

Formula One ... on water



Relying on advanced DuPont materials technology and technical assistance for 21 key components, Mercury Marine engineers achieve breakthrough performance in Verado outboard engines for water craft.

By Dino Tres, DuPont Engineering Polymers, USA

Mercury Marine has turned outboard boat engine technology on its ear with its new Verado supercharged four-stroke power plants, combining whisper-quiet operation with spine-tingling acceleration and power.

Verado, a vertically oriented, inline six-cylinder power plant, marks Mercury's entry into high-powered, whisper-quiet engines. With up to 205 kW (275 horsepower), the engine is one of the company's most powerful and quietest outboards ever produced. The new engine also holds a three-star emission

compliance rating from the California Air Resources Board and is positioned to comply with new U.S. Federal emission requirements due to come into effect in 2006.

"We leveraged the best from automotive engine design to deliver a new category of outboard engine that is dazzling the boating industry," said Rick Davis, Mercury's chief technology officer. He credits DuPont engineering polymers and technical support for making crucial contributions to the successful development of the Verado. "DuPont high-performance materials deliver major benefits over metals and thermosets in holding down weight and cost, combating corrosion and enabling us to set new standards for outboard engine performance and durability," he said.

"Strategic application of engineering polymers in this

engine has helped Mercury Marine derive significant benefits in the areas of improved Noise, Vibration and Harshness (NVH), with excellent quality and durability. Significant cost reductions due to elimination of paint, machining operations and reduced assembly costs have been attributed to the application of polymers," said Mitesh Sheth, polymer materials engineer for Mercury.

Engine subsystems using DuPont high performance polymers on Verado include cowling, supercharger, fuel delivery, cam cover, air handling, powertrain and electrical/electronic controls.

Cowl assembly: big injection moulded parts deliver big benefits

In the cowl assembly of Verado, six innovative parts made of DuPont high performance polymers provide a combination of structural, protective and aesthetic functions.

The top cowl is the largest component ever injection moulded from glass reinforced nylon. Made of a 33 percent glass reinforced DuPont™ Zytel® nylon, it is shaped like a giant scoop measuring 851 millimetres front to back, 582 millimetres across, and up to 417 millimetres deep. It weighs just over five kilograms - far less than a metal or a thermoset plastic housing.

The rear cowl, and a structural rib that is adhesive-bonded to it, are moulded from the same Zytel® resin. The front cowl is moulded from DuPont™ Minlon® mineral/ glass reinforced nylon for added flatness. The lower cowling, or chaps, consists of two mating parts moulded from DuPont™ Surlin Reflection Series® ionomer alloys for superior gloss without paint.

These components meet several demanding requirements and deliver major benefits over alternative materials.

'Formula One on water' with new Mercury Marine outboard motor



Strong, silent type: this handsome new Verado four-stroke engine from Mercury Marine relies on DuPont polymers for cowling and other key components.

For example, they:

- Mate precisely to prevent water from entering the engine compartment;
- Provide improved NVH: Verado is the quietest and lowest vibration engine in its class;
- Provide excellent structural strength and impact resistance;
- Resist motor fuel, oil, various cleaning agents and corrosive saltwater;
- Stand up to temperatures ranging up to 93 degrees C in the upper cowl;
- Weigh about 30 percent less (15.2 kg) than thermoset SMC (sheet moulding compound) parts;
- Cost 46 percent less than SMC cowls, thanks to the integration of assembly and functional features in part designs, and due to reduced costs of painting attributed to less paint consumption, reduced surface preparation and higher first pass paint line yields.

The cowl parts made of DuPont™ Zytel® and Minlon® are finished in a three-coat system providing first-pass acceptance yields of 95 percent or better at each stage, according to Mercury Marine. By contrast, SMC cowling parts used for other Mercury engines require application of filler to deal with porosity, a primer and two finish coats. Adding to cost, painting yields are low, as each

coat requires multiple passes to repair defects caused by porosity and solvent popping.

The lower cowl moulded from DuPont™ Surlyn Reflection® series ionomer alloy has a high-gloss finish and integral colour. It incurs no painting costs at all.

Smart Engine

According to Tim Reid, director of engine design for Mercury Marine, "Verado offers an integrated outboard system with uncompromised NVH, reliability, durability and performance. Features like SmartCraft® Digital Throttle and Shift (DTS), high-performance Advanced Mid-Section (AMS) with a progressive-rate outboard mounting system and Electro-Hydraulic Power Steering system make Verado a truly pioneering product in the marine industry and make this outboard best-in-class in driver interface and satisfaction. Mercury's Engine Guardian constantly monitors all vital engine functions, warning the operator of potential problems and proactively taking corrective actions to avoid engine damage. Our patented supercharger air-induction system, with a highly tuned intake resonator, reduces intake noise by up to 14 dBA in the midrange to full throttle, without sacrificing engine performance."

