Coolant Circuit in Vehicles

Alternatives to PA66

Until now, polyamide 66 was the main material used for coolant applications in automobiles. Due to increasing requirements, however, alternative materials such as PPS and PPA are becoming increasingly interesting for components. This is illustrated by the example of a coolant distribution pipe for Audi and VW vehicles.

Fig. 1. Since the two-piece coolant distribution pipe was to be joined by rotation welding, PPS was out of the question as a material. © Kuraray

The Turkish automotive supplier Boreas was looking for a high-performance engineering plastic for a coolant distribution pipe manufactured by injection molding. The tube was to be installed in VW vehicles (**Fig. 1**). It mainly regulates the transfer of coolant between the drive and the radiator of the vehicles. The main requirements for these components are high coolant and heat resistance as well as good weld seam strength. For development, the company turned to Japanese specialty chemical company Kuraray CO., LTD.

At the beginning of the project, polyphenylene sulfide (PPS) and various polyphthalamides (PPA) were considered for the application (**Table 1**). Previously, hydrolysis-stabilized polyamide 66 (PA66) was used for almost all coolant parts in the automotive industry. In contrast, other materials such as PPA and PPS were and are often considered "over-engineered." In the meantime, however, opinion seems to be turning and the materials are increasingly finding their way into vehicle coolant applications due to their good properties and availability. Materials such as PPA and PPS are increasingly being considered by OEMs for such applications, as coolant and heat resistance requirements are increasing and will continue to do so in the future.

The coolant distribution tube developed in the project was to be used in various vehicles with internal combustion engines and must show stable behavior in terms of coolant resistance even after aging at high temperatures (3000 h at 135 °C) (**Fig. 2**). Originally, Boreas had identified a PPS with 30 % glass fiber-reinforcement (PPS-GF-30) as a suitable material for the coolant distribution tube. However, during the development process, due to better manufacturability, it was decided to design the component in two parts and ultimately join them by rotation welding. PPS materials are known to have low weld strength and were therefore no longer considered as an option for the components. The selected PPS, for example, flowed over the weld areas in the rotational welding process due to its low viscosity. PPA offered itself as a substitute instead of PPS. The question, however, was which PPA exactly?

Which PPA Should It Be?

Boreas investigated various types of PPA that perform better than PPS in welding. The Genestar (PA9T) G1350A-M42 proposed by Kuraray was also examined more closely. It is characterized primarily by very good coolant and heat resistance. In addition, its good weldability makes it a favored candidate for exactly this type of coolant application. A comparison with other PPA materials, one each of a PA6T (PA6T/X) and a PA10T copolymer (PA10T/X), at Boreas led to the following results:

- The selected PA6T/X performed better than PA9T in terms of weld strength. Only after necessary changes for

Polymer type	Additional information
PPS	Polyphenylene sulfide
PA6T/XT (PPA)	Co-polymer of PA6T and another polymer (XT)
PA9T (PPA)	Coolant resistant quality G1350A-M42 Black
PA10T/X (PPA)	Co-polymer of PA10T and another polymer (X)

Table 1. Overview of the polymer types investigated. Source: Kuraray

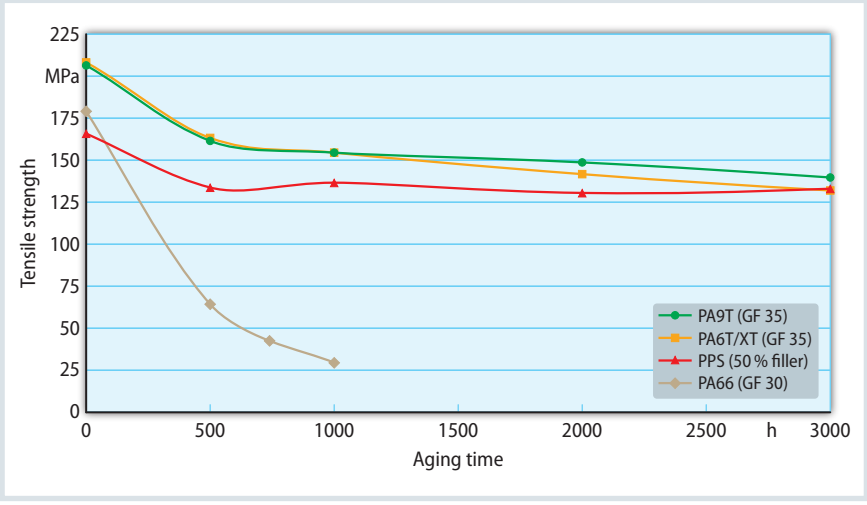

Fig. 2. Material benchmark measured with ISO A1 test bars in 50 % coolant and 50 % water: the PPA and PPS materials investigated have significantly higher long-term stability than the otherwise common PA66. Source: Kuraray; graphic: © Hanser

comparability of the process parameters for rotation welding did similar weld strengths result for all PPA grades.

