The Viability of Fiberglass as a Pool surface Alternative

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The installation of fiberglass liners in swimming pools has been used with varying degrees of success for approximately 25 years. This paper will discuss the viability of fiberglass as a low maintenance alternative to traditional plaster surfaces, and discuss specific problems resulting from the application and maintenence of the product, along with strategies to avoid these problems..

Introduction

The fiberglassing of the interiors of swimming pools and spas has enhanced the appearance, durability, and chemical resistance of the surface over traditional plaster surfaces. This enhancement has been instrumental in increasing consumer satisfaction and confidence in thier pool or spa investment. Because of its durability and chemical resistance, many fiberglass resurfacers have approached the industry with the belief that fiberglass coatings are so forgiving that anything done with fiberglass has to be far superior to more traditional plastered surfaces.

Over the past three decades, the swimming pool industry has seen a number of different types of fiberglass applications. The most common are the one step chopper gun lamination, and the one step hand lay–up application. These two methods utilize a waxed, filled, pigmented resin applied to the swimming pool surface by either spraying, or rolling with paint rollers. Fiberglass roving (???) is chopped into the resin with chopper guns; or, in hand lamination, a chopped strand mat is pasted up against the resin coated surface. The final step of this application is the application of an additional amount of resin over the fiberglass to saturate the surface.

Both of these techniques, when improperly applied, can have serious drawbacks. The application of a waxed primary coat does not allow much latitude for corrective action. Incomplete primary bonding is always a potential problem. The waxed coat in this type of process inhibits secondary bonding. The result is often times blisters (see Appendix). In addition, the one step hand lamination does not always fully saturate the fiberglass mat, leaving a "stringy" looking surface. The fiberglass then has to be lightly sanded to knock down the rough areas. Sanding may often lead to the problem of breaking the sealer finish coat and opening small pinholes, which increase the hydroscopic tendencies of the glass laminate, leading to delamination.

Another problem that plagues the fiberglass coating industry is the application of fiberglass to poorly prepared substrates. It is absolutely imperative that the surface to be fiberglassed is solid, clean, and free of paint or any other material that may inhibit primary bonding. Also, the fiberglass resurfacers have many choices as to which types of resins would be the best to use. Unfortunately, the majority of fiberglassers get into the industry with very little knowledge of resins, fillers, thixotropics, pigment loads, surfacing agents, and catalyst percentages.

Problems resulting from the above applications, which are somewhat of a low–tech "standard", have been responsible for creating skepticism among consumers and service industry technicians. If the fiberglassing industry is to remain a viable and valuable part of the swimming pool and spa industry, it must address these issues to promote consistent, superior results and to increase consumer confidence. Fiberglass technology for swimming pool and spa coatings can legitimately be a low maintenance viable alternative to plaster, and especially re–plaster.

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Problems and Corrective Measures

The remaining content of this paper will address some of the current problems with fiberglass coatings and what corrective measures should be taken to truly make fiberglass coating viable.

1. **Delamination** (pull–away from the substrate) is a common problem that has given fiberglass critics plenty of ammunition. There are several causes of delamination.
   A. Moisture on the surface at the time of laminating.
   B. Improper preparation of the substrate, leaving dirt, grit, dust or oily film on the surface, or glassing over soft plaster.
   C. Breakdown of materials in water due to the use of non–pH stable fillers in the fiberglass mixture, i.e., calcium carbonate. Too many fillers used to extend and thicken resin (Lim 1996).
   D. Water absorption through tiny fibers that are not completely encapsulated.
   E. Glassing over painted surfaces.
   F. Pinholes in laminate due to improper cure (usually too fast).
   G. Improperly cutting and sealing around fixtures and at tile line.

