Thermax® N990 - A Processing Aid for Difficult to Mix Compounds

February 18, 2022

AGENDA

Mixing

Dispersion

Mold Flow

Hardness

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FORMULATIONS

Small replacement of furnace black with Thermax® N990 for improved processing

	FKM		SBR		EPDM		NR/SBR		BIIR	
	Without Thermax®	With Thermax®	Without Thermax®	With Thermax®	Without Thermax®	With Thermax®	Without Thermax®	With Thermax®	Without Thermax®	With Thermax®
N990	**-**	**16**	**-**	**20**	**-**	**23.4**	**-**	**15**		**24**
N774	30	21								
N660			100	90			30	22.5		
N650					100	90			60	48

*Complete formulation information available

Furnace black replacement chart guideline for equal hardness

1 PART N774	=	**1.9 PARTS N990**
1 PART N660	=	**2 PARTS N990**

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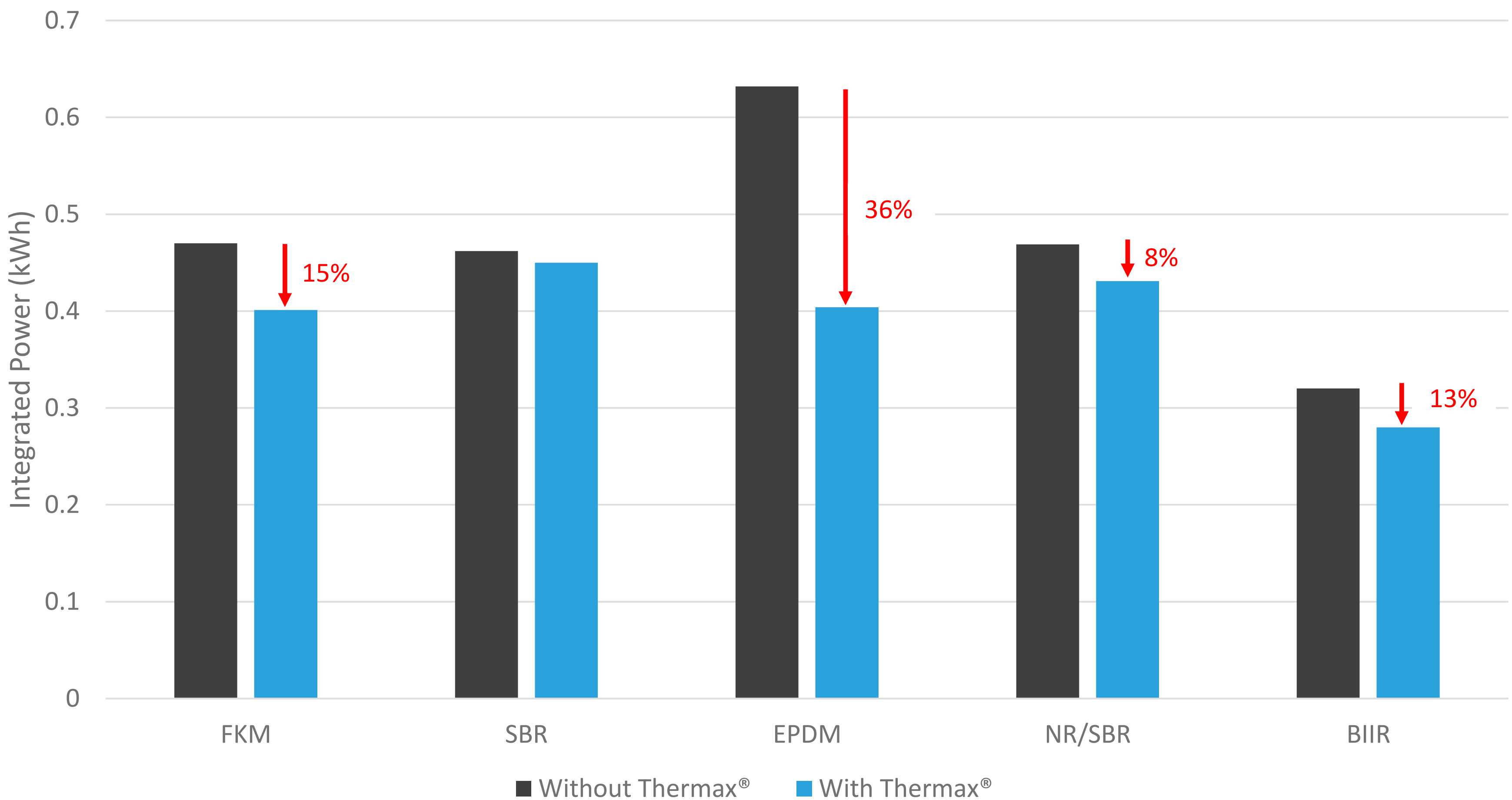
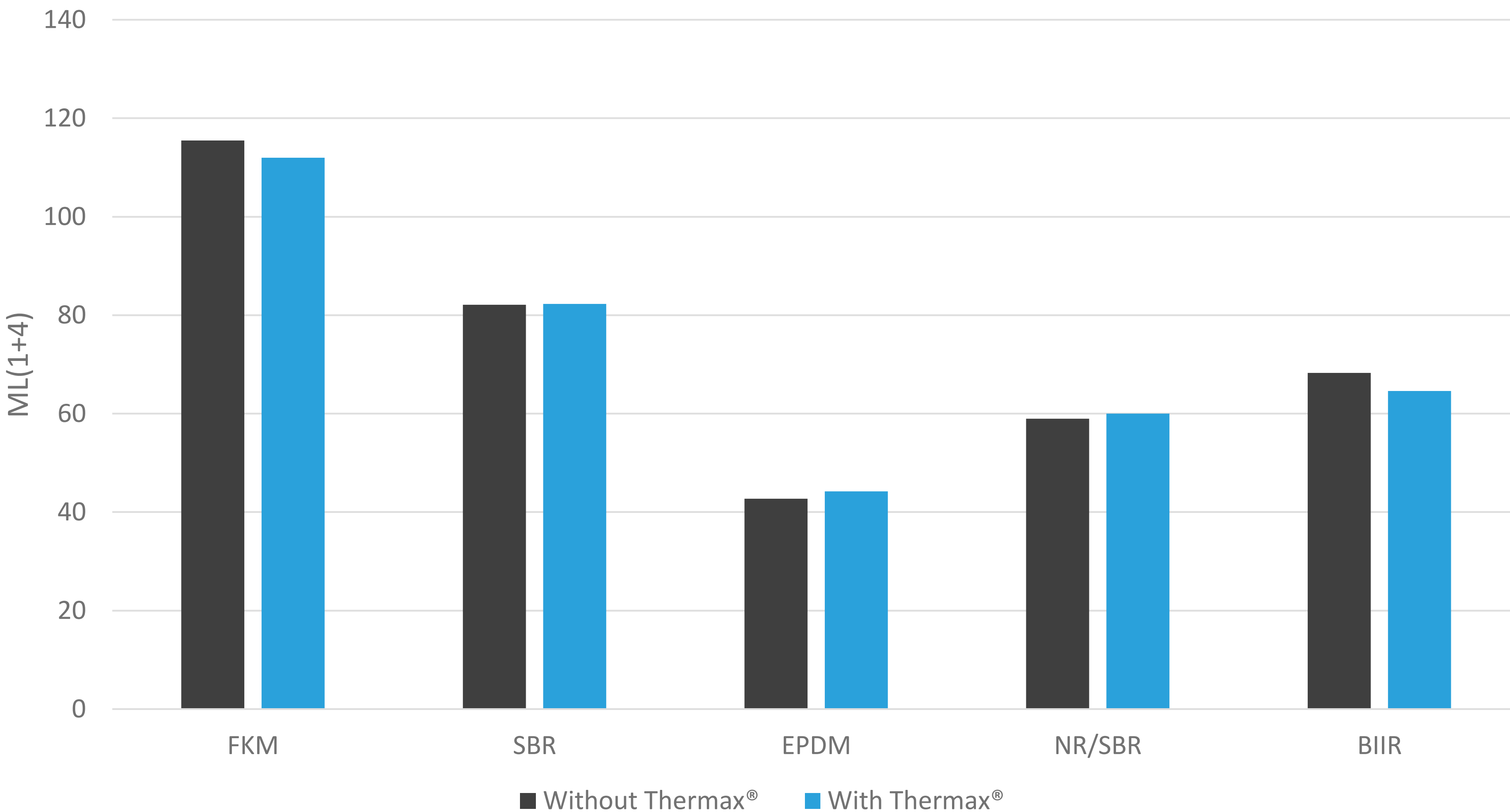
MIXING ENERGY



