APPLICATION INFORMATION

SUSTAINABLE FLAME RETARDANT SYNERGISTS FOR HALOGEN-FREE FORMULATIONS

TP-A 7

A member of ALTANA

Contents

The challenge

Flame retardants are essential for the preservation of life and architectural structures. However, in recent years, the industry is trending toward no longer using halogen containing flame retardants because they are toxic to the environment and gasses from halogen-based materials are acidic and corrosive to electronics.

This legislatively driven trend is prominent in Europe with the development of European Ecolabel Criteria for Office Buildings, state that any building element cannot contain hazardous materials including halogens (EC No. 1272/2008 CLP). In the United States, the Leadership in Energy and Environmental Design (LEED) certification system awards building owners who use alternative materials that do not contain halogenated flame retardants.

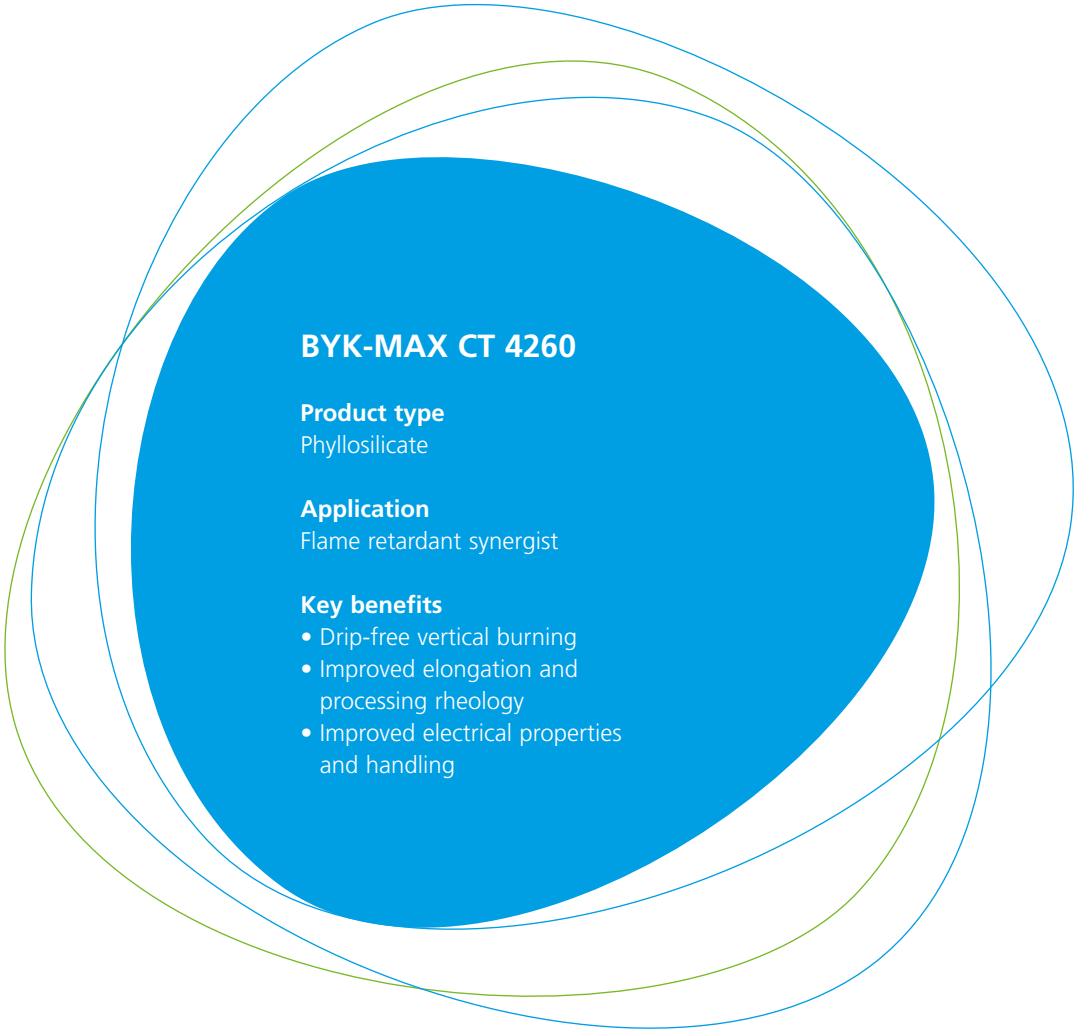
Formulation challenges can occur in non-halogen products when trying to meet flame retardant specifications, especially vertical burning tests. Typical non-halogen flame retardants such as ATH (aluminum trihydrate) and MDH (magnesium hydroxide) are required in high concentrations, making processing more demanding. This also negatively affects some mechanical properties that are important in applications such as HDPE sheet and PE wire and cable used in building and construction.

