Non-confidential attachment of PFAS public consultations

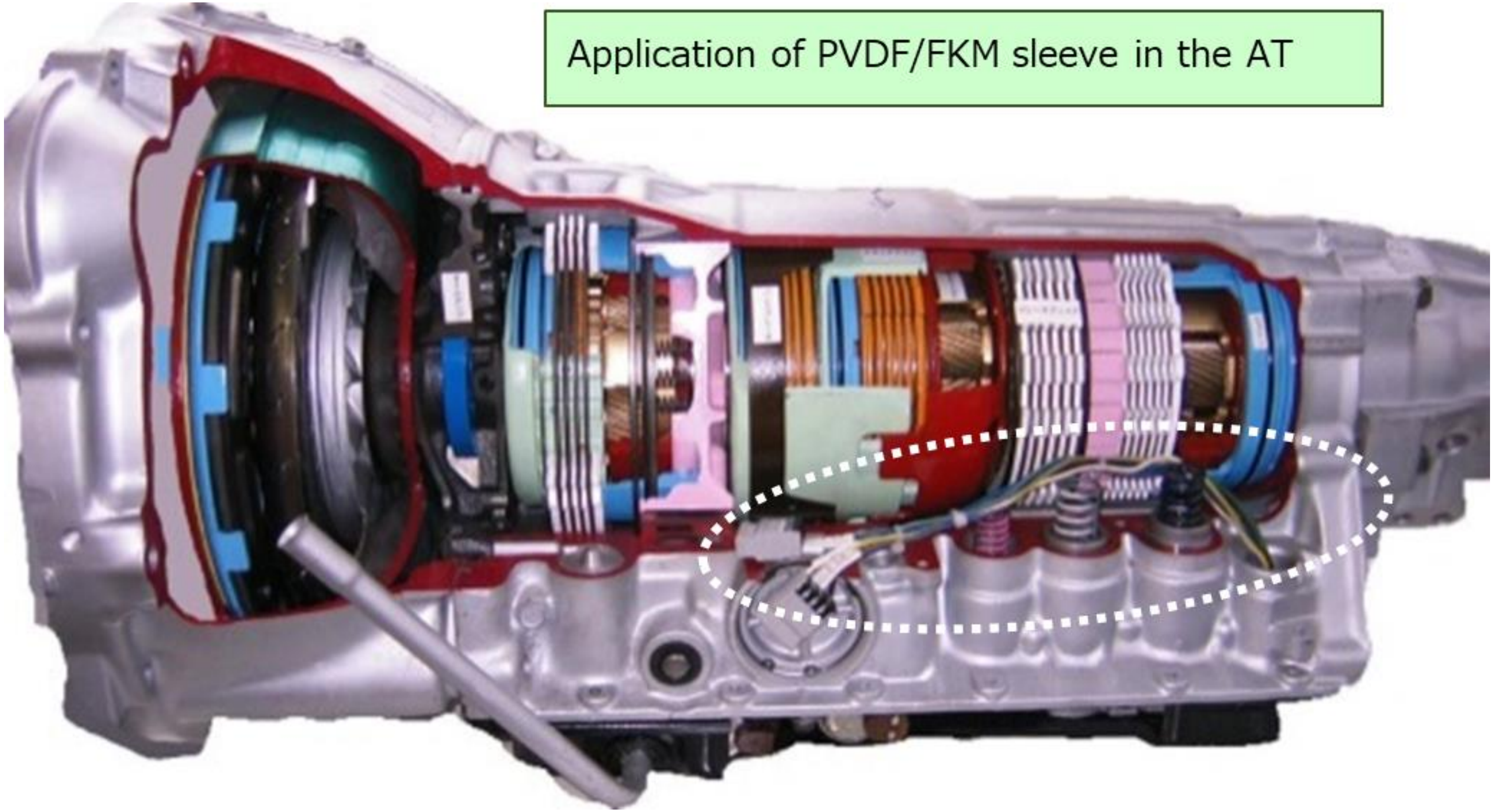
PP-SFP-IPD-Auto

24/Aug/2023

Irradiated Products Division

Sumitomo Electric Fine Polymer, Inc.