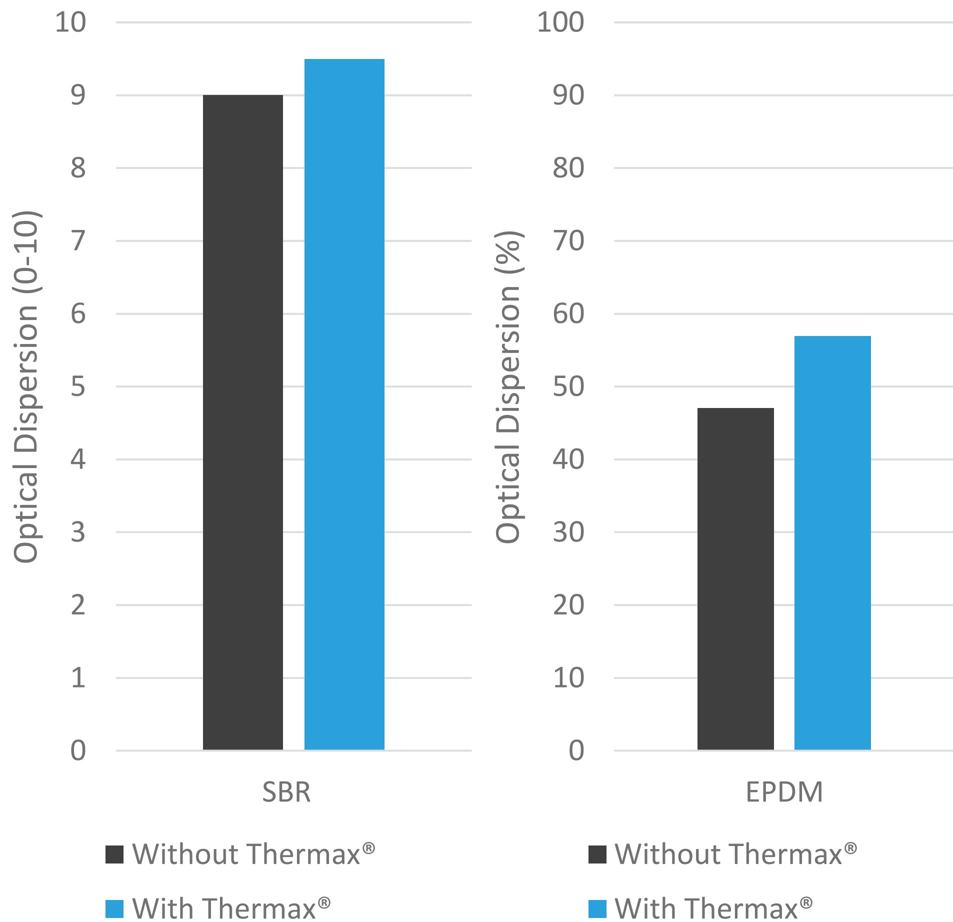
Lower mixing energy → Reduced mixing time → Increased production

RUBBER COMPOUND VISCOSITY

Only a small Thermax® N990 addition – no change in viscosity



DISPERSION



The large particle size of thermal black (avg. 280nm) creates a "ball-bearing" effect that **improves the dispersion of other materials into the mix**

