AFLAS® applications

Wire & Cable Applications

DESCRIPTION

AFLAS® Fluoroelastomers are copolymers of tetrafluoroethylene and propylene. This combination gives AFLAS Fluoroelastomers unique properties over conventional FKM-type fluoroelastomers in demanding applications found in wire & cable industries because of its excellent electrical resistivity. AFLAS Fluoroelastomers display outstanding resistance to heat, acids & bases, many solvents, ozone, and steam. Classified by ASTM D 1418-01 as FEPM.

MATERIAL FEATURES

- **Electrical Properties:** Excellent volume resistivity (greater than 10^{16} Ω-cm) unmatched by other FKM type fluoroelastomers.
- **Heat Resistance*:** Mechanical properties of AFLAS do not deteriorate even when used for prolonged exposure to 200°C. AFLAS can be used continuously for 2 to 3 months at 230°C and for 10-30 days at 260°C.
- **Chemical Resistance**: Parts fabricated from AFLAS compounds perform well in the amine and base-rich environments commonly found in sour oil and gas exploration, completion and production. In automotive and heavy equipment applications, AFLAS stands up well to attack from amine-containing additives in oils and transmission fluids.
- **Steam Resistance*:** Unaffected by extended exposure to 200°C steam.
- **Radiation Resistance*:** Stable up to 2000 kGy of gamma ray radiation.

*Insulation thickness may vary results.

END USER BENEFITS

- High heat resistant flexible cable
- Thinner insulation
- Excellent chemical durability
- Can be also used for Electron Beam crosslinking production system

TYPICAL APPLICATIONS

- Motor & electric vehicle power cable
- Cable around furnace for Glass & Steel production process
- Marine cable
- Heavy Duty cable
- Oilfield cable
- Cable for nuclear power plant
- And more…

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PERFORMANCE COMPARISON

	AFLAS	Other Fluoro-elastomers	Silicone Rubber	Ethylene Propylene Rubber
	FEPM	FKM	Q	EPDM
Specific Gravity	1.55	1.8	1.2	0.86
Electrical Resistivity	1	3	1	1
Dielectric Breakdown (kV/mm)	23	20	25	40
Volume Resistivity (Ω・cm)	10^{16}	10^{13}	10^{16}	10^{16}
Dielectric Constant (1kHz)	2.8	17	3-4	3-4
Flame Resistance	1	1	2	4
Heat Resistance	1	1	1	2
Weatherability	1	1	2	2
Ozone Resistance	1	1	1	1
Oil Resistance	1	1	2	4
Hot water & Steam Resistance	1	3	3	2

1 = EXCELLENT	2 = GOOD	3 = APPLICABLE	4 = NOT RECOMMENDED

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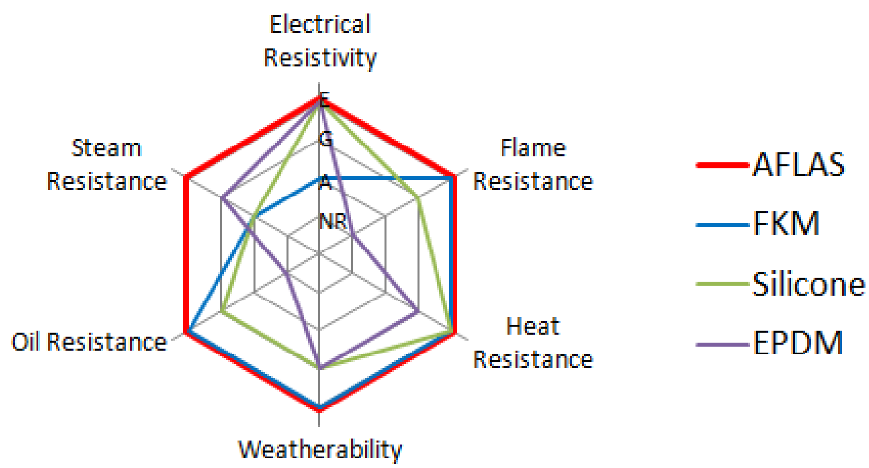

AFLAS GRADES SUITABLE FOR WIRE & CABLE APPLICATIONS

- AFLAS 150E is designed for extrusion molding into products such as wire insulators, tubes, and tapes. It produces excellent results when extrusion molded, as its low viscosity promises faster extrusion and improved surface smoothness. This document shows the basic formulation and molding conditions for AFLAS150E. The polymer is curable with either peroxides or electron beam irradiation. Appearance is black.
- AFLAS150C was designed for extrusion molded products such as wire insulator. The polymer is curable with irradiation, and easy to color by various pigments. This document shows the basic formulation and molding conditions for AFLAS 150C. Appearance is white.

Grade	Storage shear modulus G’	Appearance	Application (Cure System):
150E	115 – 205	Dark Brown	Extrusion – Wire and Cable (Peroxide)
150C	450 – 530	White	Extrusion – Wire and Cable (Electron Beam)

AFLAS FORMULATION FOR CABLE INSULATOR

The formulation for cable insulation should be determined in accordance with the cure system, extrusion and cure processes, molding speed, and properties required.

Case 1 Peroxide Curing

- For peroxide curing, both peroxide and co-agent are essential. The following are recommended.
  - Peroxide : 1,3-bis(t-butylperoxyisopropyl)benzene
    - (Commercially available examples: Perkadox 14, Perbutyl P, Peroximon F)
  - Co-agent : triallyl isocyanurate
    - Commercially available example: TAIC

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➢ Case 2 Electron Beam Irradiation Curing

・For electron beam curing, the AFLAS polymer itself can be cured.
・TAIC is also added to enhance curability.