Note

To ensure the best appearance and full functionality, please open in Adobe Acrobat.

Our products

BYK clay products for thermoplastics are organophilic phyllosilicates that provide flame retardancy to polyolefin wire and cable, decking, construction panels, pallets, and more. The benefits of clay as a char-forming material have long been recognized, however clay products are difficult to disperse and incorporate into polyolefins. On the contrary, BYK clay products have been engineered specifically for use in polyolefins to maximize ease of dispersion and flame retardant efficacy. BYK clay products can be used in their original powder form or incorporated as a concentrate for optimal handling. Typical application of BYK clay products for HFFR (halogen-free flame retardant) is 3–5 %.

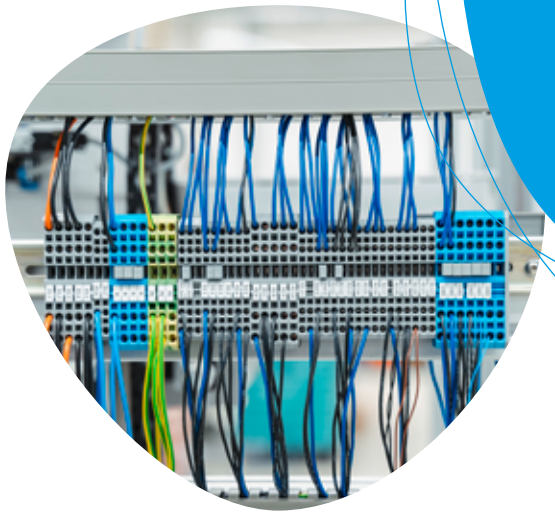


CLOISITE-20 A

Product type
Phyllosilicate

Application
Flame retardant synergist

Key benefits
- Easy processing
- Drip-free vertical burning
- Improved elongation and processing rheology
- Improved electrical properties and handling