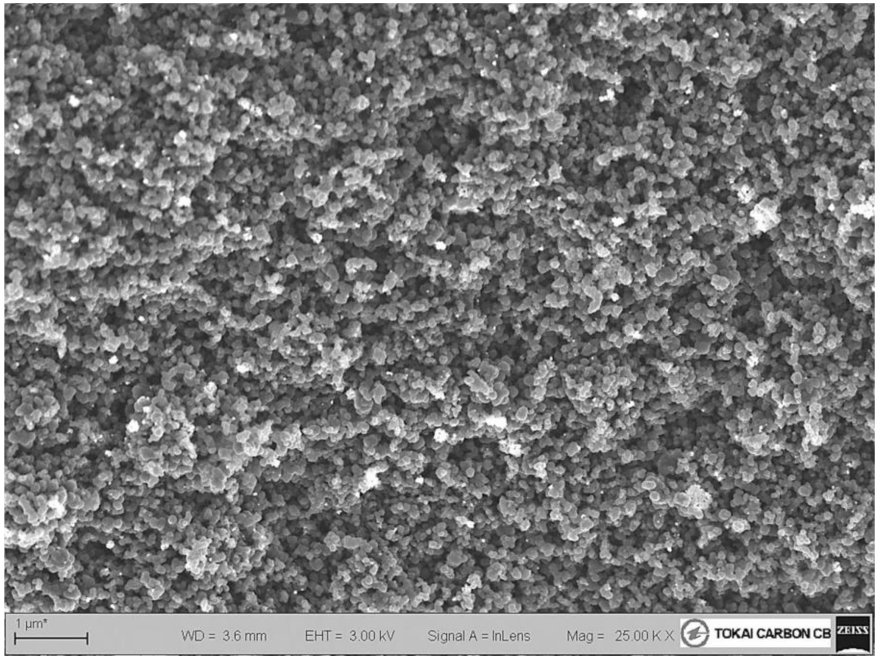
In combination with very low grit levels, thermal black N990 gives **superior surface finish** on both extruded and molded parts

Results in **consistent heat transfer** throughout the extrusion and uniform curing

