CHAPTER I

INTRODUCTION

Everyday, if we look around, we will find that plastics have many advantages to mankind. Although they have disadvantages especially when they are heated, but now they are introduced in place of metals. At present they have been developed to be added as materials that can strengthen and toughen into plastics matrixes that can bring about the capability to operate to be about the same as metals. These kinds of products are designated as "Reinforced Plastics"

1.1 Reinforced Plastics

The term "Reinforced Plastics" refers to any plastic material whose physical properties have been up-graded by the addition of some auxiliary material. This reinforced material is generally fibrous in nature, although the addition of this reinforcement may provide an increasing strength, this can also be achieved by certain non-fibrous fillers. However, the degree of reinforcement obtained with high tensile strength fibrous fillers is so much greater than that obtained with non-fibrous type materials. Reinforced plastics are analogous in several respects to reinforced concrete where the low tensile strength of concrete is up-graded with steel rods. The concrete serves to transfer the load to the encased steel rods so that the entire reinforced section acts as a unit which increases in strength and stiffness, at a considerable savings in cost and weight compared to a solid steel section of equivalent properties.

Although a number of thermosetting resins such as phenolics, melamines, silicones and epoxies are used along with certain thermoplastic such as polystyrene but the thermosetting such as polyester resins have been found to date the largest use in reinforced plastics. The popularity of the polyester is based on such unique characteristics such as their ease of combining with reinforcements and their ability to cure without giving off volatile by-products. Because of the relatively low pressure required to mold polyester resins in combination with reinforcing agents, it is possible to mold relatively large parts in lighter-weight, lower-cost molds that would be required to fabricate the same parts in metal. Likewise it is possible to form complex shapes as single pieces which in metal would require the fabrication and combination of several pieces (1).

1.2 Glass Fiber Reinforced Plastics

Glass is used in a variety of forms as a reinforcement for plastic. The availability of many types of reinforcements make possible great design scope in strength, rigidity, cost, production methods, shape, size and directional characteristics. Thus these products are also known as "Glass Fiber Reinforced Plastics" or "Glass Fiber Reinforced Polyester" and in short "Fiberglass". This is usually abbreviated to "GRP, FRP, or RP".

Glass fiber is an inorganic substance that in nature does not bond very well with plastic materials. Consequently, the glass fiber surface must be prepared by treating with sizing agents to accept a resin in much the same manner that some surfaces must be primed before being painted. The functions of a sizing agents are (1) :

1. To allow fibers to be handled without serious destruction by abrasion.
2. To hold fibers together in strand.
3. To promote attachment of glass to resin.
4. To promote rapid wetting of strand of glass fibers by resin.

The strength of the fiber glass laminates is developed from the combination of two materials. In this system glass fiber provides high structural strength combined with great flexibility and the resin added to the mixture contributes to the stress transferral from one fiber to the other. The resin surround the fiber as an enclosed armor to keep it separated and to present abrasion from adjointing fibers (2,3). In addition the resin imparts corrosion resistance to the system and contributes to its thermal and electrical properties. When these two materials are combined and changed into a solid state by heating, they become hard and unyielding with the best qualities of both materials combined into a new and better product. See Figure 1.1.

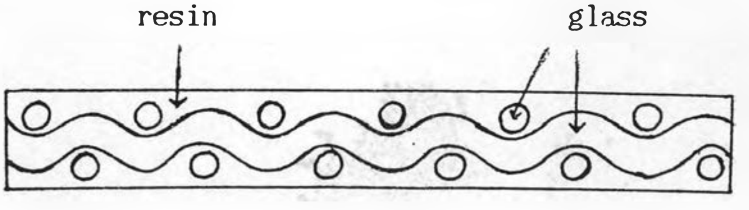

Figure 1.1 Schematic of glass strands surrounded with resin.

When glass fibers are combined with plastic resins and the resins are cured, the strength is produced only when the correct combination is kept between the two materials. In general the larger the volume of glass is in the product, the greater the strength is.

1.3 The Purpose of the Investigation

Glass fiber reinforced plastics have many properties better than general plastics, this has brought them to be used in many types of industrial applications. Especially, the construction industry, housing up to a new-fashioned architectural designs applied to a novel technology used for greenhouse construction. Particularly, roof structure of industrial factories and greenhouses where is required to use sunlight to displace electric light which it contributes to high expenses. For this reason glass fiber reinforced polyester are brought to be used for high light transmission work, not only because it has light weight, but also because of its high strength.

The transparency of laminate depends upon the refractive index of the glass fiber which should be equal to the one of the unsaturated polyester resins. There are two different ways to achieve. The first this property method is the usage of methyl methacrylate combined with styrene as crosslinking agent of a polyester. The second way is the treatment of glass fiber with sizing agent in order to increase the refractive index of the glass fiber to equal the one of the polyester resins. In the study that followed, the designed experiment was designed investigate both of the aforementioned effects with the objective of improving the transparency and strength of glass fiber reinforced polyester.

1.4 Literature Reviews

Many investigators have studied the effect of a sizing agent on transparency and strength of glass fiber reinforced polyester.

Gottfried Wiedmann, Horst Frenzel, Margit Matzke, and Ursula Renner (4) investigated the interfacial adhesion of glass fiber fabric onto polyester resins in composites and found the improved performance by treating the fibers with γ-glycidoxypropyltrimethoxysilane. Wetting agents such as resorcinol, poly(vinylpyrrolidone), or condensed silicic ester were added to the coupling agent compounds to increase the transparency of the laminate and to improve its strength properties.

