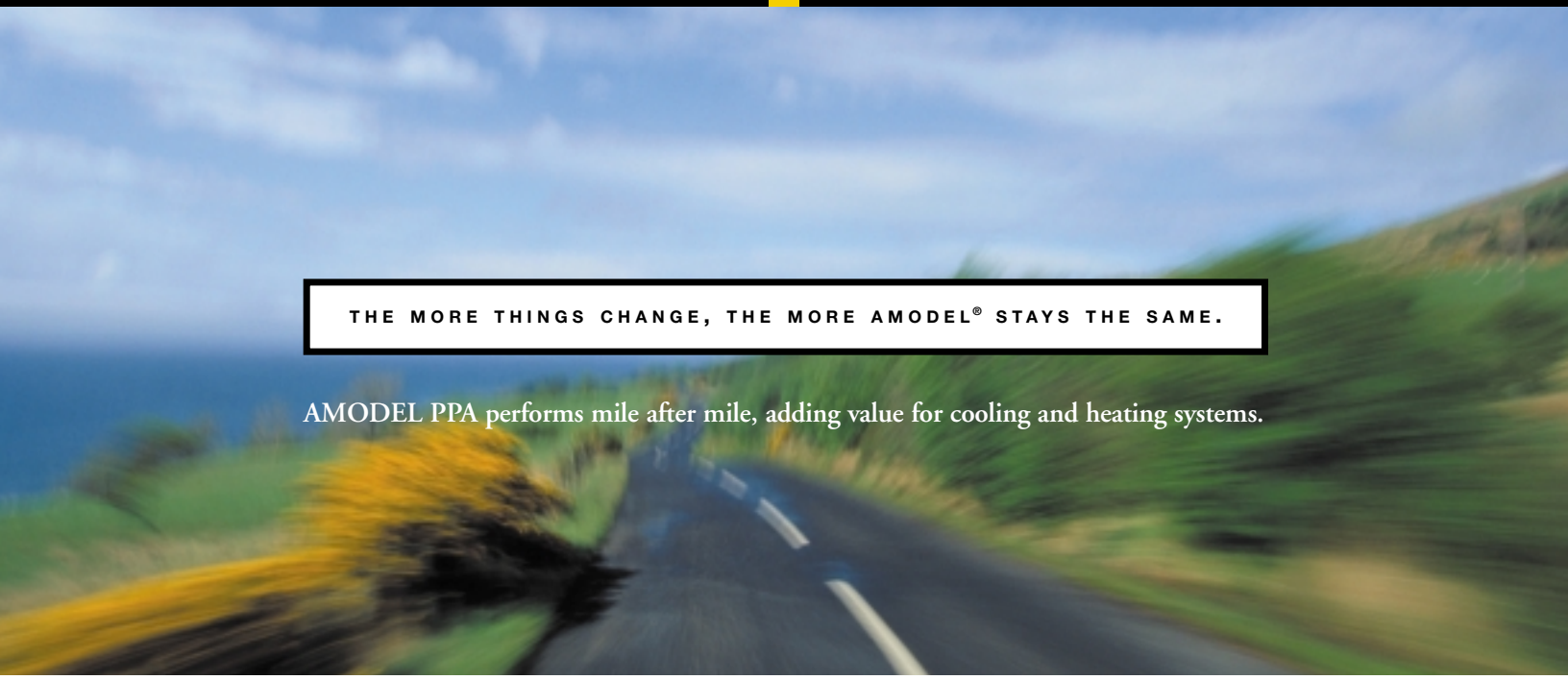


THE MORE THINGS CHANGE, THE MORE AMODEL® STAYS THE SAME.

AMODEL PPA performs mile after mile, adding value for cooling and heating systems.

Solvay
Advanced Polymers

SOLVAY


NORTH

CHANGING TRENDS DEMAND NEW LEVELS OF PERFORMANCE

There are few things more constant in the automotive world than change. Standards will evolve, systems will be modified and cost pressures will definitely continue to rise. Yet one thing can remain the same: the overall value and long-life performance of cooling and heating components molded from AMODEL polyphthalamide (PPA) resin.

