AFLAS® Fluoroelastomers for HEV/EV Cable Applications

AGC Chemicals Americas, Inc.

What is AFLAS®?

- AFLAS 100 and 150 Series are unique fluoroelastomers
  - Classified by ASTM D1418 as FEPM
- Totally different from other FKM type fluoroelastomers
  - Viton
  - Daiel
  - Tecnoflon
  - Etc.
- AFLAS 100 and 150 Series are formulated as Tetrafluoroethylene/Propylene copolymer (TFE/P)

AGC is the only manufacturer of this polymer in the world

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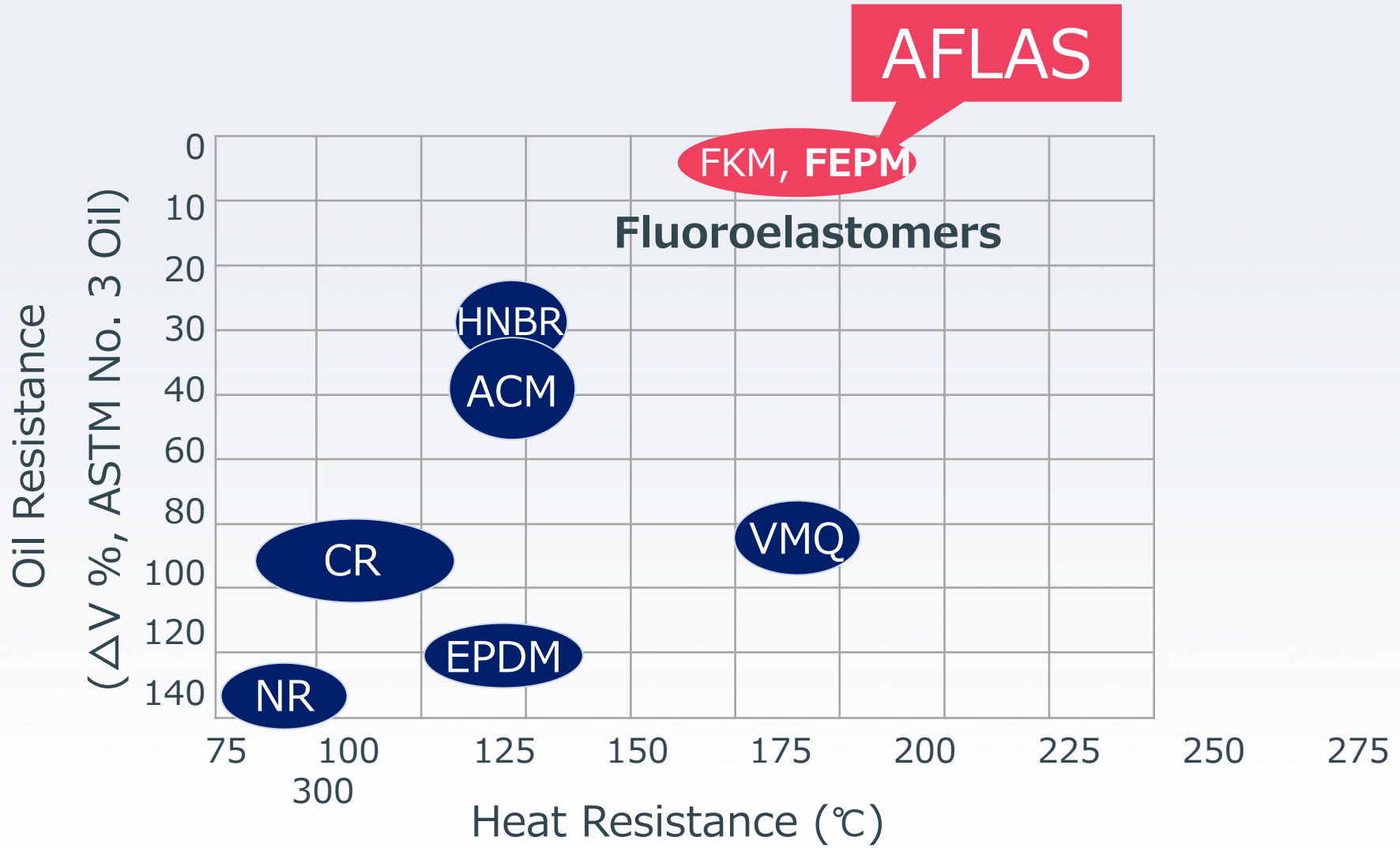
Benefits of AFLAS