CLOISITE-SE 3000

Product type
Phyllosilicate

Application
Flame retardant synergist

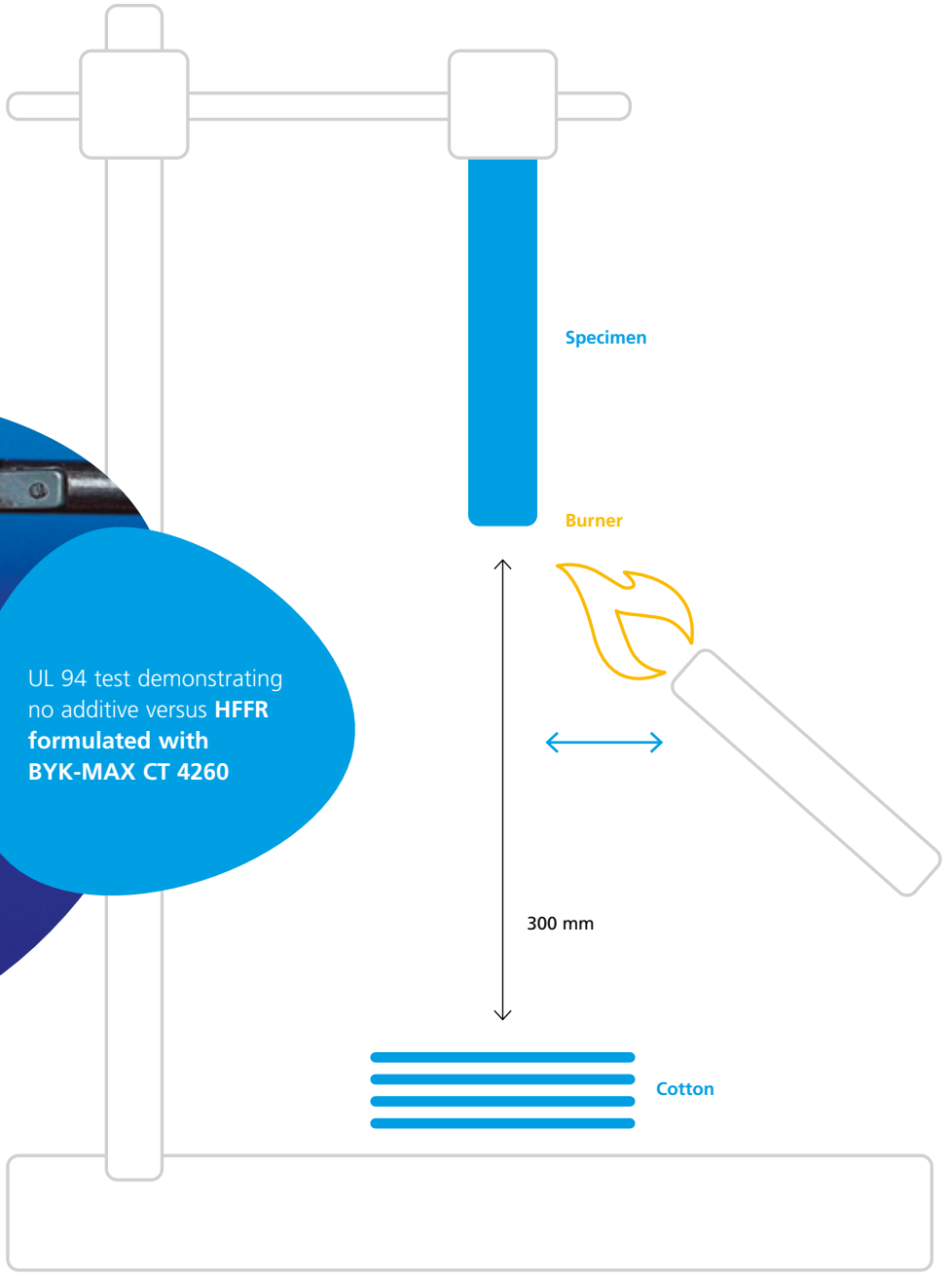
Key benefits
- Easy to process
- Drip-free vertical burning
- Improved elongation and processing rheology
- Improved electrical properties and handling
- Low water pickup in final application

Drip-free vertical burning

Burning polyethylene has a natural tendency to drip, resulting in fire spreading below the burning object. BYK-MAX CT 4260 addresses this by forming an effective char layer, sealing the burning surface, and preventing drip. Flame retardant tests, including UL 94, check the vertical burning component of an object to measure the drip and burn severity. In the UL 94 test, results showed a V_0 rating for the object containing BYK-MAX CT 4260, while the object without clay showed severe dripping.

UL 94 test

UL 94 test demonstrating no additive versus **HFFR formulated with BYK-MAX CT 4260**



The effect of BYK-MAX CT 4260 in a typical ATH polyolefin formulation was investigated to demonstrate char formation. This was done by compounding a control formulation of 65 % ATH and a formulation of 53 % ATH with the addition of 5 % BYK-MAX CT 4260 in a twin screw extruder. The compounds were then extruded into a sheet and 3 mm test pieces were cut out from each sheet. Each set of test pieces were burned in a cone calorimeter test device according to ISO 5660-1. The compound containing BYK-MAX CT 4260 demonstrated that a highly effective char layer had formed (G. 02, left). The control sheet, formulated without BYK-MAX CT 4260, demonstrated comparatively poor char layer formation (G. 02, right). Effective char layer formation is a key component of the superior non-drip performance of BYK-MAX CT 4260.

