

## **Infusion Comes to Park Isle Marine:**

### **Quality Over Quantity Or The Best Of Both Worlds?**

Vancouver Island Boatbuilder Park Isle Marine (est. 1987) made the decision this past summer to integrate vacuum infusion processing into their laminate Trawler fabrication. At first take this seems an unlikely choice. Infusion as a fibreglass composite manufacturing process, has been around since 1949.<sup>1</sup> The Vacuum Infusion Process (VIP), particularly with the new fibres and resins now available, is well suited to mass production of extremely tough but lightweight laminate products and components. Park Isle Marine, however, is committed to producing custom vessels for serious passagemaking in the oceans of the world. Is a cost-effective application of VIP possible in custom boat building? And if the economic gains are minimal, are there significant workmanship and product performance gains to justify the introduction of VIP to a custom boat building facility?

I first stumbled across Park Isle Marine while researching infusion with a friend of mine who was employed there. Vacuum Infusion Process moulding is one of several closed mould methods for fabricating fibreglass composites. A closed mould process is preferable in that it produces fewer airborne toxins and can result in a better product. Other methods include: Resin Transfer Moulding (RTM), which injects resin between a male and female mould form; Vacuum Bagging, which is sort of like doing a hand lay-up under a plastic bag that's connected to a vacuum cleaner; and Vacuum Assisted Resin Transfer Moulding (VARTM), which is pretty much the addition of a vacuum to improve the double mould process of RTM. VIP uses a vacuum under an airtight plastic film, sort of like Vacuum Bagging. Then, however, instead of having to massage resin through the fibres as in a hand lay-up, the resin is literally sucked into the fibres. It's drawn from multiple sources through several stitched layers of uni-directional fibres to form a high quality composite. In circumstances involving cored laminates the resin can be drawn through deeply scored core material at the same time as the fibre layers. We had hoped to apply VIP to the manufacture of a line of high performance sea kayaks so I was delighted to find myself invited to watch the infusion of a test panel at Park Isle Marine. I'm familiar with the more traditional method of hand lay-ups for the manufacture of fibreglass composite kayaks so was fascinated by the dramatic example of the test panel. The hull of a custom 65-foot trawler nearing completion dwarfed the whole demonstration. Over the course of the test it became apparent that the eventual objective was to infuse not just components and cabin sides but entire hulls and decks of even bigger vessels than the one towering over our heads. This just didn't seem to be a cost-effective choice. There was so much preparatory work involved just for the 6 foot by 7-foot test panel; it was hard to conceive of a tide of resin moving efficiently through an entire hull. The additional requirement, in custom boat building, for single use moulds somehow seemed to push VIP well into the realm of the impractical. Subsequent observation and further research would prove this to be a mistaken assumption.

When the finished panel was pulled from the mould the quality of the laminate was amazing. My expertise is limited by my experience in the kayak industry and recent research. The infused test panel, though, was obviously thinner, of a uniform thickness and more compact than any comparable hand lay-up. The clear gel coat on the moulded side was like glass and the inside

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<sup>1</sup> "Infusion Revisited" by Andre Cocquyt – Professional Boatbuilder Magazine, Number 69, February/March 2001.

surface that usually requires extensive sanding and preparation for finishing appeared ready for an application of its own coating of gel coat or paint. A close examination of a cross section of the panel showed resin to have penetrated completely and uniformly into all the cuts scored into both surfaces of the core material. The test was deemed enough of a success for Park Isle Marine to continue the move towards VIP for the production of custom trawlers. There were still too many unanswered questions in terms of a cost-effective application. The end product was excellent and the process well applied to production boat designs, especially small boats like sea kayaks. There was an impressive assembly of Victoria area boat design and building talent at the infusion test so I circulated and gathered a few key names for future reference. Of particular note was naval architect Greg Marshall<sup>2</sup> and engineer Gordon Lacy<sup>3</sup>, a specialist in VIP. There was a lot to be learned, however, before I could even begin to ask intelligent questions.

