# DEVELOPMENT

by Kate Hall

# VACUUM INFUSION

## D7 Boating explores new manufacturing options

**SOUTH Africa's leading resin manufacturer, NCS Resins, AMT Composites and Pongola-based D7 Boating, join forces to demonstrate the advantages of vacuum infusion techiques.**

ARTHUR Duvenage, owner of D7 Boating, wanted to produce a new boat that would measure 8,5m in length and 2,8m in width. After looking at a number of options, he decided that vacuum infusion was the best way to produce this new craft's hull.

"The main reason for producing vacuum infusion boats is to gain a lighter, stronger product with reduced material wastage and better working conditions for my staff," he said.


**To begin the process, dry fibres are laid into the mould.**

The Vacuum Infusion Process (VIP) is a technique that uses vacuum pressure differential to draw resin through the laminate structure. Materials are laid dry into the mould and the vacuum is applied before resin is introduced.

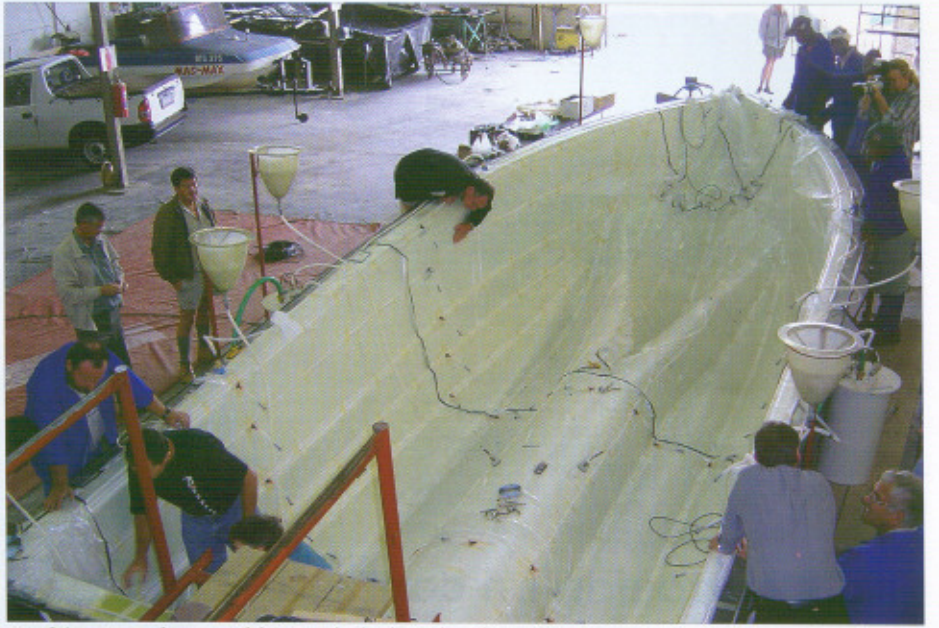
Vacuum pressure differential is used to draw resin through the laminate structure via carefully placed resin plumbing (network) tubing.

The process has many advantages, in that it only requires a one-part rigid mould tool. The "closed mould" nature of this system uses a flexible membrane (vacuum bag) as the top tool and has fewer restrictions on the size and shape of the moulding than do other boatbuilding systems. The flexible outer membrane is sealed to the mould tool, and the air is evacuated to provide pressure differential. It is important to have a flange of at least 200mm on the mould. This is for the vacuum lines and sealing tape to seal the flexible membrane.

It is most important that the mould be well constructed and have no leaks. It is good practice to use an ultrasonic leak detector to locate any leaks in the mould which should be immediately sealed before the resin is introduced. It is also best to coat the whole mould with a good covering of Flow Coat to seal it properly. Any splits in the mould should be sealed with silicone.

The catalysed resin is then introduced to the cavity between the mould surface and the vacuum bag. The resin infuses the reinforcement and is consolidated by the vacuum pressure.

Lower viscosity resin systems are preferable (below 350 cps) with a medium to long geltime and a low peak exotherm. Polyester, vinylester and epoxy resins are suitable for this application.



**At this stage the mould is sealed, the plumbing lines are in and the catalysed resin is in the pots, ready to be infused.**

Vacuum on polyester resins should be in the region of -0.60 bar, and for epoxy resins it should be as high as possible, in the region of -85 bar. It is important not to draw too much vacuum on the polyester resins, as too many volatiles in the resin may be drawn out, creating uncured areas. Vacuum is drawn until the resin has cured.

Any core material, such as Baltek end-grain balsa or Airex/Herex PVC foams, should be perforated every 100mm and the core should be scored in both directions on both sides. This will allow the resin to flow down through the perforations and along the scored lines, and then bleed down and up, wetting out the laminate.