The potential 10-30% cost savings for cooling and heating components—which a metal-to-plastic conversion can deliver—is fueling a conversion trend.

ACCELERATE YOUR COST SAVINGS TODAY

Today's vehicle manufacturers are continually looking for ways to reduce costs over that of die cast aluminum and stamped steel parts. Solvay Advanced Polymers has a solution.

AMODEL resin can offer up to 50% weight reduction and 10-30% cost savings per part compared to aluminum. Best of all, AMODEL resin is a *high-performance* polymer that can allow you to take advantage today of the cost savings available through metal replacement, and remain compatible with future designs and technologies.

KEEP PACE WITH CHANGING STANDARDS

As emissions and fuel economy standards become more restrictive over the next five years—following changes in CAFE standards and the Clean Air Act—the industry will evolve toward using more lean burn technology, as well as direct fuel injection, common rail technology and exhaust gas recirculation.

While these anticipated changes can improve the efficiency of fuel combustion, they can also drive engine temperatures up. The higher average temperatures of conventional glycol/water mixtures in cooling and heating systems can increase the corrosion of metal components, furthering the push toward engineering polymers.

Although new organic acid technology (OAT) coolants have been shown to reduce the attack on aluminum, the chemical attack on current mid-range polymers such as polyamide-6,6 (PA-6,6) is significant—up to an additional 15% reduction in properties. AMODEL resin shows superior performance in OAT coolants.

As a result, AMODEL resin can allow vehicle manufacturers to deliver a total system upgrade using new coolant technology, while taking advantage now of weight and cost-per-part reductions over die cast aluminum and stamped steel parts.

M I L E 1

original condition, 0 miles

BETTER PERFORMANCE DOWN THE ROAD

After seven years and 85,000 miles of actual vehicle use, this thermostat housing molded from AMODEL polyphthalamide (PPA) shows no measurable change. No dimensional changes, no surface degradation and no change in the performance of the polymer.

That's because AMODEL resin is a high-performance engineering polymer that features superior corrosion resistance compared to metal, plus improved hydrolytic and dimensional stability compared to PA-6,6.

same condition, 85,000 miles

MILE 2

POWERFUL BENEFITS ARE BUILT RIGHT IN

Our family of AMODEL resins is a class of semi-crystalline, aromatic polyamides that differ from conventional polyamides by featuring low moisture absorption, improved dimensional stability and higher thermal resistance. They also offer superior chemical, creep and fatigue resistance as well as higher end-use temperatures and low thermal expansion rates.

Specific glass-reinforced grades of AMODEL PPA have been developed for cooling and heating systems. These grades have superior hydrolytic stability over conventional polyamides. Further, they exhibit superior fatigue resistance and weld line strength, plus they have excellent mechanical properties at operating temperatures due to their high glass transition temperature (Tg).

In fabrication, AMODEL resin crystallizes rapidly, leading to faster molding cycles in thick or thin sections. This can lead to parts of lower total-piece cost, which is a significant advantage over other materials that require longer molding cycles.

AMODEL resin offers the best balance of performance and value for today and down the road.

PROPERTIES COMPARATOR	AMODEL® PPA	PPS	PA-6,6
Tensile strength	○	◑	●
Tensile elongation	◑	●	○
Flexural strength	○	●	◑
Flexural modulus	◑	○	●
Impact strength	◑	●	○
Weld line strength	○	●	◑
Fatigue resistance	○	●	◑
Short-term heat resistance	○	◑	●
Thermal aging	◑	○	●
Dimensional stability	◑	○	●
Hydrolytic stability	◑	○	●
Material cost	◑	●	○
Total customer value	○	◑	●

○ *expected to perform well in most applications*

◑ *adequate for many application requirements but may show some limitations*

● *limited or poor performance expected*

PERFORMANCE ON ALL SIDES IN COOLING AND HEATING SYSTEMS

Cooling and heating systems are split into two temperature zones: the cold side which includes radiator tanks and water inlets, and the hot side which includes heater cores, water outlets and water pumps. AMODEL resin offers proven performance in delivering long-life performance for many of these applications.