The first impression of Park Isle Marine is of a down to earth company committed to excellence in custom trawlers. Once I'd done my internet research, terrorised my library and skulked through a variety of local boat building facilities the owner of Park Isle Marine, Roy Parkinson, seemed as good a place as any to start. The answers to some pretty fundamental questions like "Why custom boats?" . . . "Why trawlers?" . . . "Why fibreglass?" . . . were needed to qualify and support the last but certainly not the least question, "Why infusion?"

Boat builders, as a rule, are passionate about what they do. Mass produced boats, however, appear to be dominated by numbers. Definitely more affordable, the objective seems to involve coming up with a design that is cost effective to mass produce yet caters to the needs of as broad a range of recreational boaters as possible. Custom vessels, on the other hand, tend to emerge, one at a time, from the evolution of a long-term relationship between designer, builder and customer – a relationship that's based on a shared passion for the lifestyle and craftsmanship represented by a particular type of boat. Custom boat building demands a commitment to excellence that ranges from concept and design, through material selection, assembly methods, and workmanship to finishing details and the quality of installed components.

The Park Isle commitment to full displacement Trawlers stems from a passion for serious cruising in the Pacific Northwest. This type of vessel is based on a hull design by Mr. Edwin Monk Sr., and was originally intended for fishing in the varied sea conditions off the West Coast of North America. Fishing takes place in all kinds of weather so the vessel had to be extremely seaworthy. The boat currently under construction at Park Isle Marine, and the one that will be first to benefit from infusion, is the Royal Passagemaker 65, (designed by naval architect, Gregory C. Marshall). Mr Parkinson believes that this style of boat is the ultimate Passagemaker; seaworthy, efficient, and roomy and easily handled by two people.

In the course of my research I heard arguments for steel boats, aluminium boats, wood boats and fibreglass boats. After reviewing the data I found I had a personal preference for fibreglass, but was curious as to why Park Isle had made the same choice. The answer was simple. A fibreglass boat offers the best of all possible worlds to the boat owner. Possessed of many of the positive attributes of wood, its also cost effective, lightweight, warm, dry, and low maintenance.

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<sup>2</sup> Gregory C. Marshall, Naval Architect – specialising in luxury yachts and principle designer for Park Isle Marine – est. 1992.

<sup>3</sup> Gordon Lacy, P. Eng.

The overall thrust at Park Isle Marine, then, is pretty straightforward - to craft custom vessels that represent the ultimate in structural integrity and comfort using the finest North American craftsmanship. Their clients are experienced yachtsmen (and women) with specific cruising needs who appreciate the meaning of seaworthiness and the value of quality workmanship.

So where does infusion fit in this equation of custom, comfort, quality and seaworthy? There are strong arguments for infusion simply on the basis of health, the environment and a high quality product.

The manufacture of fibreglass composites produces several hazardous air pollutants (HAP's) that include a variety of resins, styrene, acetone and methyl ethyl ketone as well as glass fibres. All these airborne toxins cease to be an issue once the laminate is cured and finished, but for the manufacturer they can be a real concern. Styrene, a by product of the glass composite curing process, is extremely irritating to the eyes and nose at low concentrations and in heavier concentrations can cause headache, dizziness and nausea. Acetone and methyl ethyl ketone, used to clean uncured resins and gelcoat from tools and equipment, are irritating to the eyes, nose and throat. Inhaling the vapours can cause drowsiness, breathing difficulties and more serious damage to the lungs and central nervous system. Glass fibres, produced in handling fibreglass and when sanding or grinding laminates prior to finishing, have a negative health impact either through inhalation as minute air born particles, or as a contact irritant to eyes, nose, throat and skin. There is a possibility that inhalation of air born particles may cause permanent damage to lungs and airways and may increase the likelihood of developing lung cancer.