   The solution for the above problems can be addressed as follows: A dry, clean surface is imperative to the success of the laminate — use a moisture meter, grinders for scouring, and a vacuum for cleaning. Check all areas for soft spots on the surface to be glassed. Any painted surface must first be sand–blasted to ensure complete paint removal. Last, an excellent primer or bonding coat, using an unwaxed high grade vinyl ester resin, is very important. Vinyl esters are more water–tight than polyesters. When the vinyl ester is catalyzed with MEK–P, cross–linking takes place, with the vinyl ester molecules linking together in such tight strands that moisture cannot penetrate the coating (Aldridge 1994). Vinyl esters also have a high corrosion resistance factor even in acidic environments and temperatures above 200ºF. Note: Besides their high cost, the only negative factor about vinyl ester resins is that they do not hold pigments as well as polyesters, which may present a problem if used in finish coating. Also, vinyl esters are not as UV stable as polyester resins. Again, this is only a problem if it is used as a finish or top coat.

2. **Chalking** (flaky or milky look when rubbed) is caused by improper cure due to the incorrect percentage of surfacing agent. A surfacing agent is a paraffin wax in a styrene liquid solution. The following suggestions will greatly decrease the occurrence of chalking.
   A. A surfacing agent is used in the finish coat of fiberglass laminate. Chemically, when the MEK–P is introduced to the resins, a catalyst or hardening reaction starts to take place. The resin reacts to the catalyst and a heating or exotherm begins. This heating causes the surfacing agent to rise to the top of the resin. If the surfacing agent is mixed thoroughly, it rises and creates an oxygen void to the laminate. It is this oxygen deprivation that allows the laminate to fully cure. After the cure–out stage, the surface will feel hard and smooth. conversely, an improperly cured surface will be softer, more susceptible to breaking down and water absorption.

      Resin manufacturers suggest a minimum of 5% surfacing agent by weight to ensure a fully cured laminate (Lim 1997). An important point is to control the mixing of the surfacing agent into the coating material. it must be continually mixed with a solid agitator that will not absorb wax and change the ration of surfacing agent to resin.
   B. To be avoided is the use of non–pH stable fillers, especially calcium carbonate to thicken the material. Many of the larger coating companies still use calcium carbonate as fillers or extenders of the resins. It is like taking ground sirloin and adding "Hamburger Helper" to make meatloaf. It is no longer "pure beef". The resins used by most fiberglass coating installers is an isophthalic polyester resin. These resins were designed to be resistant to corrosive environments, even under high temperatures. The fillers added to the mix inhibit the corrosion resistant qualities of the laminates.
   C. The improper percentage and mixing of the MEK–P. Methyl Ethyl Ketone–Peroxide is the catalyzing agent introduced to the resin which sets off the chain reaction that results in polymerization or hardening. Note: An area of debate is which system offers the best cured surface – hand lamination or gun lamination. The hand lamination method

relies on the accurate measurement of catalyst to resin by a worker pouring exact amounts proportionately with every batch to ensure an evenly catalyzed surface. The gun laminating method employs the use of a spray gun that sprays the resin through a center nozzle and injects catalyst from side orifices into the resin. The amount of catalyst is regulated by a slave pump which can be set to deliver exacting amounts of catalyst to the resin. The typical mixture of catalyst to resin is between 1% and 2% by volume, depending upon ambient air temperature.

D. The ambient air temperature is critical to a well cured laminate. As noted above, fiberglassing should be done in a moisture–free environment. The ideal ambient air environment is 77ºF. All laminates are tested at that temperature. Fiberglass lamination may still be successful done at temperatures as low as 55ºF and as high as 95ºF (Lim). The percentages of catalyst would range from approximately 3% at 55ºF to 3/4% at 95ºF. It is not recommended going below 1% MEK–P (Lim). Research and field studies have demonstrated that the best laminations are between 70ºF and 80ºF. Fiberglassing below 60ºF it is not recommended because of the long gel–time. Caution should be used in temperatures above 90ºF, especially when using a surfacing agent (wax) in the coating material. It is critical that the surfacing agent has enough time to migrate to the surface in order to seal off the oxygen which results in surface cure. A gel time of 14–20 minutes is adequate to allow the migration of the surfacing agent. Shorter gel times may inhibit the migration of the surfacing agent, resulting in unevenly cured surfaces. Note: To double check the surface cure, pour acetone onto a clean rag, then rub rag on cured fiberglass surface. When it is tack–free, then surface cure has been achieved. A tacky surface indicates oxygen inhibition, which suggests that the air did not allow the surface to cure adequately. A minimum of 24 hours should be allowed for finish coat to cure before the acetone test. A more accurate test for the cured surface is a Barcol hardness test. A Barcol gun presses a needle into the laminate and measures the hardness. The hardness measurement should be 90% of the manufacturer's specifications. For example, if the manufacturer's test the cured resin at a 50 for Barcol hardness, the field test should be at least 45. Generally, a well fabricated, well cured laminate will have a minimum Barcol reading of 30 (Ashland Chemical 1965). The pinholes from the Barcol gun should always be filled with a small amount of top coat or finish coat.