- Excellent heat resistance
  - 200°C continuous service temperature
- Superior base resistance
- Unmatched electrical resistivity compared to FKM grades
- Used today for various cable insulator applications
  - HEV / EV power cable
  - Transmission cable
  - ATF resistant

Positioning Map for Various Elastomers



Polymer Structure

FEPM = AFLAS TFE-P

$$-(CF_2\text{-}CF_2)_p\text{-}(CH_2\text{-}\underset{\displaystyle CH_3}{\underset{|}{CH}})_q-$$

TFE Pr

FKM = Viton, etc.

$$-(CH_2\text{-}CF_2)_l\text{-}(CF_2\text{-}\underset{\displaystyle CF_3}{\underset{|}{CF}})_m\text{-}\text{-}(CF_2\text{-}CF_2)_n-$$

VdF HFP TFE

Deterioration by Base

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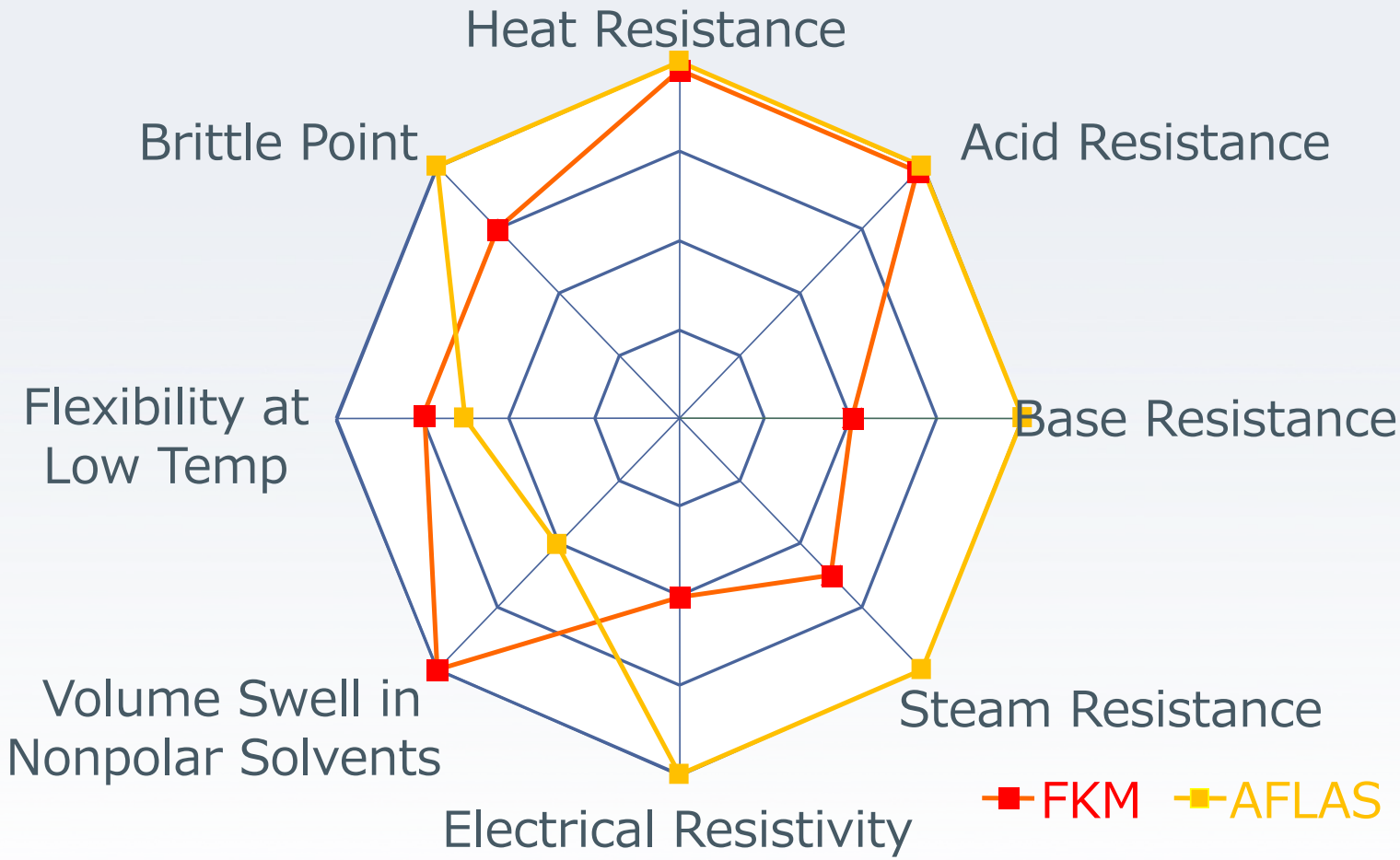
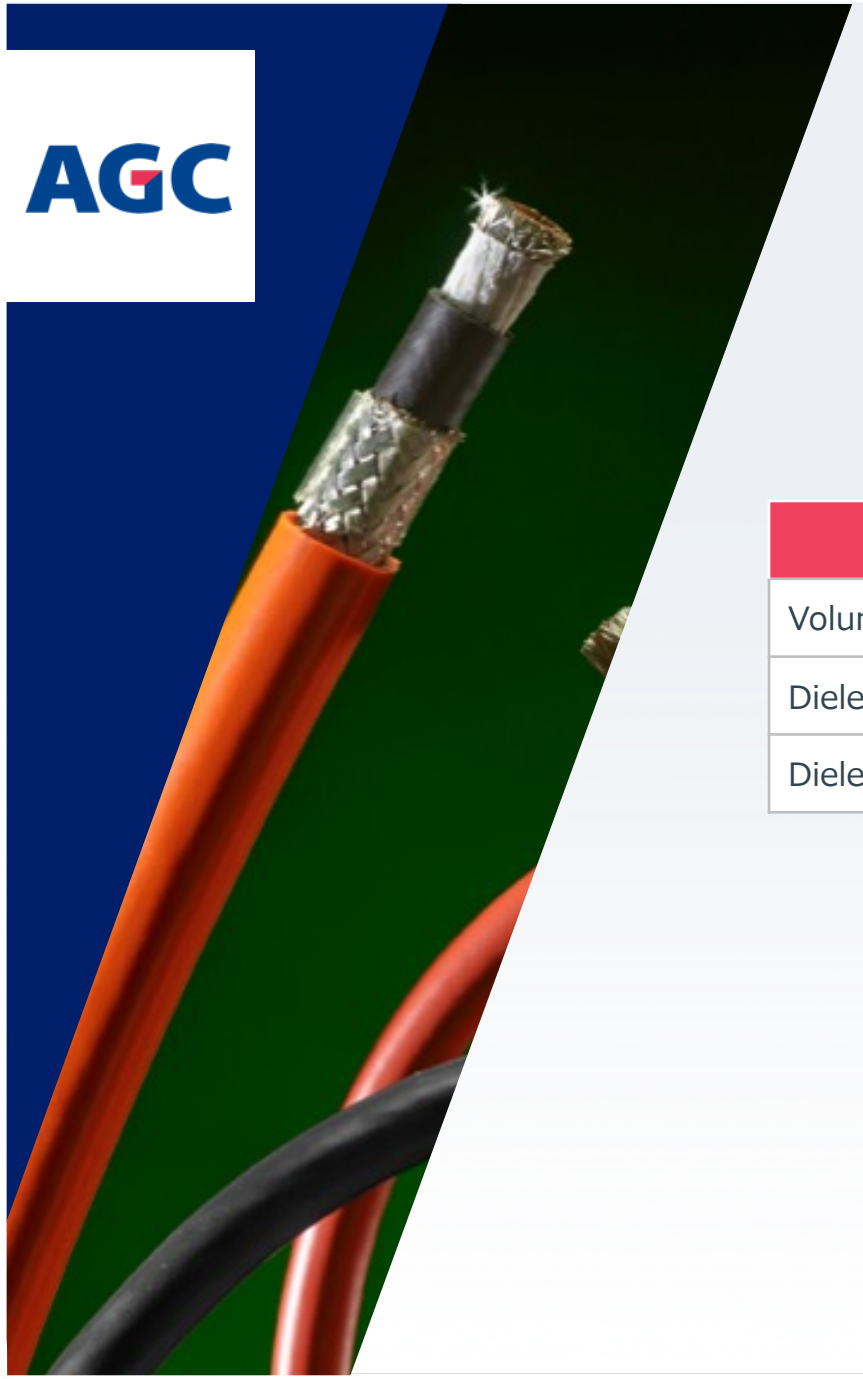
AFLAS Advantages Over FKM