Formulation used in BYK flame retardant studies

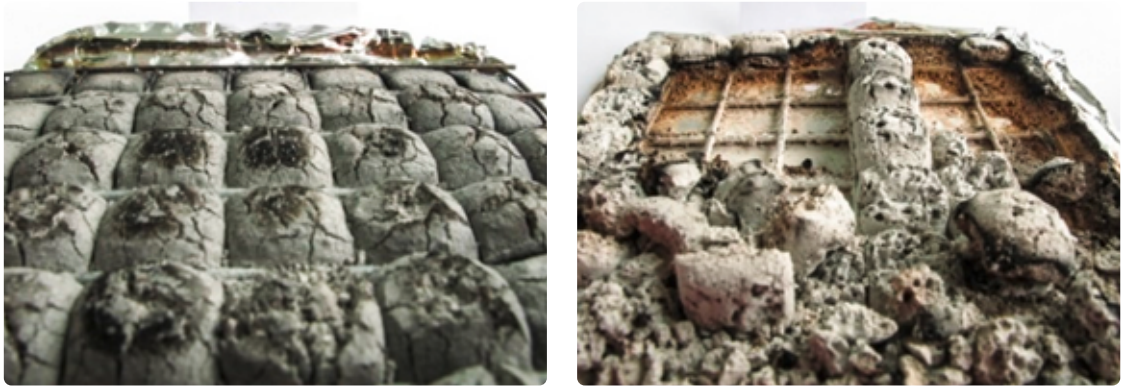
Product	% Content			
	Control	CLOISITE-20 A	BYK-MAX CT 4260	CLOISITE-SE 3000
Escorene UL00328	34.6	41.6	41.6	41.6
MARTINAL OL-104 LEO	65.0	55.0	55.0	55.0
Irganox 1010	0.2	0.2	0.2	0.2
Irgafos 168	0.2	0.2	0.2	0.2
Flame retardant additive (see head of columns)	w/o	3.0	3.0	3.0

Formulation used in all BYK flame retardant studies in a HFFR cable formulation with ATH and based on EVA (Ethylene vinyl acetate). **T. 01**

Results of burning test for formulation containing

5 % BYK-MAX CT 4260

Without additive



G. 02

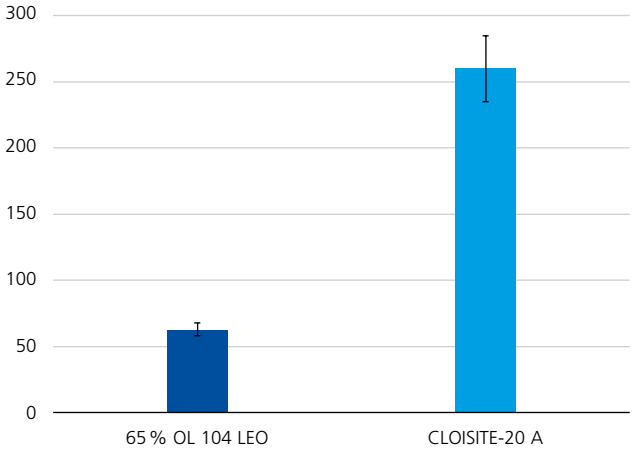
Improved elongation and processing rheology

To pass flame retardant tests, the typical concentration of ATH needs to be approximately 65 %. This high solid content results in compounding challenges and affects properties such as elongation and stiffness, making products such as wire and cable harder, less flexible, and more difficult to install. CLOISITE-20 A has been engineered to provide ease of dispersion, resulting in improved compounding and mechanical properties.