Canada is moving towards regulatory legislation for the composite plastics manufacturing industry and the US is already there. The US Congress passed Clean Air Act Amendments in 1990 identifying the release of over 10 tonnes per year of identified HAP's as a major pollution source subject to stringent regulating. Any boat builder using over 10 barrels of resin and gelcoat a year would qualify. Final US regulations and standards were to be released by the end of this year with facilities having an additional 3 years to comply. The Canadian Environmental Protection Act was amended and strengthened with regards to HAP's and VOC's (Volatile Organic Compounds) in 1999 and the National Pollutant Release Inventory requires manufacturers to register their use of identified pollutants on an annual basis. Atlantic Canada boat builders have already been hit with stringent provincial requirements for styrene emissions in amendments to the Occupational Health Regulations. (Threshold Limits for styrene – Time Weighted Average at 20 ppm. Short Term Exposure Limit at 40 ppm) Pacific Canada is not likely to be far behind. The Vacuum Infusion Process is recognised as a highly efficient closed mould process that virtually eliminates the exposure of liquid resin to the work place environment during the entire manufacturing process. It also uses less fibre and resin and requires significantly less grinding and sanding to achieve a finished product. When the process is complete there's little requirement to clean tools and equipment. The introduction of VIP, in short, makes for a much healthier workplace.

In terms of environmental concerns, infusion represents a far more efficient use of materials and resources, using less resin and fibre in the first place and producing far less waste.

VIP is only a small aspect of boat building, but effectively applied, consistently produces a superior composite laminate. The glass to resin ratio is about 65% to 70% compared to the 45% to 55% ratio that is typical of a well-done hand lay-up. The fibre in a composite laminate provides the strength so the higher ratio, with complete saturation of resin, ensures a stronger product. Too much resin, on the other hand, reduces the strength of the laminate. In a cored laminate infusion there's the added benefit of about a 50% weight reduction in the finished product. The finished laminate produced by infusion, cored or otherwise, clearly meets the demand for quality workmanship that is integral to custom boat building.

The cost effectiveness of applying infusion to custom boat building was made very apparent by a conversation with Greg Marshall and Gord Lacy. The infusion process, while producing a remarkable laminate, appeared to produce a great deal of waste in terms of hoses and plastic film. Was the process likely to evolve to the point where these items could be re-used? Setting up for the straightforward infusion of a simple test panel also seemed to be both labour intensive and time consuming. What would it be like for a large hull or a complex deck design, especially if you're only making one? What kind of impact would the introduction of infusion have on employees, beyond a cleaner environment?

Mr. Lacy was quick to clarify the issue of waste with infusion. This process saves more in terms of efficient use of laminate products than it wastes in non-reusable plastic film and hose. Hand lay-ups for laminate products, on the other hand, produce buckets of unusable hardened resin. Unlike plastics, fibreglass products cannot be recycled. There's also far more resin and fibre used for a hand lay-up than is required to produce a superior infused laminate. Then there are all the non-recyclable and non-reusable consumables used in a hand lay-up like acetone, disposable latex and rubber gloves, disposable respirator cartridges, disposable Krytex suits, disposable rollers, brushes, roller sleeves, shoes, clothes, rags, brain cells and skin cells.

The plastic film essential to VIP can be and often is, in many mass production instances, replaced with a reusable latex film. Semi-custom or semi-production boat building involves the use of similar exterior hulls with customised interiors so could also utilise reusable latex film. The practice of reusable film would have limited application in custom building but the apparent waste of infusion is more than offset by at least a 30% savings in expensive resin and fibre.

