

STARTING POINT RUBBER COMPOUNDING FORMULATIONS

Important Note:

These are Starting Point Rubber Compounding Formulations for providing guide lines only and should be confirmed by laboratory trials. It is expected that modifications may be necessary to produce satisfactory commercial products.

1. Typical Truck Tyre Formulations (Bias Ply)						
Ingredients	Tread Cap (Rib Type)	Tread (Lug Type)	Tread Base	Side Wall	Carcass Outer Ply	Carcass Inner Ply
NR (RSS)	70	100	100	60	100	100
Peptizer	0.08	0.1	0.1	0.05	0.1	0.1
BR (High Cis)	30	-	-	40	-	-
Chlorobutyl 1065	-	-	-	-	-	-
Zinc Oxide	5.0	5.0	5.0	5.0	5.0	5.0
Stearic Acid	1.5	2.0	2.0	1.0	1.0	1.0
Pilflex 13	2.5	2.5	2.5	2.5	1.0	1.0
Pilnox TDQ	0.5	1.0	0.5	1.5	1.0	1.0
N 234 Carbon Black	65	-	-	-	-	-
N 330 Carbon Black	-	55	-	-	-	-
N 550 Carbon Black	-	-	50	50	-	-
N 660 Carbon Black	-	-	-	-	-	-
N 774 Carbon Black	-	-	-	-	40	25
Aromatic Oil	15	10	12	-	6	4
Naphthenic Oil	-	-	-	5	-	-
PF Resin Tackifier	-	-	-	-	-	-
Blended Wax	1.0	0.5	2.0	2.0	-	-
Pilcure MOR	1.4	0.6	-	0.8	0.6	0.7
Pilcure CBS	-	-	1.0	-	-	-
Pilcure MBTS	-	-	-	-	-	-
Pilgard PVI	0.2	0.15	0.15	0.10	0.15	0.15
Sulfur	1.2	2.4	1.5	1.8	-	-
Insol. Sulfur (100%)	-	-	-	-	2.5	2.5
Typical Properties						
Rheometer (ODR) @ 150°C						
Scorch Time ts2 , min	8.7	5.5	5.6	8.1	5.4	6.0
Opt. Cure Time t'c90 , min	13.1	13.7	9.1	14.3	13.0	12.4
Maximum Torque MHR, lb.in	58.2	69.1	61.8	70.3	56.3	56.7
Unaged Physicals @ OCT						
Tensile Strength, MPa	22.0	25.2	22.5	17.8	21.0	21.2
Elongation at Break, %	550	475	500	450	535	560
300% Modulus, MPa	10.5	14.8	11.1	11.1	7.0	5.0
Hardness, IRHD	65	67	63	64	55	50

2. Typical Truck Tyre Formulations (Steel Radials)					
Ingredients	Treads	Side Walls	Belt	Carcass	Apex
NR (RSS)	100	50	100	100	100
Peptizer	0.1	.05	0.1	0.1	0.10
BR (High Cis)	-	50	-	-	-
Zinc Oxide	5.0	5.0	10.0	10.0	10.0
Stearic Acid	2.0	1.0	1.0	0.5	2.0
Pilflex 13	2.5	2.5	2.0	2.0	2.0
Pilnox TDQ	1.5	1.5	-	1.0	1.0
N 234 Carbon Black	60	-	-	-	-
N 326 Carbon Black	-	-	60	-	-
N 330 Carbon Black	-	55	-	-	-
N 339 Carbon Black	-	-	-	55	-
N 351 Carbon Black	-	-	-	-	55
Aromatic Oil	12	-	-	3	-
Naphthenic Oil	-	5	-	-	-
PF Resin Tackifier	-	-	2.0	-	2.0
Cobalt Napthanate	-	-	1.5	0.65	-
Bonding agent	-	-	-	-	2.0
Blended Wax	1.0	2.0	-	-	-
Pilcure TBBS	1.5	1.0	-	-	0.7
Pilcure DCBS	-	-	1.0	1.1	-
Accelerator TMTM	-	-	-	-	0.10
Pilgard PVI	0.1	0.1	0.10	-	0.20
Sulfur	1.5	1.3	-	-	-
Insol. Sulfur (100%)	-	-	5.0	4.0	4.0
Typical Properties					
Rheometer (ODR) @ , °C	150	150	160	150	150
Scorch Time ts2 , min	4.25	5.61	1.61	3.64	3.12
Opt. Cure Time t'c90 , min	7.26	9.45	24.54	14.05	10.80
Maximum Torque MHR, lb.in	68.70	67.02	104.7	84.89	107.11
Unaged Physicals @ OCT					
Tensile Strength, MPa	26.0	21.0	16.1	25.2	23.4
Elongation at Break, %	545	545	250	425	340
300% Modulus, MPa	12.9	9.40	12.3	17.23	21.3
Hardness, IRHD	67	62	75	72	80