3. **Cobalting** is the manifestation of black spots on the fiberglass surface, sometimes with trails. This is commonly called the "black plague." Cobalt Naphthenate is a promoter that, along with Dimethylanilile (DMA), is used in the resin so it will react to the Methyl Ethyl Ketone Peroxide (MEK–P) for cure. The cobalt actually does not complex with the polyesters. It is susceptible to attack by high levels of chlorine that may be present in pool water. If there is a small pinhole in the laminate where the cobalt can be exposed to chlorine, the result would be the leaching out of a black chloride salt which leaves and unsightly stain. there are two arguments on how to avoid cobalt stains:

   A. One argument, which to my knowledge has not been successfully demonstrated, is to eliminate cobalt as a promoter and instead employ a BPO (Benzyl Peroxide) cure system. The BPO system is not widely used in fiberglass laminations because it is more difficult to mix into the resin system and it may cause higher exotherm (curing) temperatures and uneven cures because of its mixing difficulty. Another problem with the BPO cure system is the need to increase pigment loads to achieve an acceptable color. The amount of pigment needed inhibits the cure and the corrosion resistance of the fiberglass composite (Lim).

   B. The second argument is to eliminate many of the fillers, such as calcium carbonate, Alumina Tryhydrate and dry pigments. Anything added to the resin formula that is dry often times does not mix well, leaving a particulate that can eventually slough off in water, resulting in pinholes which then can potentially expose the cobalt to chlorinated water. If fillers are eliminated from the polyester, and only paste pigments and thixotropes are high sheared into the resin, the chances for cobalting is very minimal. An added caution is to advise service technicians not to allow the pool water to have a free available chlorine level above 3ppm for long periods at a time. Chlorine levels of 2ppm or lower are less likely to react with the cobalt.

4. Blisters have the appearance of round bubbles or protrusions in the finish coat, usually one to six inches in diameter.

   The cause of blisters is mainly a problem with secondary bonding, i.e., top coat with wax bonding to previously waxed resin. In fiberglass resurfacing, it is not possible to apply a second finish coat over an already cured finish. The wax in the finish will prohibit secondary bonding. Even when vigorous sanding is employed, it is extremely difficult to remove the wax from the finish, especially with the dimpled surface of a chop strand mat laminate.

   Another cause of blistering is again the plague of a highly filled resin. Filled resins are more susceptible to pinholes which allow water absorption.

   The problem of blistering can be avoided by using a high grade isophthalic, corrosion resistant resin without fillers, especially in the finish coat. Only apply finish coat, unwaxed laminating surface to achieve optimum secondary bonding. The desired thickness of the finish coat should be approximately 15 mils thick when cured. this provides an excellent seal to avoid water penetration and protection against cobalt stains (Lim).

I have addressed a variety of problems within the fiberglass coating industry, as well as outlining how to avoid some of the more common mistakes made when fiberglassing.

I want to articulate some of the virtues of a fiberglass coated pool.

Since fiberglass cures dry, once the pool is filled, there is no need for labor intensive start up costs. The start up is "goof proof", allowing swimmers back into the pool as soon as the water is sanitized—no more blaming the pool technician.