Custom boat building will always involve the use of single use moulds for anything from small details to an entire hull or deck. Hand lay ups of any sized mould are time consuming. Each layer has to at least gel or even cure before the next can be applied and there is a general requirement to use more layers in a hand laid laminate to achieve the same strength as a much lighter and more compact infused laminate. The traditional laminating process also tends to produce constructs that have a certain Frankenstein appearance prior to finishing, with joins and seams connecting all the components. Each join and seam is a potential weak spot in the finished boat and requires careful attention both to ensuring a complete join and in finishing to hide the seam. With infusion there's no limit to the complexity of the part to be infused. Savings merely multiply with the complexity of the mould. Size represents no obstacle either. VIP is a work-smart process that lends itself to the development of more sophisticated single piece moulds, even for single use application.

Mr. Marshall described an interesting scenario to reinforce the serious advantages of sophisticated single piece moulds without even factoring the additional savings that would be achieved with infusion. The fabrication of a large yacht constructed with a few mould pieces would require about two 8-hour shifts to assemble while a smaller sister yacht involving over 200 mould pieces would take far longer. Generally, it's possible with smart one-piece mould construction to deliver in 8 months what a traditional and typical one off multi-piece mould design produces in 36 months. Weight savings in this instance are significant due to the lack of secondary tabbing (joining of all the moulded parts) Imagine the additional savings if it was infused! A final infused product is stronger yet uses about 30% less resin and fibre and can weigh as much as 50% less with cored laminate. Infuse your laminates with sophisticated single piece moulds and it's really cost effective!

The design implications of infusion are significant in that it produces a much stronger and lighter product and can be used with far more complex but single piece moulds. The weight factor allows the design of vessels with a lighter top structure and a subsequent lower centre of gravity, resulting in a more stable boat. The precision capabilities of infusion allow the design of complex fine details and precise component alignment in assembly.

The final concern with infusion is the cost-effective use of labour. While set up for infusion is time consuming and requires a higher level of training than does a hand lay-up it requires fewer personnel. Once the set up is complete what traditionally has taken days to complete is done in a matter of hours with minimal labour costs. Infusion can reduce the overall labour costs of composite laminating by 30% to 70%. Retraining is pretty straightforward too and can be limited to a handful of personnel. Many preliminary steps remain the same, such as preparing the mould for infusion. Beyond ensuring that the mould is airtight and has an appropriate flange, the same attention is paid to it's surface finish. The mould is waxed, gelled or painted and skinned. Skinning refers to an application of a single layer of mat laminate to protect the mould from the heat generated by the infused laminate curing process. This gel/mat layer or skin coat also helps to ensure that no print through will show through the gel coat finish.

All the subsequent layers of fibre and core are laid into the mould dry, using a spray adhesive. Following that the hoses, peel ply and plastic film are applied and the vacuum and resin tubes put in place. The integrity of the vacuum is tested and then infusion is begun. It's a little more complicated than that, but once the set up is done, a manufacturer only begins to realise the savings in labour. First, a comprehensive infusion of all the layers of fibre and core material with resin, depending on the size of the part, takes from twenty minutes to a couple of hours. As an added bonus, curing is contained by the plastic film and the finished product is just that, finished. Hours of hand lay-up, curing and re-laying are gone. Additional labour savings are realised with the elimination of hours of grinding and sanding. The removal of air born toxins from the workplace also reduces the number of lost man-hours due to illness, lowered productivity and staff turn over and retraining. It's true that this process will eliminate a few unskilled jobs, but it can also stimulate an increased status and pride of trade to fibreglass workers who take the time to learn and master the process.

Park Isle Marine, led by Roy Parkinson and advised by Greg Marshall and Gord Lacy, has made a responsible choice in turning to infusion - responsible not just in terms of economics, health

and the environment, but in terms of an ongoing commitment to excellence. The Vacuum Infusion Process is not only well suited to the mass production of water craft, it's ideal for custom boat design and custom boat building. It reduces design limitations, increases performance possibilities and product quality while delivering the best of both worlds, a cost-effective route to excellence.

When the time comes to build those kayaks maybe I'll keep a couple of them on the deck of my very own Trawler. Apparently the possibilities are almost limitless!