3. Typical Passenger Car Tyre Formulations (Radials)			4. Typical Tyre Tread formulations		
Ingredients	Tread	Carcass	Light Truck	Tractor Rear	OTR
NR (RSS)	-	70	-	-	100
Peptizer	-	0.07	-	-	0.1
SBR 1502	-	-	80	-	-
SBR 1712	82.5	20.5	27.4	137.5	-
BR	55	15	-	-	-
Zinc Oxide	3.0	3.0	3.0	3.0	5.0
Stearic Acid	2.0	2.0	2.0	2.0	2.0
Pilflex 13	2.5	0.5	2.0	2.0	2.5
Pilnox TDQ	1.5	1.0	1.0	1.0	1.5
N 220 Carbon Black	70	-	-	-	45
N 330 Carbon Black	-	-	55	60	-
N 660 Carbon Black	-	40	-	-	-
Ppt. Silica	-	-	-	10	15
TSPT	-	-	-	-	1.0
Aromatic Oil	-	-	5	5	10
Naphthenic Oil	-	12	-	-	-
Petroleum Resin	-	2.0	2.5	2.0	4.0
MC wax	3.0	-	2.0	1.5	1.5
Pilcure NS	1.0	0.7	1.0	1.2	1.2
Pilcure MBTS	-	0.1	-	-	-
Accelerator DPG	-	-	-	-	0.5
Pilgard PVI	-	0.1	-	0.05	0.2
Sulfur	2.0	-	1.8	2.0	-
Insol. Sulfur (100%)	-	2.2	-	-	1.5
Typical Properties					
Rheometer (ODR) @ , °C	150	150	150	150	150
Scorch Time ts2 , min	9.23	5.58	7.20	11.70	4.05
Opt. Cure Time t'c90 , min	19.11	12.24	16.35	30.35	12.0
Maximum Torque MHR, lb.in					
Unaged Physicals @ OCT					
Tensile Strength, MPa	22.0	17.0	18.90	19.6	24.5
Elongation at Break, %	600	570	445	600	525
300% Modulus, MPa	8.2	5.4	11.50	7.5	11.7
Hardness, IRHD	65	53	70	62	71