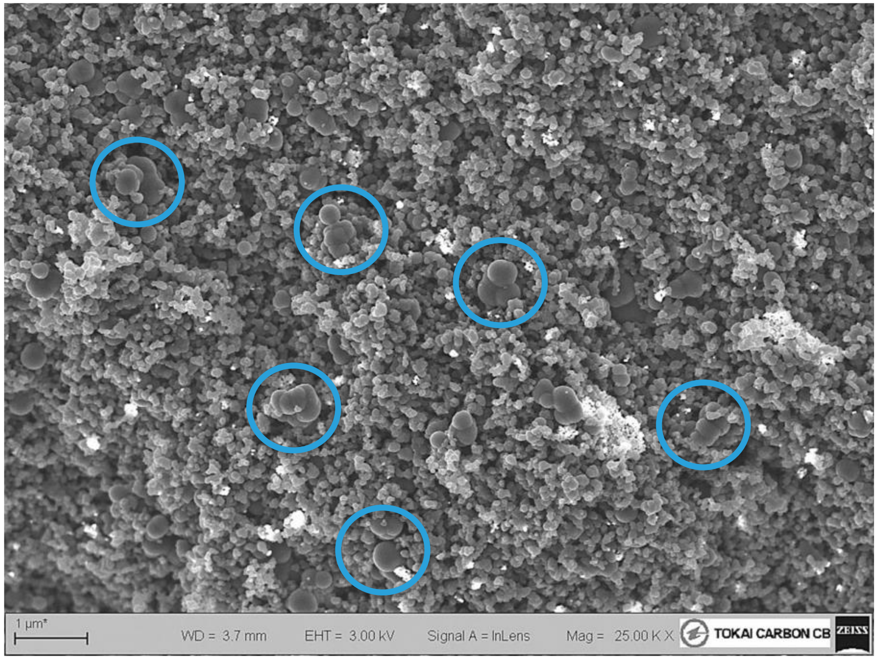
DISPERSION

SBR SEM imaging

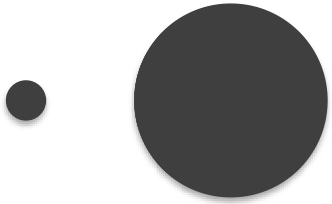
Control – 100phr N660 / No N990



90phr N660 / 20 phr N990

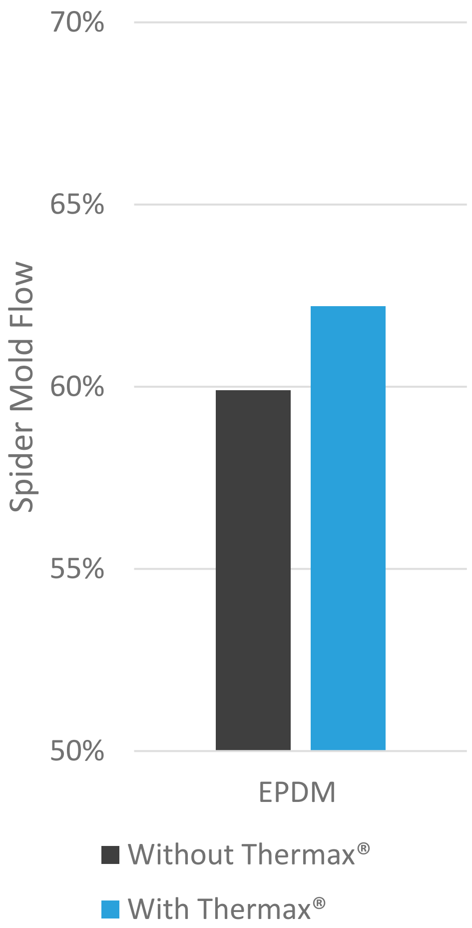


Relative particle size



N660 N990

MOLD FLOW



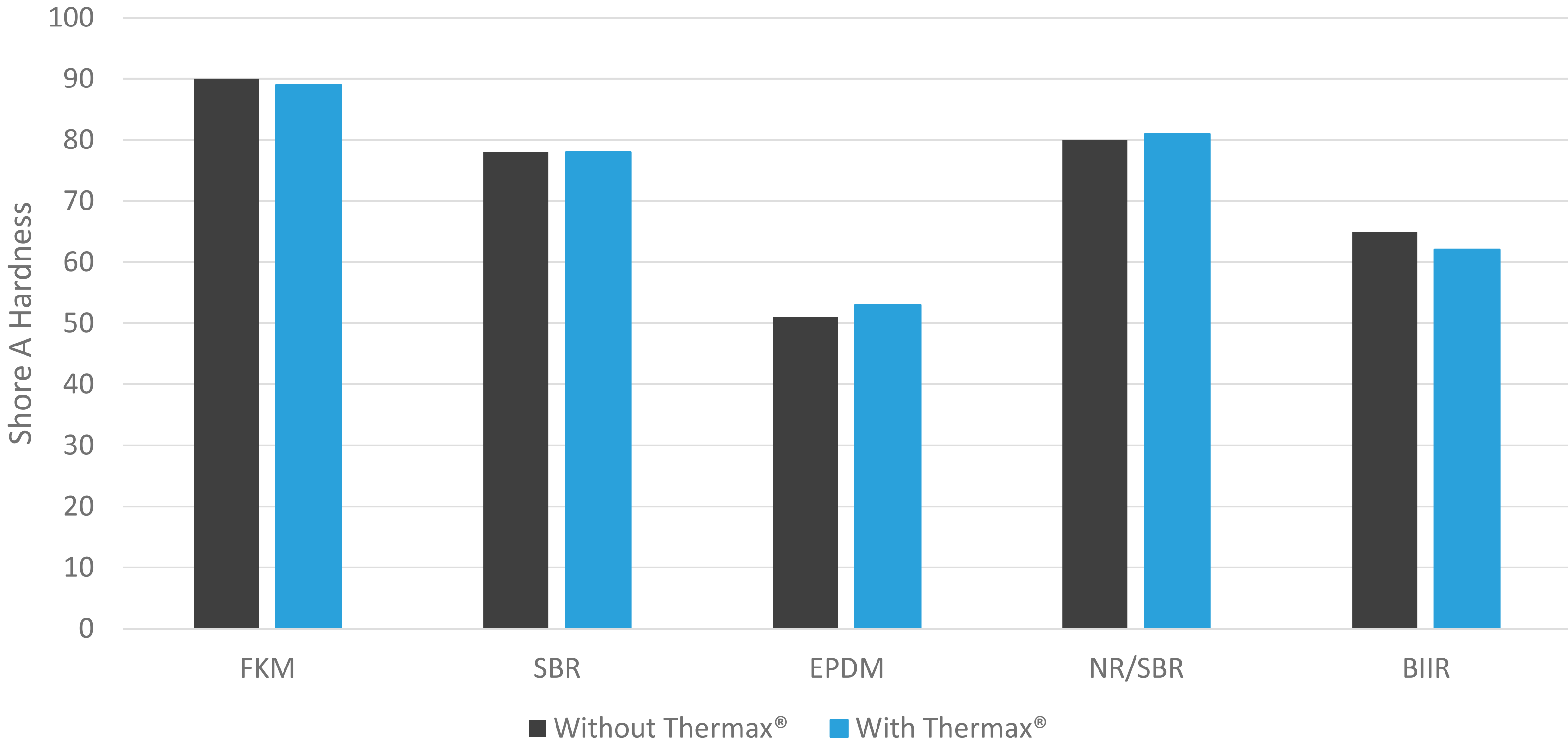
Better mold flow → Easier to mold and extrude complicated shapes → Less scrap losses

Especially important with expensive polymers and complicated rubber parts

Ex. Corner moldings, profiles, etc.