water pump housings
The minimal dimensional change of AMODEL resin when exposed to engine coolant allows for better bolt torque retention and improved overall efficiency of water pumps.

oil coolers
Oil cooler components molded from AMODEL resin can be vibrationally welded, preventing leaks even after long-term, high-temperature exposure to glycol/water.

water pump impellers
AMODEL resin can meet all the requirements for water pump impellers—including low warpage, excellent flexural modulus and strength, and resistance to engine coolant at 266°F (130°C)—at a lower cost than aluminum and PPS.

thermostat housings
AMODEL resin provides better creep resistance and less dimensional change than PA-6,6 in engine coolant environments, allowing the mechanical features of this thermostat housing to remain strong in cooling systems.

thermostat housings
The excellent property retention and surface hardness of AMODEL resin allow this thermostat housing to meet demanding validation requirements which include long-term exposure to engine coolant at 275°F (135°C).

heater core end caps
AMODEL resin features superior hydrolytic stability at 248°F (140°C) compared to PA-6,6, and improved impact and fatigue performance compared to PPS, providing greater security from leaks and heating system failures when used in heater core end caps.

turbo charger air cooler housings
High temperature resistance to 410°F (210°C) and superior mechanical properties of AMODEL resin are key for turbo charger air cooler housings where parts are subjected to high temperature cyclic fatigue testing.

electronic valve pump housings
Tighter dimensional tolerances and improved chemical resistance at 248°F (120°C) versus PA-6,6 have made AMODEL resin the standard choice for electronic valve pump housings.

AMODEL PPA OUTPERFORMS ALTERNATIVE POLYMERS

Cooling and heating systems operate in the presence of 50/50 glycol/water under pressure of 30-100 psi (0.2-0.7 MPa), with high circulation rates of 30-1000 gal/min (110-380 liters/min). A study was conducted to show the effect of various engine coolants on the tensile strength of AMODEL resin. The results, shown in Figure 1, indicate only a negligible effect of coolant on AMODEL PPA.

In a second study, the tensile strength, elongation and modulus of AMODEL PPA, PA-6,6 and PPS were compared after exposure to 50/50 glycol/water for 1000 hours at 275°F (135°C). AMODEL resin demonstrated clear performance advantages. The results, shown in Figures 2, 3 and 4, indicate that AMODEL resin can offer superior retained strength and ductility compared to either PA-6,6 or PPS. This is key to meeting the demands for increased durability in cooling and heating systems.

