

# Hot topic

Evolving fire performance requirements can be met through the use of phenolic resins

In a continuing drive to improve passenger train safety, fire specifications are getting increasingly stringent.

Meanwhile, the rail industry is becoming more global, with OEMs operating in multiple regions either through expansion or strategic partnerships. Hexion reports that European norms are becoming the de-facto fire performance standards as they are among the strictest, and using them as a guide allows OEMs to harmonize processes across their production locations and meet standardised performance specifications.

Unsaturated polyesters are often used in fibre-reinforced composites for mass transit and marine applications. "They generally require high levels of flame-retardant additives as well as an intumescent gel coat that acts as a char barrier to protect the underlying polyester structure," says Ramesh Pisipati, global business development director at Hexion. "Flame performance can be dependent on the integrity of this gel coat."

Pisipati adds that it is also imperative to manage the fabrication process to get the same part-to-part additive distribution, for uniform fire performance. "However, the high filler loading required to achieve target fire performance can present difficulties in resin transfer moulding and vacuum infusion processes," he says. "Fire resistance may also be impacted by surface finishes."

## An alternative

Hexion says phenolic resins are finding increasing use in fibre-reinforced composites as an alternative to unsaturated polyesters; the company attributes this to their fire, smoke and toxicity (FST) properties, ease of processing and low residual monomer content.

"Being intrinsically fire-resistant, phenolic resins offer a better safety margin without the need for flame-retardant additives or gel coats," says Pisipati. "This allows them to be used for even fine weave cloths for thin parts. In addition, the back face of a component made with phenolics has the same fire resistance as the front face. In the past, phenolic parts required additional surface preparation – filling in pin holes and then painting."

The company recently introduced a phenolic gel coat that it says decreases



LEFT: A door post cover for a Hitachi Class 800 train

ABOVE: A battery box for a Chevy Volt, hot-press moulded by Hexion using a phenolic SMC formulation provided by FTI Group

BELOW: A seatback, hot-press moulded using a phenolic prepreg supplied by FTI Group

RIGHT: A wash table wall manufactured by Qantos, using an RTM process, for Thameslink's Siemens Desiro

post-moulding surface preparation, saving approximately 30% of production time. "Post-curing of phenolic parts is essential to maximize physical properties and achieve the desired dimensional stability," says Pisipati.

## HL3 applications

The company reports that phenolics have been used predominantly in HL3 applications and have many years of proven fire performance at competitive cost. "In addition, they provide lightweighting benefits versus highly filled polyesters and aluminium," says Pisipati.

The use of prepregs can also eliminate the need to work with liquid raw materials. In this process, a fabric impregnated with resin and a catalyst is placed in a heated mould and formed/cured in place to produce the part. "While this has been widely used for epoxy systems, phenolic prepregs are becoming more popular as a means to



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Ramesh Pisipati, Hexion



meet both cost and fire performance targets," says Pisipati. "The development of faster drying phenolic resin systems as well as ultra-low free monomer systems has helped drive the use of phenolic prepregs for parts that need to meet stringent fire standards."

## SMC performance

Sheet moulding compound (SMC) processes have also been adapted to phenolic resins to produce composites via a compression moulding process designed to maintain target mechanical properties even after being exposed to a fire. "Phenolic resins are key components that enable such performance from SMC processes and are suited to

high-volume production of parts that need to meet exacting fire standards," says Pisipati. "Phenolics enable the fabrication of parts that do not exhibit shrinkage in service and tend not to distort at high temperatures. This makes them good candidates for insulation and exhaust shielding."

Phenolic resins with ultra-low levels of residual monomers have been introduced, to minimize worker exposure to harmful emissions. In 2018 Composites UK recognised Hexion's ultra-low emitting phenolic resins with its Innovation Award.

## EN45545 tests

Part of the EN45545 regulation specifies a series of flammability tests for materials to be used in trains. These tests check performance along the axes of fire, flame spread and toxicity and opacity of the fumes produced on combustion. In addition, a material's heat release – as measured by a cone calorimeter – is an important indicator of how likely it is to contribute to flame spread.

In tests of a 2mm (0.08in)-thick phenolic composite panel, composed of a Cellobond resin grade from Hexion, the material performed well within the specifications for HL3, for every aspect. "It is clear that phenolic resins easily meet even the most stringent HL3 category," says Pisipati. "High-strength bonds formed when phenolic systems cure result in exceptional fire and high-temperature performance. This also allows their use in a wide variety of manufacturing processes without sacrificing fire performance."

In real-world applications, Pisipati says phenolic resins can meet HL3 performance requirements at a lower per part cost than unsaturated polyesters. "These facts are making fabricators take a second look at phenolics to meet the manufacturing, cost and performance requirements of the industry," he says. ☺

## CELLOBOND PHENOLIC RESINS

Hexion has designed its Cellobond phenolic resins to enable the rail industry to make composites that easily surpass fire performance standards, irrespective of manufacturing process. "Heavy fillers, in widespread use to improve polyester fire performance, can easily drop out of solution during processing and cause variable fire properties," says Pat Colclough, Hexion's business manager for Northern Europe. "Intumescent gel coats can be damaged and need precision coating to work effectively. Choosing phenolic resins avoids these issues."

He also says that unfilled phenolic resins provide big weight savings over polyester and aluminium, benefitting fuel efficiency and making them easier to install. He points out that phenolic resins contain virtually undetectable levels of free formaldehyde, and are styrene-free, future-proofing them regarding handling and use. "Composites parts manufactured with Hexion phenolic systems are fully competitive on cost and available globally through an established network of suppliers," adds Colclough.

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