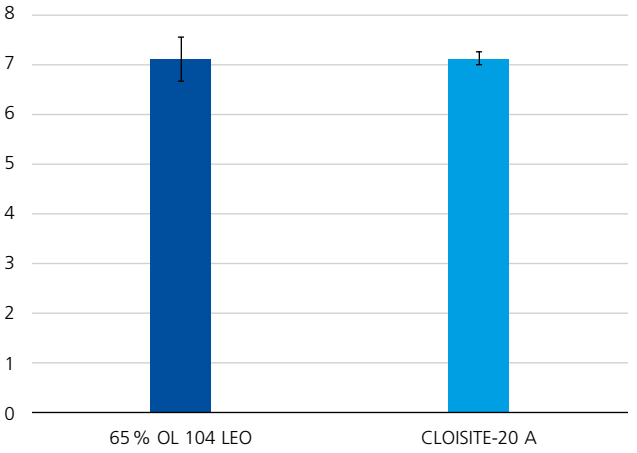
The use of CLOISITE-20 A also allows the total solids content to be reduced, resulting in increased elongation and flexibility, with a lower viscosity compound.

The addition of 3 % CLOISITE-20 A to 55 % ATH resulted in 250 % increased elongation without any adverse effects on tensile strength and lowered the viscosity of the compound.

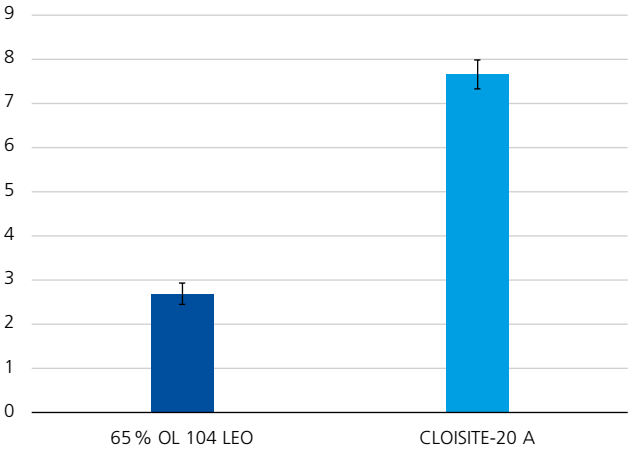
Elongation at break (%)



Tensil strength (N/mm²)



MVR 150 °C/21.6 kg (ml/10 min)



Comparison of elongation at break, tensile strength, and melt volume flow between a 65 % ATH (control) with 55 % ATH plus 3 % CLOISITE-20 A formulation. Elongation and tensile strength measured according to DIN 53504.

G. 03–05

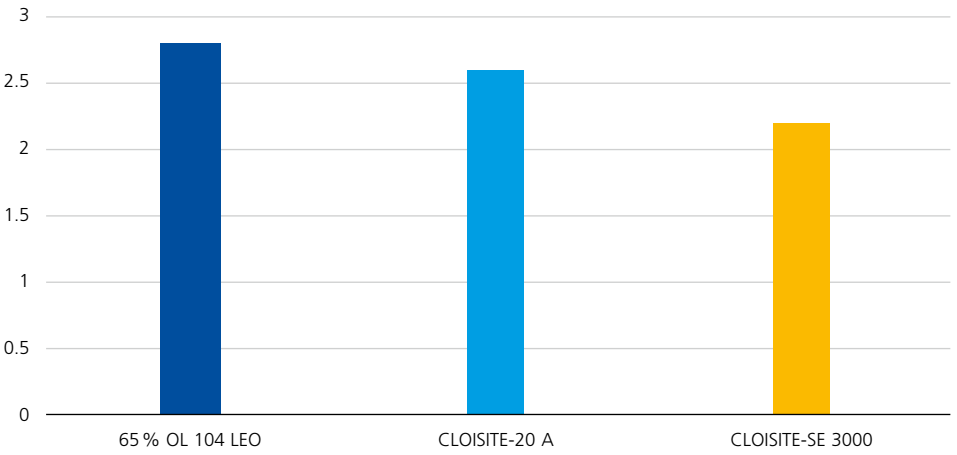
Improved electrical properties and processing

Mineral fillers can be hygroscopic, which can adversely affect electrical insulation properties.