Figure 1

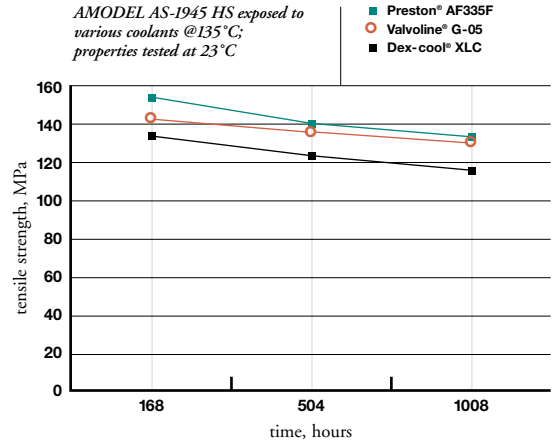


Figure 2

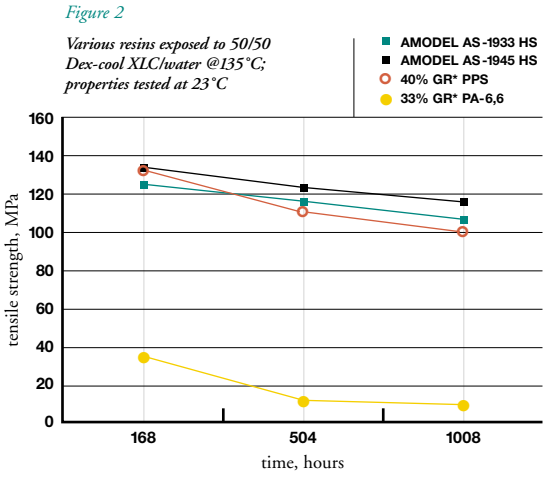


Figure 3

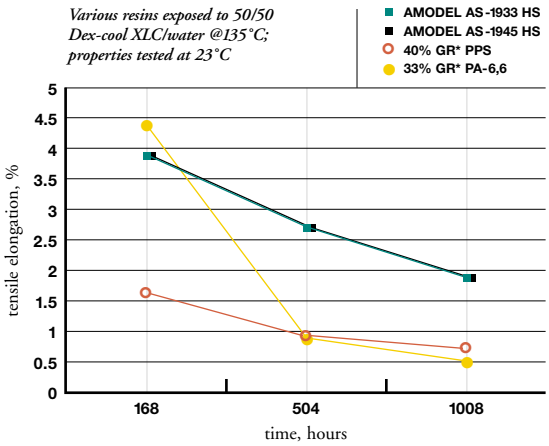
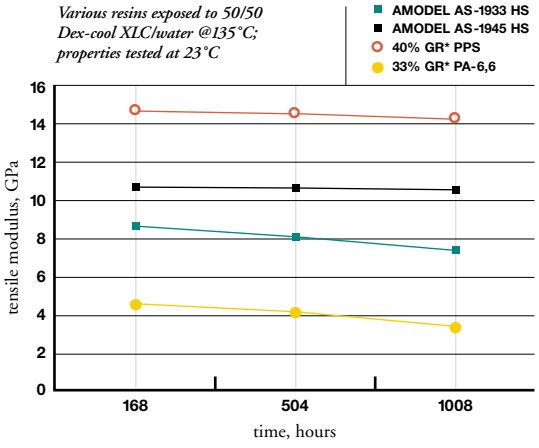


Figure 4



*glass-reinforced

ONGOING ROADSIDE ASSISTANCE

Our technical support specialists worldwide are available to assist you with your design, tooling and fabrication needs during your development phase. Additional services may include helping you with processing assistance, tool design, mold flow, FEA, product development, specifications development, certification to specification and chemical resistance testing.

CHOOSE A PARTNER WHO CAN GO THE DISTANCE

As the automotive industry continues to undergo mergers, acquisitions, alliances and globalization, you need to partner with raw material suppliers who can add value in product, technology and service, and at the same time lower the total system cost.

Our approach to product development is targeted and focused on specific applications. This has lead to the successful development of over 30 cooling and heating applications worldwide. We're looking forward to working with you.

Solvay Advanced Polymers

The headquarters for Solvay Advanced Polymers is located in Alpharetta, Georgia.

To learn more about our products and services, please visit our website at ***www.solvayadvancedpolymers.com.***

Health and Safety Information

Material Safety Data Sheets (MSDS) for Solvay Advanced Polymers products are available upon request from your Solvay Advanced Polymers sales representative or by writing to the address shown on the back of this brochure. Always consult the MSDS for the product you consider using.

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USA
Solvay Advanced Polymers, L.L.C.
4500 McGinnis Ferry Road
Alpharetta, GA 30005-3914 USA
Phone: +1.770.772.8200
800.621.4557 (USA)
Fax: +1.770.772.8454

Germany
Solvay Advanced Polymers GmbH
Roßstraße 96
D-40476 Düsseldorf GERMANY
Phone: +49.2843.73.2139
Fax: +49.2843.73.2143

Singapore
Solvay Asia Pacific, P.T.E. Ltd.
8 Cross Street #24-01, PWC Building
SINGAPORE 048424
Phone: +65.6438.8886
Fax: +65.6438.8111

Japan
Solvay Advanced Polymers, K.K.
3rd Floor, Nihon Seimai Ichibancho Building
Ichiban-cho-23-3, Chiyoda-ku
Tokyo 102-0082 JAPAN
Phone +81.3.5210.5570
Fax: +81.3.5210.5580

Benelux and Other Countries
Solvay Advanced Polymers Belgium
Industriepark De Bruwaan 9
B-9700 Oudenaarde BELGIUM
Phone +32.55.33.9505
Fax: +32.55.31.5129