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PRODUCT DEVELOPMENT INFORMATION

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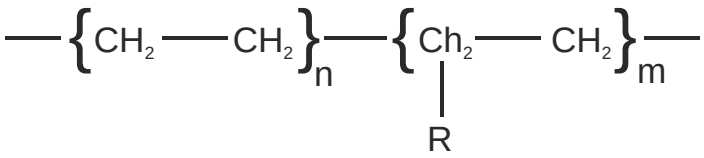
ALPHA - OLEFIN COPOLYMER (TAFMER™) AS EPDM MODIFIER

(*TAFMER – BRAND NAME OF M/S. MITSUI CHEMICALS)

In the current scenario of achieving the better compound cost of the product without affecting the quality is a high task for the compounders / designers of the rubber compound. In order to achieve the goal, we are sharing some of the possibilities of using the α - olefin co-polymer in reducing the EPDM RUBBER Compound cost without much effect on the quality.

TAFMER -α- OLEFIN CO-POLYMER – Ethylene Butene Co-polymer whose structure is as follows:



The Basic property of TAFMER is as follows:

- No Diene
- Higher Crystallitinity than EPDM
- Lower Molecular Weight than EPDM

The Blending of TAFMER(- range of grades are available) with EPDM will have the following advantages:

- It improves the flow property of the EPDM compound(in the highly loaded formulations) – the mooney viscosity of the compound can be reduced by blending the TAFMER grades which gives an option of the possibility of increasing the filler content, which will save the cost of the EPDM compounds.
- Also Tafmer blended EPDM compounds will have higher Tensile value in the low filler compounds.
- Higher Elongation can be achieved.
- The Blend give better light stability than 100% EPDM based compounds.
- Good extrudability & better surface finish can be achieved.

- In Sulfur cure the usage of Tafmer is restricted to the max.of 10 phr (parts per hundred of rubber).
- In all EPDM blends the 100 parts of Rubber has to be calculated as the combination of EPDM + TAFMER. i.e. When Tafmer is used as the blends the portion of the EPDM Rubber is replaced by the required Tafmer grade.
- In Peroxide based formulation higher dosage can be used.

The following are the properties study by our principal on the blends of Tafmer with EPDM.

BASED ON SULFUR CURE

EPT/TF Blend and EPT High Loading Data (Sulfur Cure)

		1	2	3	4	5	6	7	11	12
		3092M	3092M/DF610 Blend			3092M/DF810 Blend			3092M High Loading	
<Formulation>										
3092M		100	90	80	70	90	80	70	100	100
3090EM										
DF610			10	20	30					
DF810						10	20	30		
ZnO		5	←	←	←	←	←	←	5	5
StA		1	←	←	←	←	←	←	1	1
PEG#4000		2	←	←	←	←	←	←	2	2
FEF (Asahi#60G)		160	←	←	←	←	←	←	185	210
Paraffinic oil (PS-430)		100	←	←	←	←	←	←	125	150
Light CaCO3 (Silver W)		30	←	←	←	←	←	←	30	30
Total		398	398	398	398	398	398	398	448	498
EPT Content	%	25.0	22.6	20.1	17.6	22.6	20.1	17.6	22.3	20.1
<Process-ability>										
Mixing ability in Bunbary		Good	Good	Good	Good	Good	Good	Good	Good	Good
Roll Processing		Good	Good	Good	Good	Good	Good	Good	Good	Good
Extrudability										
Screw	rpm	33	33	34	32	33	32	32	-	-
Rubber Temp.	°C	104	104	104	105	107	107	106	-	-
Pressure	kgf/cm2	77	72	74	73	75	72	66	-	-
Comp'd ML(1+4)125°C		49	44	44	43	48	44	37	51	46
Vm		53	50	49	47	49	46	42	46	40
t5	min	5.0	5.3	5.3	5.7	5.4	5.8	6.1	5.2	6.1
<MDR> 170°C, 20min										
ts1	min	0.5	0.6	0.6	0.6	0.6	0.6	0.7	0.6	0.7
TC10	min	0.6	0.6	0.7	0.7	0.6	0.7	0.7	0.7	0.7
TC50	min	1.9	2.4	2.4	2.5	2.3	2.4	2.5	2.7	3.0
TC90	min	7.0	9.6	9.8	10.8	9.5	10.4	11.0	10.5	11.2
ML	dNm	1.9	1.8	1.7	1.7	1.7	1.6	1.4	1.7	1.6
MH	dNm	19.2	16.0	14.8	12.8	15.7	14.0	11.9	16.4	14.0
<Cured Properties> 170°C×15min										
Density		1.20	1.20	1.20	1.20	1.20	1.20	1.21	1.20	1.20
Hardness	Shore-A	74	73	73	74	76	77	77	73	71
Hardness, 0°C	Shore-A	83	84	85	84	84	85	85	82	81
Hardness, -20°C	Shore-A	92	93	92	92	92	93	93	90	90
M100	MPa	4.9	4.6	4.4	4.1	4.7	4.8	4.7	4.1	3.9
M200	MPa	10.4	9.7	8.8	8.0	9.7	9.4	9.1	8.2	7.6
M300	MPa			11.7	10.7	13.3	12.2	11.6	11.0	
Tensile Strength	MPa	13.6	12.9	11.8	10.9	13.4	12.7	12.0	11.2	9.8
Elongation	%	290	290	315	320	310	330	340	315	280
<Compression Set> 170°C, 20min										
100°C, 22h	%	38	42	49	58	43	50	62	48	54
70°C, 22h	%	13	15	18	24	18	24	33	15	16
23°C, 22h	%	10	12	14	17	12	13	14	10	9
0°C, 22h	%	61	62	62	56	57	51	44	64	70
<Heat Aging> 100°C, 72h										
AH		+3	+4	+4	+2	+3	+2	+3	+4	+4
Ac(TB)	%	+8	+11	+10	+16	+9	+10	+13	+10	+17
Ac(EB)	%	-29	-28	-32	-33	-31	-30	-32	-32	-25