Resistance to Automotive Fluids

Oil	Component	Application	Temperature (°C)	AFLAS®	FKM
Engine Oil		Crank Shaft Seal	160	⌽	△
AT Fluids		Transmission Seal	160	⌽	△
Gear Oil		Pinion Seal	135	⌽	X
Brake Fluids	Polyglycolether		135	○	○
Coolants	Glycol-H_20	Cylinder Liner Seal	135	○	△
Operating Oils	Glycol-H_20	Shock Absorber Seal	110	○	△
	Phosphate		–	○	○
	Silicone Oil		–	○	⌽
Fuels	Gasoline		110	X	⌽
	Light Oil		–	X	⌽
	Heavy Oil		–	⌽	△
	100% Methanol		–	⌽	△

⌽: Suitable ○: Applicable △: Caution X: Not Applicable



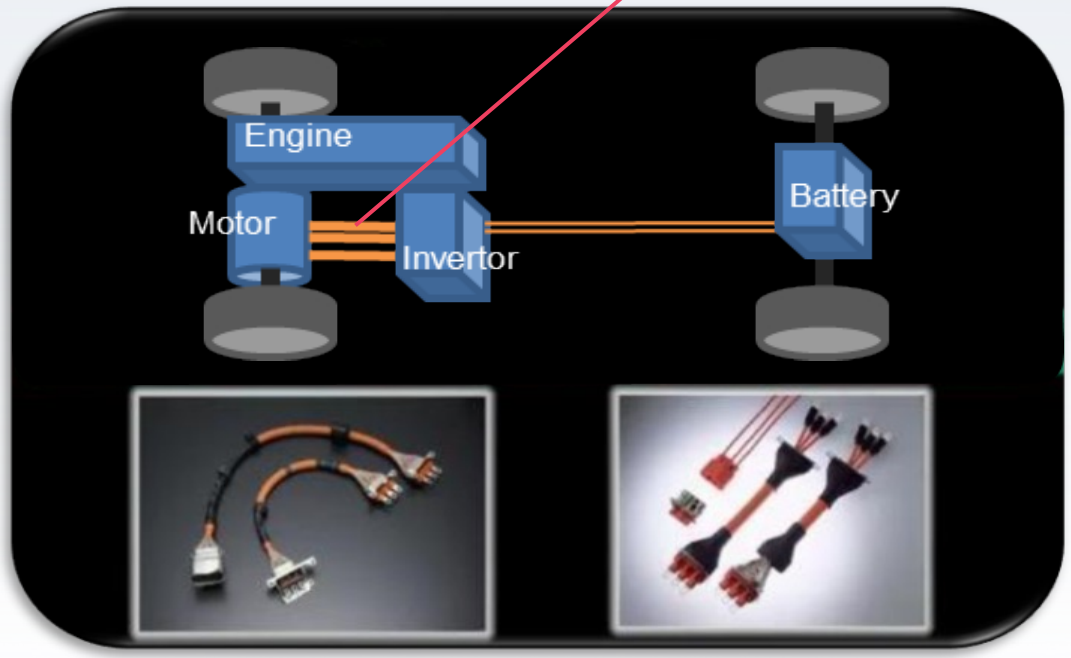
Electrical Resistivity

	AFLAS 150	AFLAS 200	FKM	EPDM	Silicone
Volume Resistivity (Ω•cm)	10^{16}	10^{15}	10^{13}	10^{16}	10^{16}
Dielectric constant (1 kHz)	3	6	10	2	4
Dielectric strength (kV/mm)	23	16	20	40	25

AFLAS has excellent electrical resistivity and heat resistance.