HARDNESS

Maintain **equivalent hardness** using higher replacement ratio



1 PART N774	=	1.9 PARTS N990
1 PART N660	=	2 PARTS N990

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PHYSICAL PROPERTIES

Maintain **physical properties** while using Thermax® N990 as a processing aid

	Tensile Strength (MPa)		Elongation (%)	
	Without Thermax®	With Thermax®	Without Thermax®	With Thermax®
FKM	16.8	16.8	142	141
SBR	20.4	21.7	147	167
EDPM	12.3	10.5	633	613
NR/SBR	18.6	19.1	189	192
BIIR	13.8	12.0	640	646

COST

Higher total filler loading = cost reduction

Reduced power consumption = cost reduction

Less scrap losses = cost reduction

FKM	HNBR
Butyl	PU

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THERMAX AS A PROCESSING AID

Lower mixing energy

Increased dispersion

Better mold flow

→

Less power consumption

Reduced mixing time

Easier to mold and extrude complex parts and profiles

→

Lower electricity costs

Increased production

Less scrap losses

Additional benefits:

- **Reduced number of mixing passes**
- **Less use of plasticizer and dispersants**

THERMAX AS A PROCESSING AID

Use Thermax® N990 to maintain the desired hardness of a compound while improving dispersion, mold flow and lowering mixing energy

Questions?

Technical Data?

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FKM SEALS AND GASKETS

	Control	A
DAI-EL G-7451	100	100
N990	**-**	**16**
N774	**30**	**21**
Calcium hydroxide	6	6
Magnesium oxide	3	3

FKM PROCESSING ADVANTAGES

- Reduction in mixing power consumption
- Reduction in Mooney Initial Viscosity and ML1+4

Data Point	Units	Control	A
N774/N990	phr	30/0	21/16
Mixing Energy			
Integrated Power	kWh	0.470	0.401
Mooney Viscosity			
Initial Viscosity	MU	183.3	170.7
ML1+4	MU	115.5	112.0

FKM PHYSICAL PROPERTIES

- No significant changes in physical properties

Data Point	Units	Control	A
N774/N990	phr	30/0	21/16
Shore A Hardness			
Hardness	pts	90	89
Tensile			
Tensile Strength	MPa	16.8	16.7
Elongation	%	142	141
Compression Set			
Static Compression Set	%	13.4	13.4

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SBR BEAD INSULATION

	Control	A
SBR 1500	100	100
N990	**-**	**20**
N660	**100**	**90**
Naphthenic oil	10	10
Zinc oxide	4	4
Stearic acid	1.5	1.5
SP-1068	2.5	2.5
6PPD	1.5	1.5
TMQ	1.0	1.0
DCBS	1.75	1.75
Crystex HD OT20	6.0	6.0
Retarder CTP	0.2	0.2

SBR PROCESSING ADVANTAGES

- Slight reduction in mixing power consumption
- Improvement in filler dispersion
    - Leads to improvement in adhesion, physical, and dynamic properties

Data Point	Units	Control	A
N660/N990	phr	100/0	90/20
Mixing Energy			
Integrated Power	kWh	0.462	0.450
Mooney Viscosity			
ML1+4	MU	82.1	82.3
Dispersion			
Optical Dispersion		9	9.5

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SBR PHYSICAL AND DYNAMIC PROPERTIES

Data Point	Units	Control	A
N660/N990	phr	100/0	90/20
Shore A Hardness			
Hardness	pts	78	78
Tensile			
Tensile Strength	MPa	20.4	21.7
Elongation	%	147	167
Compression Set			
Static Compression Set	%	29	25
BF Goodrich			
Temperature Rise	°C	29	23
Dynamic Compression Set	%	7.1	2.5
Adhesion to Bead Wire			
Pull-out Force, RT	N	1035	1121
Pull-out Force, 100°C	N	396	505