5. Truck Tyre Retreads						
Ingredients	Conventional (Hot Cured)			Precured (Cold Cured)		
	NR	NR-BR	Light Duty	NR	NR-BR	NR-BR
NR (RRS Lot)	100	75	80	80	70	60
Peptizer	0.1	0.1	0.1	0.1	0.1	0.1
NR-BR (High Cis content)	-	25	20	20	30	40
Zinc Oxide	5.0	5.0	5.0	5.0	5.0	5.0
Stearic Acid	2.5	2.5	2.5	2.5	2.5	2.5
Pilflex 13	0.5	0.5	0.5	1.0	1.0	1.0
Pilnox TDQ	1.0	1.0	1.0	1.0	1.0	1.0
N 220 Carbon Black	-	-	65	-	-	-
N 339 Carbon Black	50	50	-	55	55	55
Highly Aromatic Oil	6	12	20	12	14	16
Paraffin Wax	1.0	1.0	1.0	1.0	1.0	1.0
Pilcure DCBS	0.7	-	-	-	-	-
Pilcure MOR	-	0.8	1.2	1.0	1.1	1.2
Pilgard PVI	-	0.2	0.2	0.15	0.1	0.1
Insoluble Sulfur (100%)	2.5	1.6	1.6	-	-	-
Sulfur	-	-	-	1.8	1.6	1.6
Typical Properties						
Rheometer (ODR) @ 140°C						
Scorch Time ts2 , min	7.25	10.0	12.5	5.45	5.90	6.15
Opt. Cure Time t'c90 , min	32.0	22.0	23.0	11.2	12.2	12.6
Maximum Torque MHR, lb.in	70.0	64.0	72.0	65.7	66.8	67.5
Unaged Physicals @ OCT						
Tensile Strength, MPa	27.0	24.0	22.5	28.3	26.0	24.5
Elongation at Break, %	580	580	550	600	580	550
300% Modulus, MPa	9.0	8.5	10.0	11.2	11.8	12.5
Hardness, IRHD	62	61	65	62	62	63
Tear Strength, kN/m	115	95	125	125	108	96
Abrasion loss (DIN), mm ³	135	85	90	80	63	42

6. Retreading Materials			
Ingredients	Cushion Gum		Vulcanizing Solution
	Hot Cure	Cold Cure	
NR (RSS lot)	100	100	100
Zinc oxide	5.0	5.0	10.0
Stearic acid	1.0	1.0	0.5
Pilnox TDQ	1.0	1.0	1.0
N 774 Black	35	35	15
Aromatic Oil	5.0	7.5	-
Wood Rosin	2.0	3.0	4.0
Pilcure MOR	0.7	-	-
Pilcure CBS	-	1.0	-
Pilcure MBTS	-	0.4	1.0
TMTM		0.4	-
Pilgard PVI	0.1	0.20	-
Insol. Sulfur (100%)	2.5	2.5	4.0
Typical Properties			
Rheometer (ODR) @ 140°C			
Scorch Time ts2 , min	8.75	3.64	2.25
Opt. Cure Time t'c90 , min	19.5	5.70	15.0
Maximum Torque MHR, lb.in	74.0	88.0	68.0
Unaged physicals at optimum cure.			
Tensile Strength, MPa	26.5	20.5	22.5
Elongation at Break, %	600	475	700
300% Modulus, MPa	4.0	9.5	2.5
Hardness, IRHD	52	52	50