- The very good results of the component test (in accordance with the Volkswagen Group Technical Terms of Delivery "TL52682 – Requirements for coolant-carrying components") to investigate the hydrolysis resistance of various PPA grades at 135 °C for 3000 h led to the conclusion that PA9T is more suitable for this application to meet the very high requirements for this component.
- The components were successfully subjected to assembly testing under series production conditions, which also compared the component with the overall application in terms of feasibility, process time optimization and assembly speed. Several advantages were achieved with PA9T.
- In terms of long-term heat resistance, the PA 9T showed significant advantages over the other materials.

Together with the logistics and service package offered by Kuraray, these results led to the decision to use Genestar G1350A-M42 Black for the application. The material is very well suited for demanding coolant applications manufactured by injection molding. With its very good weld line strength in various welding technologies, the material enables the development of very complex designs. The lower density of 1.40 g/cm³ allows the overall weight of the application to be reduced. This makes it possible to reduce CO_2 emissions or extend the range of electrically powered vehicles. Kuraray is also currently working on another material development for laser-transparent, black extrusion materials. These are to be used to connect pipelines and manifolds cost-effectively and safely.

1.5 Million Components Made of PA9T

The coolant distribution pipe has been in use at Audi in the Q2, Q3, TT and A3 vehicles since February 2020. It is also used in various models at Volkswagen (Tiguan, Golf, Passat and Arteon), Seat (Tarraco) and Skoda (Octavia, Superb, Kodiaq) (**Fig. 3**). 1.5 million components per year are now produced from these. Boreas is already working on a further development: a new design for connecting multiple coolant manifolds will soon be filed for patent. ■

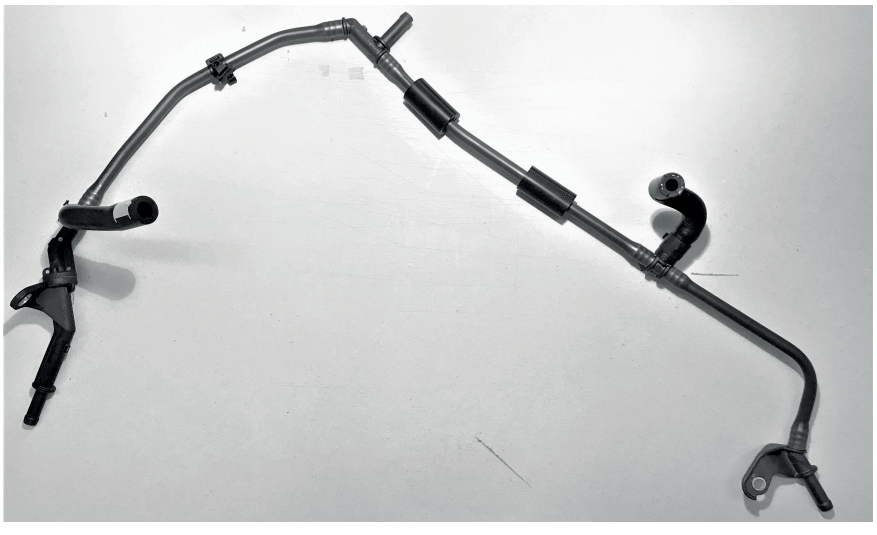

Fig. 3. The coolant distribution pipe made of PA9T is now used by Audi as well as VW, Skoda and Seat. © Kuraray

Info

Company Profile

Boreas Engineering was founded in Istanbul in 2013 by a team of five engineers. With experts in plastics and rubber, the company supports its customers in the development of new products and processes. Boreas has experience in water injection technology, thermoforming and blow molding, and the combination of injection molding and plastic welding technology, among others.

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