A well cured fiberglass surface is easy to clean, stain resistant, stays smooth, and is user friendly. The fiberglass liner also has a superior thermal coefficient; thus, it stays warmer and has a longer life expectancy than other more traditional surfaces. Some fiberglassers even offer custom colors that can have a high degree of color uniformity, as well as cutting down heating cost. Fiberglass is also totally water–tight. It eliminates exposed rebar, does not spall or chip, and has a flexural strength that accommodates many expansive soil areas.

The research, technical support and field testing has been accomplished so that when done correctly, taking all precautions into account, resurfacing a swimming pool and spa with fiberglass makes the fines, long lasting pool surface. The fiberglass resurfacing industry has the opportunity to alleviate the most common concerns and make the necessary corrections, adjustments and changes to produce the very best fiberglass coated surface.

In closing, all individuals and companies involved in the fiberglass coating of swimming pools and spas should form a fiberglass coating industry. There must be an agreement on which types of applications and products used will meet the necessary standards. the chemists for the resin manufacturers could serve on an advisory committee along with respected people in the industry to create a standard for certification. Those companies that meet the industry criteria will then be able to use the certification logo in advertisements and sales. The resin manufacturers and suppliers can assist in "policing" the industry by selling only those approved products to the fiberglass resurfacing companies.

Let us take this opportunity to advance our technology to a new and higher level and give legitimacy to fiberglass surfaces as a truly viable alternative for swimming pool and spa coatings.

When done correctly and taking all precations into account, resurfacing a swimming pool or spa with fiberglass will make for the very best, long lasting surface. Our research and field testing has allowed us to address the common concerns and make corrections, adjustments, and changes to produce the very best fiberglass coating materials.

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About the Author

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fiberglass finishes. Mr. Dietz is a former educator, and has been involved in many educational seminars in the swimming pool and spa industry on subjects relating to fiberglass.

Appendix

Problem	Possible Causes	Possible Solutions
Bond Failure (Separation from the surface substrate)	1. Glassing over a painted surface 2. Moisture on surface at time of glassing 3. Improper preparation, leaving dirt, grit, or oily film on surface 4. Water absorption through tiny fibers because of incomplete coverage of fiberglass material 5. Breakdown of material because of the use of non–pH stable fillers, such as calcium carbonate 6. Improper cut and seal around fixture and at tile line 7. Bubbles in laminate due to pinholes	1. Sandblast and grind surface to remove paint 2. Dry–out cracks and other sources causing moisture 3. Grind surface and vacuum clean, then bond coat 4. Complete wet–out of fiberglass during lamination 5. All pH stable fillers and thixostropics high sheared into gel mixes. Finish coating should be free of fillers 6. Cut minimum of 1/2” depth with diamond blade and seal 7. Air release agents added to resins and rib rolling to remove bubbles
Chalking (Flaky or milky look when rubbed)	1. Improper cure due to incorrect percentage of surfacing agent 2. Use of non–pH stable materials 3. Improper mix and use of catalyst 4. Ambient air temperature either too cold or too hot to allow adequate cure	1. Minimum 5% surfacing agent used in finish coat only. Surfacing agent not to be used in lamination coats 2. Fillers that are pH stable and cannot break down. Eliminate fillers in finish coat. Fillers reduce the corrosion resistence of the overall composite 3. Mix with drill motor or use sprayer with slave pump 4. Do not laminate in temperatures below 60ºF or above 90ºF. Canopy pool while glassing in hot weather. Check surface cure with solvent before filling 5. Use of heater belts to warm up resins in cool weather
Stains Brown or Gray look to surface	1. Iron fallout due to low alkalinity in combination with cast iron headers, impellers or water source 2. Improper cure	1. Periodic use of chelation, sequestering, or deionizing agent to keep metals in suspension 2. Maintain proper alkalinity 100–150ppm. Change out heater with bronze header 3. Test cure with acetone before filling, raise wax percentage, regulate