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EPDM PROFILE

	Control	A
Royalene 645	70	70
Royalene 509	60	60
N990	**-**	**23.4**
N650	**100**	**90**
Calcium carbonate	42	42
Zinc oxide	10	10
Stearic acid	1.5	1.5
Polyethylene glycol	4	4
Paraffinic oil	31.5	31.5
Naphthenic oil	31.5	31.5
DPTT	1	1
TMTD 75 EPR	2	2
ZDBC 80 EPR	1.9	1.9
Sulfur 80 EPR	0.4	0.4
Desical P	10	10

EPDM PROCESSING ADVANTAGES

- Significant reduction in mixing energy consumption
- Slight increase in Mooney viscosity but also spider mold flow
- Significant improvement in dispersion

Data Point	Units	Control	A
N650/N990	phr	100/0	90/23
Mixing Energy			
Integrated Power	kWh	0.632	0.404
Mooney Viscosity			
ML1+4	MU	42.7	44.2
Spider Mold			
Flow	%	59.9	62.2
Optical Dispersion			
Dispersion	%	47.0	56.9

EPDM PHYSICAL AND WEATHERING PROPERTIES

- Decrease in tensile strength and elongation as well as compression set
- Properties are generally similar between the two compounds

Data Point	Units	Control	A
N650/N990	phr	100/0	90/23
Shore A Hardness			
Hardness	pts	51	53
Tensile			
Tensile Strength	MPa	12.3	10.5
Elongation	%	633	613
Compression Set			
Static Compression Set	%	23.4	20.5
Tear Strength			
Tear Strength	N/mm	26.4	25.4
Weathering			
ΔE* (color change)		1.8	1.6

NR/SBR SOLID TIRE SUB-TREAD

	Control	A
TSR 20	50	50
SBR 1500	50	50
N990	**-**	**15**
N660	**30**	**22.5**
N330	55	55
Zinc oxide	4	4
Stearic acid	2	2
Naphthenic oil	10	10
6PPD	1.5	1.5
TMQ	1.5	1.5
TBBS	0.5	0.5
MBTS	0.3	0.3
DTDM	1.4	1.4
Sulfur	3	3

NR/SBR PROCESSING ADVANTAGES

- Reduced mixing energy consumption
- No significant difference in viscosity

Data Point	Units	Control	A
N660/N990	phr	30/0	22.5/15
Mixing Energy			
Integrated Power	kWh	0.469	0.431
Mooney Viscosity			
ML1+4	MU	59.0	60.0

NR/SBR PHYSICAL AND DYNAMIC PROPERTIES

- No significant changes in physical properties
- Significant increase in blow out time

Data Point	Units	Control	A
N660/N990	phr	30/0	22.5/15
Shore A Hardness			
Hardness	pts	80	81
Tensile			
Tensile Strength	MPa	18.6	19.1
Elongation	%	189	192
Compression Set			
Static Compression Set	%	12	14
BF Goodrich			
Temperature Rise	°C	27	27
Dynamic Compression Set	%	3.4	3.0
Blow Out Time	min	9.0	16.1

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BIIR INNERLINER

	Control	A
X_Butyl® BB 2030	100	100
N660	**60**	**48**
Thermax® N990	**0**	**24**
Stearic acid	1	1
SP1068 resin	4	4
Paraffinic oil	7	7
MBTS	1.3	1.3
Zinc oxide	3	3
Sulfur	0.5	0.5

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BIIR INNERLINER PROCESSING ADVANTAGES

- Reduced mixing energy consumption
- No significant difference in viscosity

Data Point	Units	Control	A
N660/N990	phr	60/0	48/24
Mixing Energy			
Integrated Power	kWh	0.32	0.28
Mooney Viscosity			
ML1+4	MU	68.3	64.6

BIIR INNERLINER PHYSICAL AND DYNAMIC PROPERTIES

- Improved failure cycling and adhesion
- Decrease in oxygen permeation

Data Point	Units	Control	A
N660/N990	phr	60/0	48/24
Shore A Hardness			
Hardness	pts	65	62
Tensile			
Tensile Strength	MPa	13.8	12.0
Elongation	%	640	646
Failure testing			
Cycles to Failure	kilocycles	336	408
Permeation			
Oxygen transmission rate	cm^3/m^2day	168	154
Adhesion			
Adhesion to Ply skim	N/mm	7.12	8.66