Increasing safety and performance of MCCBs with engineering plastics

To guarantee the optimal operation of the growing global energy network, there has been an increase in the use of electrical systems to improve energy efficiency and create a safe and reliable system. As part of this, the use of molded case circuit breakers (MCCBs) is on the rise.

At the same time, electrical systems are becoming smaller, linked to a need for increased performance, safety and cost effectiveness. This places greater mechanical requirements on the materials used to make them. DSM has developed a complete portfolio of engineering plastics to help fulfill these needs.

DSM: The market leader in MCBs

Over the last few decades, DSM has played a pioneering role in replacing thermoset materials in miniature circuit breakers (MCBs). The majority of the world's MCBs are now manufactured in thermoplastic materials. The main drivers have always been a simultaneous need to reduce costs while increasing safety and performance. DSM's tailor-made halogen-free flame retardant polyamides – Akulon® – facilitated this transition, while providing

DSM with substantial knowledge and expertise in optimizing polymer compounds to achieve the best performance in arc breaking systems. The increasing requirements for MCCBs has triggered DSM to further develop its broad portfolio of engineering plastics – based on Akulon® (PA6, PA66), Stanyl® ForTii™ and Stanyl® – to replace thermosets.

DSM portfolio

The DSM portfolio contains advanced materials in the Stanyl polyamide 46 range—including a new generation of Stanyl CR halogen-free UL94 V0 flame retardant grades—new halogen-free FR grades of Akulon polyamide 6 and 66, and Stanyl ForTii. DSM offers solutions for each of the housing components, as well as the functional internal parts in the arc-extinguishing chamber of the circuit breaker, resulting in a 100% safe and cost-effective solution.

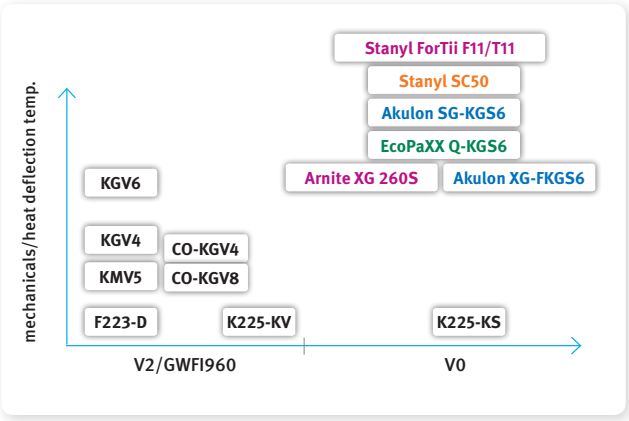

Fig.1 Halogen free flame retardant portfolio

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These materials enable DSM's customers to produce parts with improved electrical endurance, enhanced aesthetics and reduced wall thicknesses compared with parts made in traditional thermoset compounds.

MCCB housings

Replacing the thermoset materials typically used in MCCB housing with DSM engineering plastics results in thinner wall thicknesses with a volume reduction of up to 25%. This leads to cost reductions up to 15%, while increasing design flexibility and facilitating smart assembly solutions and integrated functionality. DSM's materials provide improved safety and electrical endurance, as well as increasing the use of environment-friendly materials.

DSM also offers a selection of halogen-free flame-retardant PA6 and PA66 materials. Akulon XG-FKGS6 and Akulon SG-KGS6 are 30% glass-reinforced flame retardant materials that meet UL94 V0 at very thin wall thicknesses, and are optimized for use in the bottom and middle cover of the MCCB.

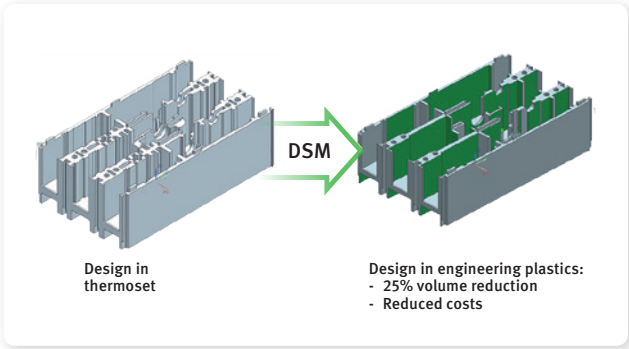


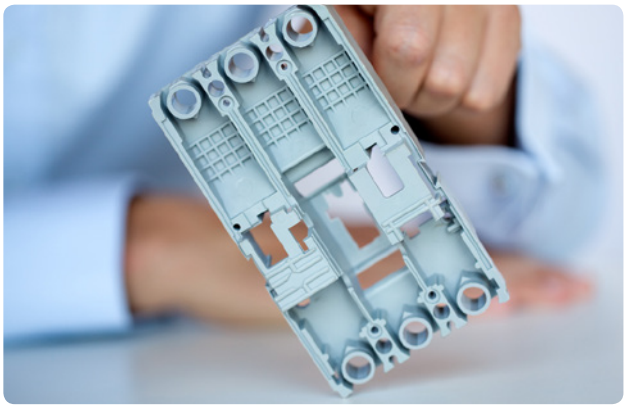
Fig.2 Optimized design of MCCB housing

DSM's portfolio of UL94 V2/GWFI 960°C PA6 grades deliver even better price performance. Akulon K222-KGV6, a 30% glass-reinforced polyamide 6, has proven performance in MCB housings, and is also suitable for use in MCCB applications with low thermo-mechanical demands. Its formulation has been optimized for electrical performance.