The vacuum infusion process has a number of advantages:

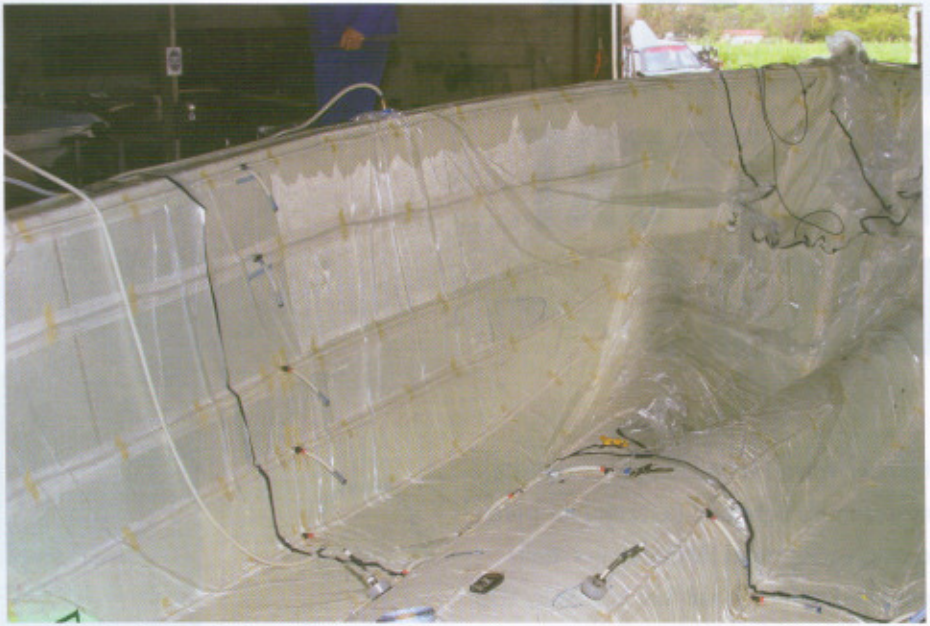
- Reduced styrene emission in the work place;
- Improved laminate performance through better resin-to-fibre ratio (60-75% fibre by weight);
- Lighter, stronger products;
- Repeatability, more consistent quality of products;
- Professional finish to back surface of moulding;
- Better control of resin and reinforcement usage;
- Reduced trimming and finishing operations;
- Cleaner and safer working conditions for production staff;
- Fewer restrictions on size and shape of hull;
- Changes to laminate construction and design (e.g. adding core materials like PVC foam, end-grain balsa or Soric) are easily accommodated, without having to make new moulds.
- All types of fibre reinforcement can be used, from Kevlar® to carbon and glassfibre in either stitched, woven or chopped strand mat.
- Using stitched glassfibre will give added strength, with results of up to 40% higher mechanical properties.

**Constructing the D7 ski-boat**

New generation stitched glass fabrics, together with Lantor Soric in the hull and Baltek end-grain balsa in the deck, were used as the core materials to create a sandwich laminate. The Soric also acted as the flow medium in the laminate. The hull infused in 4,14 hours, and the deck infused in four hours.

The laminate specification for this particular hull was as follows:

- NCS Ultragel 21 (Polyester Gelcoat)
- Lantor D7760 Finishmat
- Combination mat 450g/sqmCSM and 600g/sqm Bi-axial glass fibre (0/90 orientation)
- 600g/sqm Bi-axial glass fibre (±45 orientation)
- 6mm Lantor Soric XF
- 600g/sqm Bi-axial glass fibre (±45 orientation)
- 600g/sqm Bi-axial glass fibre (0/90 orientation)
- Resin system: NCS 236 (low viscosity @ 180 cps)



**Resin being infused through the lay-up.**

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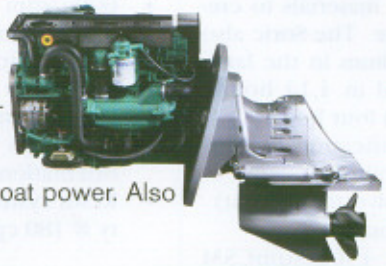

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**The finished product — the D7 hull — being removed from the mould.**

The laminate specification for the deck was as follows:

- NCS Ultragel 21 (Polyester Gelcoat)
- Lantor D7760 Finishmat
- Combination mat 450g/sqmCSM and 600g/sqm Bi-axial glass fibre (0/90 orientation)
- Two layers 759g/sqm Triaxial stitched glass
- 1000g/sqm Injectex glass
- Balsa D100 rigid sheets 25mm
- 1000g/sqm Injectex glass
- 2 layers 759g/sqm Injectex glass
- Combination mat 450g/sqmCSM and 600g/sqm Bi-axial glass fibre (0/90 orientation)
- Resin system: NCS 236 (low viscosity @ 180 cps)

Achieved results:

- Resin content by weight: 38%
- Fibre content by weight: 62%

The total weight of the deck is approximately 400kg and the hull 600kg.

Arthur Duvenage said afterwards, that he was most impressed with how easy the system was and thanked the competent staff from AMT and NCS who were on hand to assist.

**AMT Composites offer the following:**

- **Vacuum infusion technology;**
- **Kevlar, carbon and glass fibres;**
- **Polyester and epoxy gelcoats and resins;**
- **Vacuum bagging auxilaries;**
- **Core materials (PVC foam and end-grain balsa);**
- **Adhesives.**

**NCS Resins offer the following:**

- **Top-class technical expertise;**
- **In-house vacuum infusion technology;**
- **Training and laboratory analysis for vacuum infusion;**
- **Polyester gelcoats and resins for vacuum infusion — these being both orthopthalic and isopthalic;**
- **A vinylester resin especially designed for vacuum infusion, having a good cure profile linked with low viscosity;**
- **Infusion core material (Soric range);**
- **Stitched glass fabrics;**
- **Analytical capabilities of all supplied resins.**