7. Auto Tubes (Butyl, Bromobutyl-NR Based)			8. Auto Tubes NR Based			
Ingredients	Butyl	NR-BIIR	Ingredients	Truck (HR)	Pass. Car	Two / Three Wheeler
Butyl 301	100	-	NR (RSS 1)	100	100	100
Bromo Butyl	-	50	Peptizer	0.1	0.1	0.1
NR (RSS 1)	-	50	Zinc oxide	5.0	5.0	5.0
Zinc oxide	5.0	5.0	Stearic acid	1.5	1.5	1.5
Stearic acid	1.0	1.0	Pilnox TDQ	1.5	1.0	1.0
Pilnox TDQ	-	1.0	Pilflex 13	0.5	0.5	0.5
Pilflex 13	0.5	1.0	N 550 Black	30	30	20
N 550 Black	-	20	Ppt. CaCO ₃	-	20	30
N 660 Black	70	5	Naphthenic Oil	5.0	7.5	5.0
Paraffinic Oil	20	-	Paraffin wax	1.0	1.0	1.0
Naphthenic Oil	-	2.0	Pilcure CBS	1.5	1.0	1.2
Paraffin wax	-	1.0	Pilcure TMT	0.4	0.2	0.2
Pilcure TMTD	1.0	1.0	Pilgard PVI	0.15	0.15	0.15
Pilcure MBTS	0.5	1.0	Sulfur	0.75	1.25	1.25
Pilcure DTDM	-	0.6	-	-	-	-
Sulfur	2.0	-	-	-	-	-
Typical Properties			Typical Properties			
Rheometer @ 160°C			Rheometer @ 160°C			
Scorch Time ts2 , min	3.05	1.90	Scorch Time ts2 , min	2.0	2.45	2.50
Opt. Cure Time t'c90 , min	11.5	5.0	Opt. Cure Time t'c90 , min	2.8	3.1	3.25
Maximum Torque MHR, lb.in	62.0	46.0	Maximum Torque MHR, lb.in	56.0	61.0	52.0
Unaged physicals at optimum cure.			Unaged physicals at optimum cure.			
Tensile Strength, MPa	11.0	13.5	Tensile Strength, MPa	24.0	22.0	22.5
Elongation at Break, %	650	500	Elongation at Break, %	525	540	560
300% Modulus, MPa	4.0	7.5	300% Modulus, MPa	8.0	7.5	6.3
Hardness, IRHD	51	51	Hardness, IRHD	52	52	53
Tear Strength, kN/m	32.0	40.0	Tear Strength, kN/m	38	42	35

9. Bicycle Tyre & Tube Compounds							
Ingredients	Bicycle Tyre Treads			Casing	Tubes		Curing Bags
	Rickshaw	Premium	Low cost		Premium	Low cost	
NR (RSS lot)	60	60	60	100	100	100	100
Peptizer	0.06	0.06	0.06	0.25	0.20	0.20	0.10
BR (High cis)	20	10	-	-	-	-	-
Reclaim	40	60	80	-	-	-	-
Zinc oxide	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Stearic acid	1.5	1.5	1.5	1.0	1.5	1.5	1.0
Pilnox TDQ	1.0	1.0	0.8	1.0	1.0	1.0	2.0
Pilflex 13	0.5	0.5	0.3	-	0.3	-	0.5
N 330 black	35	30	-	-	-	-	25
N 660 black	-	-	30	10	15	10	-
China clay	30	40	40	30	-	50	50
Ppt. CaCO ₃	-	-	-	-	60	30	-
Whiting	-	-	-	30	-	-	-
Aromatic Oil	10.0	10.0	8.0	-	-	-	5.0
Naphthenic Oil	-	-	-	5.0	10.0	12.5	-
Brown Factice	-	-	-	-	4.0	4.0	-
Wood Rosin	2.5	2.0	2.0	2.5	-	-	-
Paraffin wax	1.0	1.0	1.0	-	1.0	1.0	1.0
Pilcure CBS	1.0	-	-	-	1.2	1.2	1.0
Pilcure F	-	1.0	1.2	1.0	-	-	-
Pilcure TMT	0.15	0.10	0.10	0.25	0.10	0.10	-
Pilgard PVI	0.10	0.10	0.10	0.10	0.10	0.10	0.12
Sulfur	2.3	2.4	2.5	2.2	1.65	1.70	1.5
Typical Properties							
Rheometer (ODR) at 150 °C.							
Scorch time ts ₂ , min	3.0	1.75	1.4	3.0	4.1	4.2	5.4
Cure time t ₉₀ , min	5.75	6.0	5.75	5.2	6.0	7.0	9.5
Max. Torque M _{HR} , lb.in	70.0	62.0	65.0	66.5	65.0	51.0	56.0
Unaged physicals at optimum cure.							
Tensile Strength, MPa	14.5	12.0	10.0	17.0	16.5	13.5	23.0
Elongation at Break, %	450	420	380	550	575	475	570
300% Modulus, MPa	7.7	4.5	4.5	5.0	4.0	6.50	7.5
Hardness, IRHD	62	60	62	54	54	56	59
Abrasion Loss, mm ³	165	200	240	-	-	-	-