Light Stability of TAFMER™-EPDM Blend

①Discolouration after UV irradiation

		A	B	C	Ref
TAFMER™	DF610	33	50	60	
EPDM	★	67	50	40	100
Peroxide	DCP	2	2	2	2
Additives	Antioxidant	0.3	0.3	0.3	0.3
Slip Agent	Zinc Stearate	0.2	0.2	0.2	0.2
Discolouration (⊿E) after UV irradiation	Irradiation time-24hr	0.4	0.7	1.1	1.3
	Irradiation time-48hr	0.6	0.8	1.2	1.5
	Irradiation time-120hr	0.7	1.2	1.4	2.2

(UV intensity of UV tester is 10 times stronger than that of SWOM.)

TAFMER™ can provide better light stability than EPDM.

OBSERVATIONS:

- In Sulfur cure, as the Tafmer(Alpha-olefin copolymer) dosage increases, the compression set property is also on the higher side. So the dosage is restricted only upto a max. of 10 phr.
- Tafmer blends increases the flow of the compound in the above study (as mooney viscosity is on the lower side when compared with 100% EPDM at same filler dosage). Also the Elongation @ break increases.

BASED ON PEROXIDE CURE

EPT/TF Blend Data (PO cure)

		1	2	3	4	5	6	7
		3092M	3092M/DF610 Blend			3092M/DF810 Blend		
<Formulation>								
3092M		100	90	80	70	90	80	70
DF610			10	20	30			
DF810						10	20	30
ZnO#1		5	←	←	←	←	←	←
StA		1	←	←	←	←	←	←
PEG#4000		2	←	←	←	←	←	←
FEF (Asahi#60G)		160	←	←	←	←	←	←
Paraffinic oil (PS-430)		100	←	←	←	←	←	←
Light CaCO3 (Silver W)		30	←	←	←	←	←	←
Perhexa 25B		3.8	←	←	←	←	←	←
TAIC		1	←	←	←	←	←	←
Total		402.8	402.8	402.8	402.8	402.8	402.8	402.8
EPT Content	%	24.8	22.3	19.9	17.4	22.3	19.9	17.4
<MDR> 180°C, 15min								
ts1	min	0.5	0.6	0.5	0.6	0.6	0.6	0.6
TC10	min	0.5	0.5	0.5	0.5	0.5	0.5	0.5
TC50	min	1.6	1.7	1.6	1.7	1.6	1.7	1.7
TC90	min	4.8	4.9	4.8	4.8	4.8	4.8	4.8
ML	dNm	1.6	1.5	1.4	1.4	1.6	1.4	1.2
MH	dNm	10.4	8.9	8.6	8.0	9.2	8.5	7.5
<Cured Properties> 180°C×10min								
Hardness	Shore-A	71	70	71	72	75	78	78
M100	MPa	2.9	2.7	2.6	2.7	3.4	3.6	3.6
M200	MPa	6.4	6.0	5.5	5.4	7.0	7.1	7.2
M300	MPa	9.3	8.5	7.7	7.3		9.6	9.8
Tensile Strength	MPa	9.1	8.8	8.6	7.9	9.2	9.8	10.0
Elongation	%	310	320	380	370	310	325	325
<Compression Set> 180°C, 10min								
150°C, 22h	%	25	28	34	34	29	31	33
0°C, 22h	%	74	73	67	67	63	58	53
<Heat Aging> 150°C, 72h								
Hardness	Shore-A	72	70	72	71	75	77	77
Tensile Strength	MPa	6.9	6.3	6.0	5.5	7.2	7.3	7.6
Elongation	%	350	360	410	410	350	340	380
AH		+1	±0	+1	-1	±0	-1	-1
Ac(TB)	%	-24	-28	-30	-31	-21	-25	-24
Ac(EB)	%	+13	+13	+8	+11	+13	+5	+17