Typical application of PFAS tubing for automatic transmission (AT) of automotive



Comparison table of general characteristic of PFAS(PVDF) and its alternatives

		PFAS Alternatives in the Proposed Restrictions→						
Materials	PVDF	EPDM	Silicone	PEEK	Mica	Polyvinyl chloride	Polyethylene	Ceramic Based
Flexibility	Semi rigid	Flexible	Flexible	Rigid	Rigid	Flexible～Semi rigid	Flexible～Semi rigid	Rigid
Continuous use temperature(℃)	175	90	180	260	＞500(Mica) 180(Adhesive)	100	120	＞500
Tensile breaking strength(MPa)	45	5～20	3～12	90		15～50	10～30	
Tensile breaking elongation(%)	200	100～800	100～500	50	≒0	500～100	500～1000	≒0
Flexural Modulus(MPa)	800	5~10	5~10	4000	＞10000	20～3000	20～2000	＞10000
Oil resistance	Excellent	Poor	Poor	Excellent	Poor (Adhesive)			
Abrasion resistance	Excellent	Poor	Poor	Excellent	Excellent			
Heat Shrinkable Tubing (Shrink ratio)	Possible (min.50%)	Possible (50%)	Possible (50%)	Possible (15～20%)	Impossible	Possible (min.50%)	Possible (min.50%)	Impossible

Comparison of properties between [PVDF] and other PFAS alternatives.
Gray shaded cells are issues when substituting PVDF sleeve.
Materials with 175℃ or higher are Silicone, PEEK, Mica and Ceramic.
Mica and Ceramic are inorganic, so cannot processed into tubing.
Silicone and PEEK are potential candidate, but they have following issues:

PEEK：Very stiff（see "Flexural Modulus")

Silicone：Weak in mechanical strength (see "Tensile breaking strength"), oil resistance, abraision

Therefore, they cannot be the substitute of PVDF heat-shrink tubing.

Comparison between current PVDF/FKM and silicone in sleeve shape component

Characteristics	Unit	Oil imersion /Requirement	PVDF/FKM		Silicone	
Tensile strength	MPa	Initial	25.8		9.6	
	MPa	120C×1,000hours	21.9	Pass	1.6	**Failure**
Variation(1,000hours)	%	＜30%	15.0		83.3	
mass variation	g	Initial	1.2		1.5	
	g	120C×1,000hours	1.2	Pass	1.6	Pass
Variation(1,000hours)	%	＜10%	-0.8		-6.9	
Dimension variation[Inner diameter]	mm	Initial	4.40		4.02	
	mm	120C×1,000hours	4.45	Pass	4.23	Pass
Variation(1,000hours)	%	＜10%	-1.14		-5.2	
Dimension variation[Wall Thickness]	mm	Initial	0.49		0.88	
	mm	120C×1,000hours	0.49	Pass	0.83	Pass
Variation(1,000hours)	%	＜10%	0.00		4.79	
Dimension variation[Length]	mm	Initial	80.0		80.0	
	mm	120C×1,000hours	81.1	Pass	82.7	Pass
Variation(1,000hours)	%	＜10%	-1.4		-3.4	
Dynamic Cut-Through	N	Initial	125.2		38.6	
	N	120C×1,000hours	125.8	Pass	14.7	**Failure**
Variation (1,000hours)	%	＜30%	0		61.9	

Comparison between current material [mixture of PVDF/FKM] and silicone in sleeve shape
Data of original and after oil immersed [120℃, 1000Hrs]

The test condition and requirements are in line with the spec of a major car manufacture's.
You can see from the data that PFAS (PVDF/FKM) is within the spec, but silicone is significantly out of spec on tensile strength and abrasion resistance (dynamic cut-through) worse than PFAS. This is data of 120℃, minimum temp requirement, but inside of transmission may rise up to 150℃, which is considered to be worse than the status of the table.
Thus, we can say there is no alternative material of PFAS for this application.