10. Footwear Compounds							
Ingredients	Microcellular Sheets		Hawaii		Other Soling Materials		
	Premium	General Purpose	Sole	Strap	Neolite	Miner's Shoes	Canvas Shoes
NR (RSS lot)	35	45	70	100	70	100	100
Peptizer	0.05	0.05	0.07	0.2	0.07	0.10	0.10
High Styrene Resin	65	55.0	30	-	30	-	-
Zinc oxide	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Stearic acid	4.0	4.0	4.0	1.5	1.0	1.0	1.0
Pilnox SP	2.0	1.5	1.0	1.0	1.0	1.5	1.5
N 330 Black	-	-	-	-	-	20	-
Aluminum Silicate	50	40	40	-	40	30	20
China clay	50	80	80	30	60	30	40
Ppt. CaCO ₃	-	-	-	40	40	-	40
Micro Crumb	50	60	-	-	-	-	-
Hawaii Crumb	-	-	30	-	-	-	-
Wood Rosin	4.0	4.0	3.0	-	4.0	2.0	2.0
Naphthenic Oil	5.0	5.0	10.0	5.0	5.0	5.0	5.0
Diethylene glycol	2.0	2.0	2.0	-	1.5	1.0	1.0
Paraffin wax	1.0	1.0	1.0	0.5	-	-	-
DNPT blowing agent	3.0	4.5	6.0	-	-	-	-
Pilcure F	1.3	1.4	1.2	1.2	-	-	-
Pilcure CBS	-	-	-	-	1.0	1.0	0.75
Pilcure TMT	-	-	-	-	0.2	0.3	0.25
Pilgard PVI	-	-	-	-	0.10	0.10	0.10
Sulfur	2.2	2.3	2.3	2.0	2.4	2.4	2.0
TiO ₂ & Color	As req.	As req.	As req.	As req.	As req.	As req.	As req.
Typical Properties							
Rheometer (ODR) at 150 °C.							
Scorch time ts ₂ ,min	1.60	1.70	1.50	4.0	5.0	4.0	3.5
Cure time t ₉₀ ,min	6.20	5.20	4.50	7.0	7.5	6.5	5.8
Max. Torque lb.in	30.0	30.50	27.0	55.0	70.0	78.0	65.0
Unaged physicals at optimum cure.							
Linear Exp. %	35	40	42	-	-	-	-
Sp. gravity	0.48	0.54	0.40	-	-	-	-
Hardness, Sh A	56	55	45	52	80	65	56
Split tear st., kgf	5.5	4.5	5.0	-	-	-	-
Tensile strength., MPa	-	-	-	19.5	9.0	20.0	14.0
E.B., %	-	-	-	600	350	475	500
300% Mod., MPa	-	-	-	-	7.5	8.5	4.2
Tear strength. kN/m	-	-	-	35	-	-	-

