or roller. Mixing of pigment, gelcoat, resin, catalyst and accelerator is done carefully as presence of any bubbles will lead to shrinkage defect, surface uneven defect, waviness defect, etc. After applying mixture of pigment, gelcoat, resin, catalyst and accelerator on first layer on Fibreglass mat another layer of Fibreglass mat is applied which is properly align with the first layer of Fibre mat with uniform pressure. If there is any misalignment between the first and second layer of Fibreglass mat or if uniform pressure is not applied on to the Fibreglass mat it will lead to waviness defects. After first and second layer of Fibre glass mat again the mixture of pigment, gelcoat, resin, catalyst and accelerator is applied. After mixture of pigment, gelcoat, resin, catalyst and accelerator on the second layer of Fibre glass mat, third layer is applied again with the proper alignment and uniform pressure then again mixture of pigment, resin, catalyst and accelerator is applied. Fourth layer of Fibreglass mat is applied with proper alignment and uniform pressure. Now if the fourth layer is the top layer than only pigment,gelcoat

and resin is applied without mixing of catalyst and accelerator. After applying the top most layer of Fibreglass mat with pigment and resin it is then leaven to cure for some time as it will require some time to be cured.

After 45 to 60 minute the module or piece comes up little bit from die cavity thus leaving the die which becomes easier for operator to remove piece from die. Once the piece or module is removed from the die it is then sent into the finishing department. In finishing department grinding, drilling and buffing is done. Grinding is done so as to remove or shorten the dimension, drilling is done so that for assembly purpose it is mate to another piece with the help of nut and bolt. Buffing is done so as to get shiny finish on the surfaces. Once the finishing is done onto the module or piece it is then sent into quality control department. The quality control Department test dimension, safety requirement and defects. If the product passes the quality control then it is packed for shipping purpose. If the products don't match the required quality it is rejected. The operation department look into the reason for defect if the product need some operation to match the quality then certain operations are performed otherwise it is discarded.

Although after following all the necessary procedure for getting defect free products, certain unwanted defect occurs. The defect may be due to poor resin bonding with catalyst and accelerator. Since in Fibre reinforced glass plastic moulding all the raw material such as Fibre glass mat, resin, gel coat, catalyst, accelerator and pigment which are required for the production are constant. The Fibreglass mat cannot be changed as it is the base of the product and there is no substitute for replacing the Fibreglass mat. Gelcoat are used to provide high quality surface finish also it is used along with resin hence there will be no benefit for changing or removing or replacing gelcoats. Resin which are used for production are polyester resin. The polyester resin provides high strength, stiffness and along with gelcoat its mechanical properties increases. Replacing polyester resin with vinyl ester resin will increases the cost and hence it cannot be accepted. Since resin is the binder in Fibre reinforced glass plastic, resin can be considered as the key of the Fibre reinforced glass plastic moulding process. The factors on which resin depends are curing time, gel time, peak exothermic temperature and pot life. The main factors are curing time, gel time and peak exothermic temperature. Curing time, gel time, and peak exothermic temperature are different for different compound. Hence the only parameters that can changed in Fibre reinforced glass plastic moulding is catalyst and accelerator. Using different catalyst and accelerator may help in proper binding of resin and hence it may result in a smaller number of unwanted defects which will ultimately lead to decrease the cost. Hence certain experiment have to be perform for getting the idea of effect of different catalyst, accelerator on resin.

Proposed Experimentation The resin selected will be the Polyester resin, two catalyst Dimethyl terephthalate, Methyl ethyl ketone peroxide will be used. Accelerator Potassium, Sodium, Copper, Vanadium will be used for conducting experiment. Since in manufacturing of FRP moulding mixture of resin, catalyst and accelerator are used, hence combination of resin, catalyst and accelerator will result into two specimen i.e Specimen A and Specimen B. Specimen A.1 will contain the combination of Polyester resin+ Dimethyl terephthalate+ Potassium. Specimen A.2 will contain the combination of Polyester resin+ Dimethyl terephthalate+ Sodium. Specimen A.3 will contain the combination of Polyester resin+ Dimethyl terephthalate+ Copper. Specimen A.4 will contain the combination of Polyester resin+ Dimethyl terephthalate+ Vanadium. Similarly Specimen B.1 will contain the combination of Polyester resin+ Methyl ethyl ketone peroxide +Potassium. Specimen B.2 will contain the combination of Polyester resin+ Methyl ethyl ketone peroxide + Sodium. Specimen B.3 will contain the combination of Polyester resin+ Methyl ethyl ketone peroxide +Copper. Specimen B.4 will contain the combination of Polyester resin+ Methyl ethyl ketone peroxide +Vanadium. After mixing of all the mixture properly and naming the specimen accordingly to the mixture the observation will be noted in terms of curing time, gel time and peak exothermic temperature. Curing time can be known when the module or piece leaves the die cavity and automatically get little bit up that means it has been cured. Gel time can be known when the mixture of accelerator, catalyst and resin which will be in liquid state gets converted into solid states. Peak exothermic temperature can be noted during curing period with the help of infrared thermometer.The table given belowshows the different catalyst, accelerator and specimen which are require for performing the experiment.