Internal functional components

Akulon, Stanyl and Stanyl ForTii meet all the stringent requirements for tripping bars, pripping unit parts and chamber materials, where thermo-mechanical and electrical performance are essential. DSM's new Stanyl ForTii portfolio provides exceptional characteristics for parts with more demanding requirements.

Stanyl ForTii F11 and F12 are cost-competitive solutions that offer a heat deflection temperature (HDT) of 305°C, combined with excellent dielectric aging performance at 150°C. The materials have high CTI values at 600 Volts to ensure good electrical endurance, even in the colour black. They also offer low corrosion – both in manufacturing and use – low outgassing, and improved surface aesthetics.



Arc chamber parts

The ever-increasing market requirements also demand higher performance from MCCBs. Higher breaking capacities need to be realized with smaller components. This requires optimization of the design, but also of the polymer materials used in the MCCB. Particularly in thermoset designs, the decreased space creates issues with arc breaking and, potentially, low isolation resistance, due to soot formation and deposition during and after breaking.

This can create a safety hazard, in addition to reducing the electrical endurance of the device. DSM has developed a Stanyl PA46 compound that significantly improves the arc breaking performance of an MCCB, with lower energy dissipation due to faster arc quenching, and higher isolation resistance after (repetitive) short circuits due to lower soot formation. Both contribute to the improved safety and performance of the MCCB.

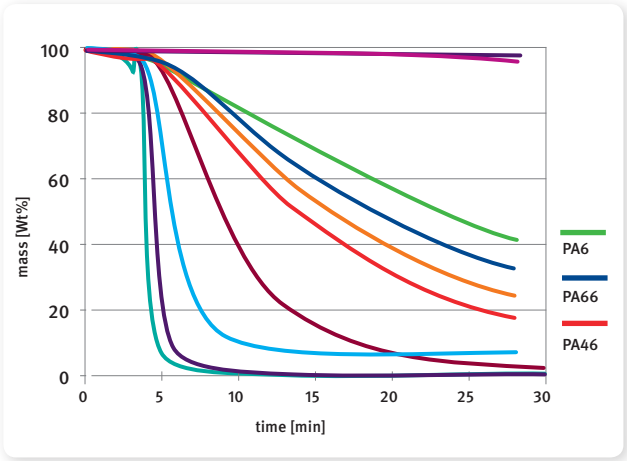


Fig.3 Gas out performance of several materials

The newly developed Stanyl CR310 compound features a melting point of 295°C, making it suitable for use in high breaking capacity MCCBs. Current solutions based on BMC, PA6/POM, and PA6/PP blends will melt under these conditions. Stanyl CR310's high melting point combined with DSM's newly developed flame retardant create a unique functional behavior not seen in more conventional systems.

Specifically, its highly functional generation of arc-quenching gas helps to cool and extinguish the arc without deposition of soot that could jeopardize the risk of restrike and lower isolation resistance.

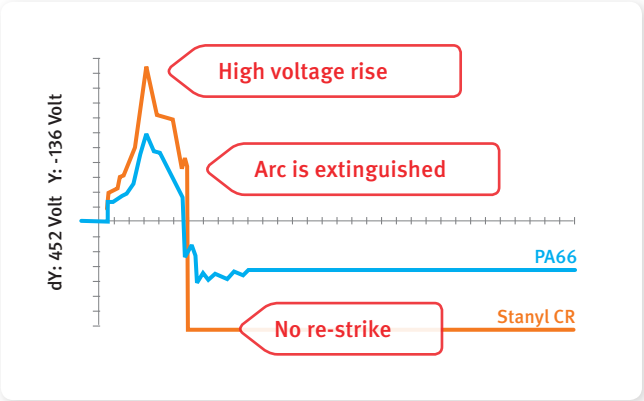


Fig.4 Arc quenching performance

In arc chamber tests, Stanyl CR310 demonstrates faster arc extinguishing due to arc-quenching gas generation, and higher isolation resistance after short circuit due to lower carbonization. This advanced electrical performance results in MCCBs with better electrical endurance, lower thermal load on the housing, and increased overall safety.

Jiangsu Phono Electrical Co. Ltd., in Zheng Jiang (Zhenjiang), Jiangsu, China, is the first company to launch an MCCB created from DSM's Engineering Plastics. According to its General Manager, Mr. Jiang, "Jiangsu Phono Electrical was impressed by DSM's knowledge of this application, the depth of the advice it offered, its willingness to innovate together with us, and its continuous support, as well as the material offer."

DSM Engineering Plastics

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