Takeshi Moritani and Yukio Nosaka (5) studied the sizing agents for glass fibers with good affinity toward polyester resins. These sizing agents are prepared from a vinyl ester resin emulsion obtained by emulsion polymerization of a vinyl ester or a mixture of vinyl ester and a monomer in the presence of 70-90% poly(vinyl alcohol) nonionic surfactant. When it was used as reinforcing material for unsaturated polyester resin, the resulting glass fiber reinforced plastic showed good transparency.

Toshihito Fujita, Kazunobu Inoue, Hirokazu Inoguchi, and Tadanori Kitamura (6) studied sizes for glass fibers contained unsaturated polyester (glycol component contained $\leq$ 10 mole% bisphenol) emulsion and organochromium or organosilicone compound. The sizes had better impregnability on glass fiber, and the sized glass fiber gave polyester composites with good transparency.

Junichi Furukawa and Yoshinao Kono studied the sizing compositions for glass fibers which produced glass fiber reinforced articles with improved transparency. Thus, 1:2 molar bisphenol A propylene oxide adduct 1050, fumaric acid 323, polyethylene glycol emulsifier no. 1500 343, hydroquinone 1, and silicone antifoaming agent 0.3 g were heated 160-210°C under N_2 atmosphere, to provide a bisphenol A fumaric acid-propylene oxide polymer (I) with acid value 25. A sizing composition consisting of I oil-in-water emulsion (30% polyester) 3.0, γ-methacryloxypropyltrimethoxysilane 0.18, fatty acid amide 0.08, triethanolamine salt of a metallic oxyacid (7) or triethanolamine sulfate or sulfonate (8) antistatic agent 0.10, HCO_2H 0.04, and water 96.6% was applied to a glass fiber fabric.

Junichi Furukawa, Yoshinao Kono, and Kahei Sakaguchi (9) studied the sizing agents for glass fibers. Thus I oil-in-water as in (7,8) was prepared by addition of polyethylene glycol N-stearylaminoethyl ether (17.2 g) to the compound and polymerized to give a polymer (I) with oxidation value 20. A glass fiber fabric was immersed in a composition of an aqueous emulsion containing 30% I 3, (3-methacryloxypropyl)trimethoxysilane 0.18, an aliphatic amide lubricant 0.08, triethanolamine lauryl sulfate 0.10, AcOH 0.04% and H_2O. A laminate of the resulting fabric and unsaturated polyester showed good transparency.

Nippon Glass Fiber Co., Ltd. (10) investigated the glass fiber-reinforced unsaturated polyester boards with excellent transparency and heat resistance. These glass fibers were treated with a sizing agent containing poly(vinyl acetate) 6, adipic acid-ethylene glycol copolymer 0.6, acrylic silane derivative 0.3, and fatty amides 0.1%.

Dainippon Ink and Chemicals, inc. (11) studied the water-resistant sizes which show excellent adhesion to glass fibers and polyester matrix resins. Thus, neopentyl glycol 936, Unicol BA-P2 1095, polyethylene glycol number 3000 421, isophthalic acid 996, phthalic anhydride 592, and NaOAc 0.16 part were mixed and heated to give a polyester of molecular weight 4200, 300 parts of which was mixed with 129 parts ethylene glycol monoethyl ether, then with water to give a stable 30% solids dispersion. Glass cloth dipped in a size of this dispersion 6, vinyltris(β-methoxy)silane 0.3, Cirrasol 185 A (lubricant) 0.15, and water 93.55% showed good filament cohesion and no blocking, an when impregnated with unsaturated polyester, formed transparent sheets.

Hiroshi Masuda (12) investigated glass rovings coated with an aqueous mixture of 50% Epikote 828 5.4, 50% Epikote 100 2.8, and 3-(trimethoxysilyl)propyl methacrylate 0.4% dried and wound to give rovings. An unsaturated polyester reinforced with these fibers had a transparency of 78%.

Seiichi Shimanuki, Michio Tanabe, and Ryozo Koike (13) investigated the glass fiber treated with ~~the~~ octyldimethylammonium ethosulfate to give plastics having water and boiling resistance, good appearance, and good light transmission.

Anton Miskolci, Jozef Matula, Juraj Forro, and Stanislav Florovic (14) studied the aqueous lubricants that improve the processability of glass fiber moldings in the manufacturing of low-color, transparent polyester laminates contain unsaturated polyesters 1-6, hydrolyzable 3-methacryl-oxypropyl tri-C_{1-3}-

alkoxysilanes 0.1-0.4, antistatic agents 0.1-0.7, nonionic surfactants, hydrolysis catalysts, and pH regulators 0.01-1.0%.

Juraj Forro, Stanislav Florovic, and Jozef Martisovic (15) studied the lubricants for glass and mineral fibers are prepared from an amide from oleic and diethylenetriamine was mixed 100 g at 130°C with 30 g epoxy resin, 8 g AcOH at 50°C were diluted with H_2O to a 25% solution. This solution 5, 3-(trimethoxysisyll)propyl methacrylate 0.2, AcOH 0.1, LiCl 0.2, oxyethylated nonylphenol 0.1 and H_2O 94.4% were coated on glass fibers and used to prepared laminates with unsaturated polyester with transparency 85-90% vs. 70-75% with a poly(vinyl acetate) dispersion as film-forming agent.

1.5 Objectives for this Study

1. To study the effect of sizing agent and the properties of glass fiber reinforced polyester in related to its transparency.

2. To obtain a guideline for the developments in a manufacturing process of a high quality reinforced material.