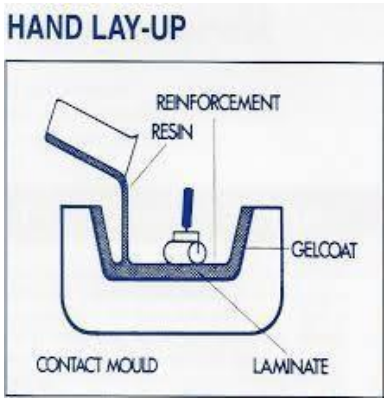

Fig 1 Hand lay up of FRP moulding

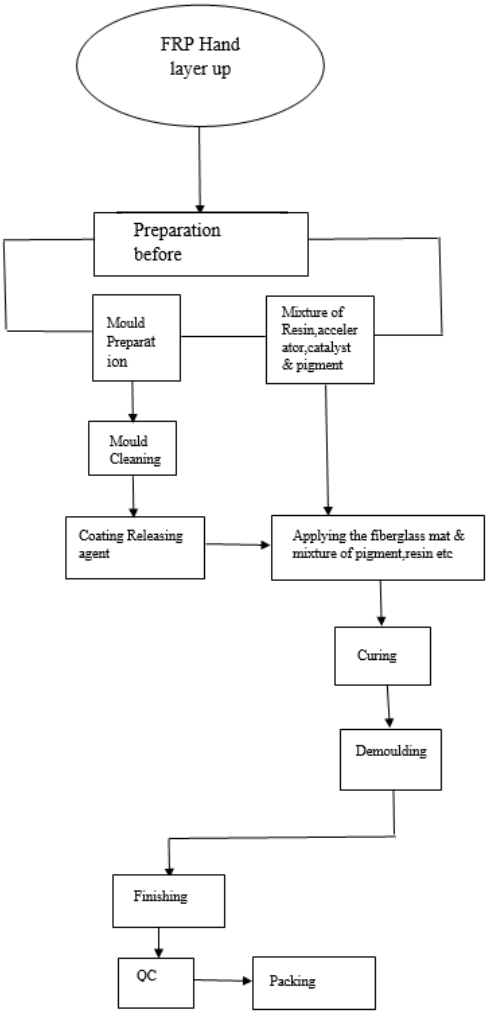

Fig 2 Hand Layout of FRP moulding process

TABLE 1 Apparatus table

No.	Resin	Catalyst	Accelerator	Specimen A	Specimen B
1	Polyester resin	Dimethyl terephthalate	Potassium	Resin 1+catalyst 1+accelerator 1	Resin 1+catalyst 2+accelerator 1
2		Methyl ethyl ketone peroxide	Sodium	Resin 1+catalyst 1+accelerator 2	Resin 1+catalyst 2+accelerator 2
3			Copper	Resin 1+catalyst 1+accelerator 3	Resin 1+catalyst 2+accelerator 3
4			Vanadium	Resin 1+catalyst 1+accelerator 4	Resin 1+catalyst 2+accelerator 4

TABLE 2 Observation Table of specimen

Sr No	Specimen A	Specimen B	Curing Time	Gel time	Peak exothermic temperature
1	Resin 1+catalyst 1+accelerator 1	Resin 1+catalyst 2+accelerator 1			
2	Resin 1+catalyst 1+accelerator 2	Resin 1+catalyst 2+accelerator 2			
3	Resin 1+catalyst 1+accelerator 3	Resin 1+catalyst 2+accelerator 3			
4	Resin 1+catalyst 1+accelerator 4	Resin 1+catalyst 2+accelerator 4			

V. CONCLUSION

After studying the process of Fibre Reinforced glass plastic moulding process it was found that Fibreglass mat cannot be changed as it is the base of the product and there is no substitute for replacing the Fibreglass mat. Gelcoat are used to provide high quality surface finish also it is used along with resin hence there will be no benefit for changing or removing or replacing gelcoats. Resin which are used for production are polyester resin. The polyester resin provides high strength, stiffness and along with gelcoat its mechanical properties increases. Replacing polyester resin with vinyl ester resin will increases the cost and hence it cannot be accepted. Since resin is the binder in Fibre reinforced glass plastic, resin can be considered as the key of the Fibre reinforced glass plastic moulding process. The factors on which resin depends are curing time, gel time, peak exothermic temperature and pot life.

The main factors are curing time, gel time and peak exothermic temperature. Curing time, gel time, and peak exothermic temperature are different for different compound. Hence the only parameters that can changed in Fibre reinforced glass plastic moulding is catalyst and accelerator. Using different catalyst and accelerator may help in proper binding of resin and hence it may result in a smaller number of unwanted defects which will ultimately lead to decrease the cost.

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