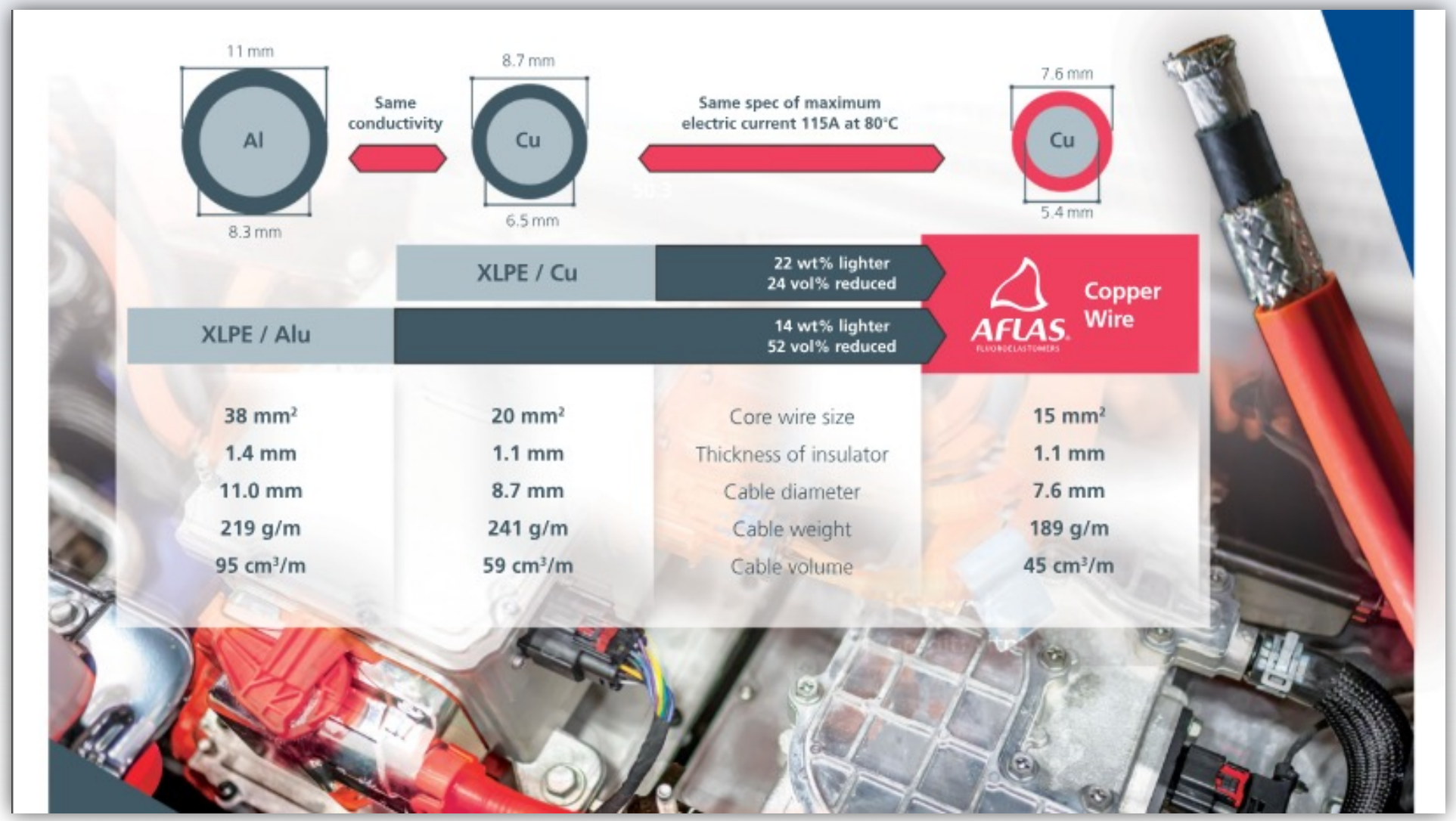
Weight Reduction Concept for HEV/EV Cable

Choice of High Voltage Cable



XL-PE: (150°C)
AFLAS: (200°C)

Weight Reduction Concept: Cable Comparison



AFLAS Performance Over XL-PE Cable

Advantages of AFLAS cable concept:

- Non-Flammable
- Weight Reduction
- Improved Flexibility
- Vibration Resistance
- Excellent Heat Resistance
- Superior Chemical resistance

Disadvantages of XL-PE material usage:

- Filler added (lots of Mg(OH)2)
- Stiff
- Limited Heat Resistance

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