BYK looked at both untreated and surface-treated clay's effect on the water absorption of an ATH formulated HFFR cable. This was done by compounding a control formulation of 65 % ATH, which was compared to formulations of 55 % ATH with 3 % CLOISITE-20 A (non-treated clay) and 55 % ATH with 3 % CLOISITE-SE 3000 (surface modified clay) on a twin screw extruder. The compounds were extruded into a sheet and 2 mm test pieces were cut out from each sheet and weighed before and after storing in water for 7 days at 70 °C. Results showed that CLOISITE-SE 3000 showed significantly less water absorption. As a benefit of reduced water absorption, compounds supplemented with BYK additives showed significantly higher volume resistivity.

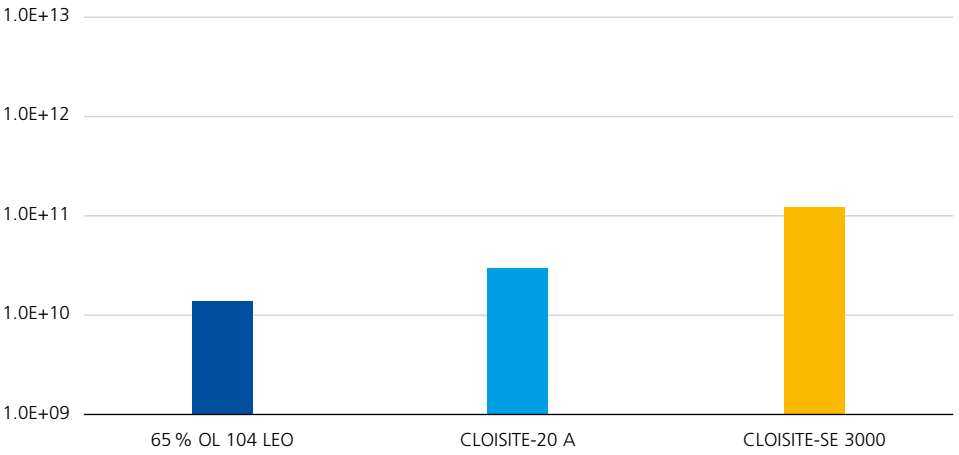
Due to the significantly higher bulk density of surface modified CLOISITE-SE 3000 compared to untreated CLOISITE-20 A, the product is even easier to handle and process during the compounding process.

Water absorption



Water absorption (%) after 7 days stored in water at 70 °C (according to ASTM D257, ASTM D4496-04, ASTM D991-89(2005)). Comparison of 65 % ATH (control) versus 55 % ATH plus 3 % CLOISITE-20 A and 55 % ATH plus 3 % CLOISITE-SE 3000. **G.06**

Volume resistivity



Volume resistivity (Ohm x cm) after 7 days at 70 °C stored in water. Comparison of 65 % ATH (control), 55 % ATH plus 3 % CLOISITE-20 A, and 55 % ATH plus 3 % CLOISITE-SE 3000. **G.07**

Conclusion

BYK offers a range of clay products with the common benefit of improved HFFR performance when used with typical highly filled ATH and MDH HFFR systems. BYK-MAX CT 4260 is a general-purpose grade, providing improved burning characteristics, particularly vertical burning, through effective surface char formation. Improved mechanical properties such as elongation and rheology are also achieved as a result of lower overall solids content of the clay containing formulations.

Further benefits with respect to processing and rheology can be achieved with CLOISITE-20 A, while improved electrical properties, such as volume resistivity after storage in water can be achieved with CLOISITE-SE 3000.

Using BYK clay-based additives for HFFR formulations will provide drip-free vertical burning as well as improved elongation, processing rheology, electrical properties, and handling.

TP-A 7 11/2021

BYK-Chemie GmbH
P.O. Box 10 02 45
46462 Wesel
Germany
Tel +49 281 670-0
Fax +49 281 65735

info@byk.com
www.byk.com