➢ Fillers in common for both cases

・ Reinforcing Filler : MT-Carbon (N990)
・ Extending Filler: $CaCO_3$ (Natural)
: $BaSO_4$
・ Processing Aid : Sodium stearate, calcium stearate
Carnauba Wax
Silicone-based processing aid (Example: Struktol® WS280)
Fatty acid amide (Example: Armeen18D)
PTFE lubricant (Example: Fluon® PTFE Lubricant L-169)
・ Surface improver : Low Molecular Weight Polyethylene (Example: ACPE AC-617A)
・ Color Pigment : Common color pigments (for 150C)

Basic formulation

(phr)

	AFLAS 150E	AFLAS 150C
AFLAS 150E	100	
AFLAS 150C		100
MT Carbon (N990)	5	5
CaCO3 (Natural)	40	40
TAIC	5	4
Perkadox14	1	
Sodium stearate	1	1
ACPE AC-617	2	2
Mooney Viscosity ML1+4 (121°C) ML1+10	33 30	98 95
Cure system	Peroxide Cure Electron Beam	Electron Beam
Cure Condition	>160°C × >several minutes	100 – 200 kGy
Post-Cure Condition	ex:>180°C × 4 hrs	

TAIC: triallyl isocyanurate
Perkadox14: Peroxide = 1,3-bis(t-butylperoxyisopropyl)benzene, 100% active

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AFLAS 150E PROCESSING FOR CABLE

AFLAS 150E can be extruded into cable insulators using conventional rubber extruders and wire and cable molding facilities. The molding conditions should be adjusted according to the requested conductor size and the insulation wall thickness, molding facilities, and formulation. Set a molding temperature below the minimum curing temperature as a general extrusion molding condition (approx. 100°C or lower). If uncured, an extrusion-shaped compound will easily deform. To retain the shape without deformation, cure the surface by a continuous curing technique. Next, conduct a post cure as the main cure. Conduct the continuous cure by a method that prevents oxygen from inhibiting the cure, such as continuous steam curing, oil-bath curing, or salt bath curing.

AFLAS 150E CURE CONDITION FOR PEROXIDE CURE SYSTEM

Curing for extrusion molding takes place in two steps. First, cure the surface by a continuous curing technique to ensure shape retention. Next, conduct a post cure as the main cure. The standard condition for the post cure is 200°C X 4 hours. Conduct the continuous cure by a method that prevents oxygen from inhibiting the cure, such as continuous steam curing, oil bath curing, or salt bath curing. The temperature should generally be set between 170°C and 230°C.

AFLAS 150C PROCESSING AND CROSS-LINKING FOR CABLE

AFLAS 150C can be extruded into cable insulators using conventional rubber extruders and wire and cable molding facilities. It needs to be cured by E-Beam after molding. It does not need peroxide, so it can be molded at higher temperature up to around 200°C. It had better to be cooled after molding to prevent deformation. Recommended dosage level of E-Beam is from 100 to 200 kGy.

If at any time you have questions or concerns about a specific application, please contact your account manager or assistance.

SURFACE IMPROVEMENT

The surface finish of the insulated rubber depends on the molding conditions and formulation.
The formulation and molding conditions have the following influences:

- Higher molding temperatures lead to higher flowability. In peroxide curing, scorching must be prevented.
- MT-Carbon confers good reinforcement and surface smoothness, but too much MT-Carbon leads to low dielectric breakdown.
- Fumed silica confers good reinforcement and high electrical resistivity, but it sometimes roughens the surface finish.
- Processing aids improve surface smoothness but sometimes weaken heat resistance.

The surface characteristics of the molded products are affected by various factors. The following chart gives examples of factors.

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AFLAS® FLUOROELASTOMERS

Factors (examples)	Influence and tendency
Formulation (1)	The Mooney viscosity varies from formulation to formulation, and this affects the surface characteristics.
Formulation (2)	Fillers with small particle-diameters and highly interactive fillers degrade the surface characteristics.
Formulation (3)	The addition of a processing aid for extrusion molding improves the surface characteristics. Representative examples of processing aids include low molecular weight polyethylene and wax. Note, however, that an excessive amount of processing aid will have adverse effects. As a rule of thumb, add 2 parts or less.
Molding condition (1)	The extruder temperature is one of two factors with especially strong effects on the surface characteristics (the other is the molding speed). The surface characteristics generally improve when the temperature increases, as the higher temperature enhances material fluidity and discourages shearing at the discharge portion. Note, however, that this condition is closely related to the molding speed.
Molding condition (2)	The molding speed is one of two factors with especially strong effects on the surface characteristics (the other is the extruder temperature). The surface characteristics generally improve when the molding speed decreases, as the lower molding speed reduces shearing at the discharge portion. Note, however, that under certain conditions, the surface characteristics can improve if the shearing force exceeds a certain shear zone. This condition is closely related to the molding temperature.
Shape of the molded product	The shape of the molded product and differences in thickness or width may affect the surface characteristics.
Shape of the dies	The shape of the metal fitting (die) at the discharge portion of the extruder may affect the surface characteristics.

NOTE: The data listed here represents typical values for the stated grades of AFLAS® fluoroelastomers. This information should be used as a guide only and not to establish specification limits or design criteria. AGC Chemicals Americas assumes no obligation or liability for any advice furnished by us or for results obtained with respect to this product. All such advice is provided free of charge and the buyer assumes sole responsibility for results obtained in reliance thereon.

For more information and samples contact

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