Light Stability of TAFMER™-EPDM Blend

①Discolouration after UV irradiation

		A	B	C	Ref
TAFMER™	DF610	33	50	60	
EPDM	★	67	50	40	100
Peroxide	DCP	2	2	2	2
Additives	Antioxidant	0.3	0.3	0.3	0.3
Slip Agent	Zinc Stearate	0.2	0.2	0.2	0.2
Discolouration (⊿E) after UV irradiation	Irradiation time-24hr	0.4	0.7	1.1	1.3
	Irradiation time-48hr	0.6	0.8	1.2	1.5
	Irradiation time-120hr	0.7	1.2	1.4	2.2

(UV intensity of UV tester is 10 times stronger than that of SWOM.)

TAFMER™ can provide better light stability than EPDM.

OBSERVATIONS:

- In peroxide cures, the softer grades gives lower physical properties, not much change in the hardness, but harder grades(DF 810) gives higher tensile values when compared to the 100% EPDM, but with little higher hardness.
- But the ageing properties @ 150 deg,C for 72 hr. the results shows positive elongation at break. – could be better choice for higher hardness compounds for better flowability and better E.B.% after ageing.
- Also gives excellent UV irradiation, colour stability.

TAFMER SELECTION OF GRADES FOR THE EPDM BLENDS

Basic Properties of TAFMER™ DF Series

	Item	Test Method	Unit	DF605	DF610	DF640	DF710	DF740	DF7350	DF810	DF840	DF8200	DF940	DF110	DF140
Basic Physical Properties	MFR(190°C)	ASTM D1238	g/10min	0.5	1.2	3.6	1.2	3.6	35	1.2	3.6	18	3.6	1.2	3.6
	MFR(230°C)	ASTM D1238	g/10min	0.9	2.2	6.7	2.2	6.7	65	2.2	6.7	34	6.7	2.2	6.7
	ML1+4(100)	JIS K6395	-	65	40	16	40	16	-	40	16	5	16	40	16
	Density	ASTM D1505	kg/m³	861	862	864	870	870	870	885	885	885	893	905	905
Mechanical Properties	Tensile strength at break	ASTM D638	MPa	5<	3<	3<	15<	8<	2<	37<	27<	12	28	25	20
	Elongation at break		%	1000<	1000<	1000<	1000<	1000<	1000<	1000<	1000<	950	900	600	550
	Torsional rigidity	ASTM D1043	MPa	2	2	2	3	3	3	9	9	9	14	30	30
	Surface hardness	ASTM D2240	Shore A	58	57	56	73	73	70	87	86	85	92	96	95
Thermal Properties	Melting point	ASTM D2117	°C	50>	50>	50>	55	55	55	66	66	66	77	94	94
	Vicat softening point	ASTM D1525	°C	-	-	-	41	41	41	56	55	55	61	82	80
	Brittleness temperature	ASTM D746	°C	-70>	-70>	-70>	-70>	-70>	-70>	-70>	-70>	-70>	-70>	-70>	-70>

Note: All of the above listed data are representative values, and not specific ones.

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