		catalyst, heat resins to promote cure. Corrosive resins are not designed for pools. Eliminate fillers in finish.
Cobalting Black spots with possibility of trails	1. High chlorine in combination with microscopic pinholes 2. Lack of adequate surfacing agent 3. Improper cure due to catalyst and surfacing agent ratio 4. Use of improper resins, i.e., orthophthalic	1. Resins should be thoroughly mixed with air release agent in a high shear mixer 2. High concentration of wax in finish coat provides barrier and prevents cobalt from being attacked by chlorine 3. Catalyst use adjusted to weather and temperature range 1.5% – 2.25% 4. Use only non–corrosive isophthalic resins
Blistering Small bubbles – usually the size of a dime	1. Gel coat finish too thin 2. Application of finish over already finished over already finished surface – poor secondary bonding 3. Water penetration	1. Clean laminated surface with acetone prior to spraying on finish coat 2. Waxed finish coat cannot be adequately applied over waxy surface 3. Apply thick finish using caution to avoid runs
Air bubbles, voids Entrapped air in and between glass piles	1. Application of too many piles of glass at one time 2. Inadequate rolling between applications 3. Vigorous mixing causing incorporation of air into resin 4. High viscosity resin used in combination with thick glass	1. Apply fewer plies at one time and roll thoroughly 2. Reduce mixing speed 3. Resin viscosity can be reduced by adding 3 – 5% styrene
Blisters Round, elevated areas of varying sizes on laminate surface, may occur individually or in a group	1. Too rapid cure with high exothem may cause separation at mat surfaces 2. Presence of moisture in glass, resin, or filler	1. Reduce exotherm of resin system by laying up fewer plies at one time 2. Reduce exotherm by lowering DMA or catalyst level 3. Insure proper storage of resin, glass, and filler, away from sources of moisture
Cracks Cracks running along laminate either on or just below the surface	1. Overly resin–rich areas 2. Cracks may result from dramatic changes in the temperature conditions of the equipment (thermal shock cracking) 3. Resin shrinkage during cure	1. Reduce resin content 2. Monitor and minimize temperature fluctuations during equipment operation
Delamination Separation of glass layers, occurs particularly in areas of high stress; i.e., small–diameter pipe, knuckle	1. Inadequate saturation of glass with resin 2. Application of two layers of woven roving with no chopped mat in between 3. Application of laminate to an FRP surface that has been allowed to cure	1. Insure glass is completely saturated with resin and roll thoroughly 2. Always use alternating layers of woven roving and chopped mat 3. Before applying another FRP layer, lightly sand areas that have been cured for long periods of time

joints, etc.	several weeks 4. Use of rapid cure systems in small radii areas	4. In tight radii areas use a low–exotherm system to reduce resin shrinkage and stress build–up
Scorching/Burning Discoloration of laminate as it cures	Generation of very high exotherm temperatures due to one or a combination of the following: hot working temperatures, high DMA and/or catalyst levels, laying up too many piles at one time	1. Reduce DMA and/or catalyst levels particularly if working temperatures are high 2. Reduce number of plies laid up at one time and all9ow to cure before applying additional layers
Spotty Cure Laminate surface is soft in some areas while cured hard in others	Incomplete or inadequate mixing of promoters and/or catalyst	1. Adjust mixing to achieve a small vortex and good movement of resin surface 2. Mix thoroughly after addition of each additive 3. Dissolve cobalt in small amount of styrene before adding to resin
Tacky Surface Laminate surface is tacky to the touch or fails to pass acetone sensitivity test	1. Incomplete cure caused by air inhibition 2. Cobalt level too low	1. Apply a resin/wax topcoat to tacky surface (see page 12) 2. Do not use a resin/wax topcoat if additional bonding is to be done to the surface 3. Increase cobalt level
Wrinkle Crease or wrinkle of glass on or near the laminate surface.	Wrinkling of Veil (particularly synthetic veil) or glass can occur when laminating over uneven surfaces or when using stiff, heavy glass in corners	1. Use 1 oz.(300 g/m***2) or 1 1/2 oz. (450 g/m***2) mat where wrinkling is a problem 2. Reduce resin viscosity by adding 3 – 5% styrene