Supercharger boosts power of compact engine

Verado is the world's first production outboard featuring a supercharger. According to Mercury, the supercharger enables its 2.6 litre Verado engine to deliver significantly higher torque and acceleration than competitive 3.0 to 3.6 litre four-strokes. Its performance equals that of a 4.0 to 4.5 litre, naturally aspirated engine, which would be far too bulky and heavy for an outboard, Mercury engineers say.

The supercharger, a rotary Lysholm-type co-developed by Mercury and IHI Turbo America, uses rotors coated with DuPont™ Teflon® fluoropolymer. "Teflon® was critical to our success," said Davis. "Other materials caused the rotors to quickly corrode and wear out."

Fuel module meets stringent requirements

Verado has an innovative electrically powered fuel delivery module located outside the engine compartment, between the engine and the propeller. The module is protected in a two-piece

housing moulded from DuPont™ Zytel® HTN high performance polyamide. It contains two fuel pumps, one to draw fuel into the housing from the tank and another to pump it to the fuel injection rail.

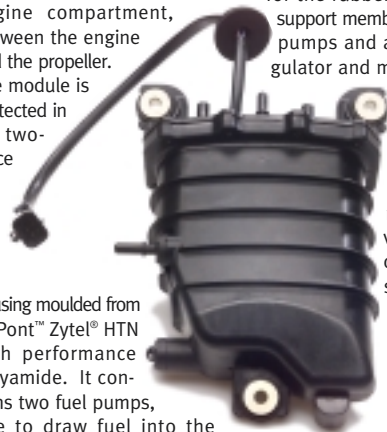
Thanks to the use of Zytel® HTN and astute part design, the housing can meet demanding requirements and deliver cost and performance benefits over metal housings:

- It stands up to nearly continuous contact with motor fuel on the inside and seawater on the outside. In certain boat application and running conditions, the fuel delivery module operates continuously immersed in saltwater.

- It costs about 15 percent less than an equivalent aluminum module and has numerous integral features that avoid the need for separate parts and/or costly machining that would be required with a metal housing. The module provides a weight reduction of 19.7 percent (0.45 kg) compared to an aluminum module.

The housing's moulded-in assembly features include: fittings for in and out fuel lines; a manifold reference line, a groove for the rubber sealing ring; support members for the fuel pumps and a pressure regulator and mounting ears.

Integrated fittings reduced the potential for leak paths and polymer materials provided excellent corrosion resistance.



The Verado's fuel module.

The Verado's cam cover.



can be ultrasonically welded into the cover.

Cam cover seals oil in, water out

The cam cover of the Verado (above) is moulded from DuPont™ Minlon® mineral/glass-reinforced nylon. It provides a 1.8 kilogram weight saving and considerable cost savings compared with an aluminum cover.

The cover draws on the material technology and design principles employed for similar nylon components used on automotive engines, but it overcomes unique oil-sealing challenges posed by the engine's vertical position and the marine environment.

The integration of functional and assembly features in the cover reduces costs by reducing part count and minimizing assembly steps. For example, an oil-air separator is moulded-in. Another cost-saving feature involves a separately moulded breather plate, which unlike a metal part,

Air handling system helps keep down noise

Verado engines also deliver cost, weight and performance benefits by incorporating automotive industry learning into the design and materials employed for the air intake manifold and resonator.

The air intake manifold (below) is a one-piece design that delivers a weight saving of more than 50 percent compared with aluminum, better corrosion resistance, and runners with smoother interior surfaces for improved air flow to the engine. It is moulded from 33 percent glass-reinforced Zytel® nylon.

The resonator efficiently manages noise, vibration and harshness and incorporates an air filter in its design. The resonator is a two-chamber design consisting of a centre tube injection moulded from Zytel® 15 percent glass-reinforced nylon, and a blow moulded outer body also made of Zytel®.

Powertrain components 'have what it takes'

The powertrain of the Verado engine also includes a torsional damper made of DuPont high performance polymers. The torsional damper, moulded from DuPont™ Vamac® ethylene acrylic elastomer, is pressed into place on the flywheel to dampen torsional harmonic movements. The damper made of Vamac® meets Mercury's demanding requirements for resistance to hot oil at temperatures ranging up to 150 degrees C.

Electrical system

Verado comes with state-of-the-art electrical controls and systems. For protection and servicing ease, its modules are consolidated in a control box with a cover, both moulded from a glass-reinforced grade of DuPont™ Crastin® PBT thermoplastic polyester.

Comprehensive technical support

"DuPont technical support played a major part in our success with polymer components," said Mitesh Sheth, the plastics engineer at Mercury Marine who led in coordinating contacts between the two companies and with the moulder suppliers.

"DuPont technical support played a major part in our success with polymer components."

Mitesh Sheth, plastics engineer, Mercury Marine



CONTACT

Mercury Marine
P.O. Box 1939
Fond du Lac, Wisconsin 54936
USA
Tel: +1 920 929 5340
www.mercurymarine.com

The Verado's air intake manifold.