11. Belting Compounds									
Ingredients	Conveyor belt Covers			Conveyor belt Fabric rubberizing			V-Belt		
	Super Quality	Heat Resist.	Food Contact	Super Quality	Heat Resist.	Nylon Fabric	Base	Cushion	Jacket Friction
NR (RSS 1)	100	100	100	100	100	100	60	100	80
Peptizer	0.2	0.2	0.2	0.3	0.3	0.3	0.10	0.3	0.3
SBR 1502	-	-	-	-	-	-	40	-	20
Zinc oxide	5.0	5.0	5.0	5.0	10.0	5.0	10.0	5.0	5.0
Stearic acid	2.0	2.0	2.0	1.0	1.0	1.0	1.5	0.5	1.0
Pilflex 13	1.0	1.0	-	1.0	1.0	0.5	1.0	0.5	1.0
Pilnox TDQ	1.0	2.0	-	1.0	2.0	1.0	1.0	1.0	1.0
Pilnox SP	-	-	2.0	-	-	-	-	-	-
N 330 black	45	45	-	-	-	-	-	-	-
N 660 black	-	-	-	-	-	-	75	30	20
N 774 black	-	-	-	15	15	30	-	-	-
Ppt. Silica	-	-	-	-	-	10	15	-	-
Ppt. CaCO ₃	-	-	-	25	25	-	-	-	20
Al. Silicate.	-	-	50	-	-	-	-	-	-
Cl Resin	2.0	2.0	2.0	5.0	5.0	5.0	5.0	3.0	5.0
Aromatic Oil	6.0	6.0	-	10	10	-	-	-	-
Naphthenic Oil	-	-	5.0	-	-	-	5.0	5.0	5.0
Paraffin wax	0.5	0.5	1.0	-	-	-	-	-	-
Pilcure MOR	-	-	-	-	-	-	1.0	1.0	1.0
Pilcure CBS	0.8	1.3	0.8	1.0	1.0	1.0	-	-	-
Pilcure MBT	-	-	-	-	-	-	0.2	0.2	0.2
Pilcure TMT	0.05	0.4	0.2	0.05	0.5	-	-	-	-
Pilgard PVI	0.10	0.12	-	0.15	-	0.15	0.15	0.10	0.10
Insoluble S	-	-	-	2.6	0.75	2.80	-	-	-
Sulfur	2.3	0.7	2.75	-	-	-	2.75	2.5	2.5
Resorcinol	-	-	-	-	-	2.5	-	-	-
Resimene 3520	-	-	-	-	-	1.6	-	-	-
Typical Properties									
Rheometer (ODR) at 140 °C.									
ts ₂ ,min	5.75	4.75	5.40	6.70	4.00	5.40	10.40	7.50	10.80
t' 90 ,min	13.50	7.00	8.75	11.50	6.20	8.50	26.0	14.8	18.0
MHR lb.in	77.0	54.0	70.0	65.0	57.0	70.0	100.0	67.0	71.5
Unaged physicals at optimum cure.									
T.S. , MPa	28.0	24.0	20.5	23.5	21.0	25.7	17.5	25.5	20.5
E. B. , %	500	550	575	550	600	540	300	500	500
300% Mod., MPa	7.50	8.50	5.50	5.8	5.0	5.9	17.5	7.5	6.5
Hardness, IRHD	64	60	58	54	52	55	74	47	50
Tear Strength, kN/m	70	60	40	37	32	44	60	58	50

12. Air / Water Hose Compounds							
Ingredients	Water Suction & Discharge	Braided Textile Reinforcement		Air hose Low pressure Type 1 & 2		Air hose High pressure Type 3	
	Tube and Cover	Tube	Cover	Tube	Cover	Tube	Cover
NR (RSS lot)	100	80	100	90	100	90	100
Peptizer	0.10	0.1	0.1	0.10	0.1	0.10	0.10
BR (High cis)	-	20	-	10	-	10	-
Zinc oxide	5.0	5.0	5.0	5.0	5.0	5.0	5.0
Stearic acid	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Pilflex 13	-	-	-	-	0.5	-	0.5
Pilnox TDQ	1.0	1.0	1.0	1.0	1.0	1.0	1.0
N 550 black	15	35	40	40	40	45	45
China clay	100	100	80	75	100	60	50
Whiting	100	80	80	75	-	50	-
Naphthenic oil	5.0	5.0	10.0	5.0	10.0	5.0	10.0
Mineral rubber	5.0	3.0	3.0	3.0	3.0	3.0	3.0
Wood rosin	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Paraffin wax	1.0	-	1.0	-	1.0	-	1.0
Pilcure MBTS	1.0	1.0	1.0	1.2	1.2	1.2	1.2
Sulfur	2.5	2.6	2.0	2.6	1.75	2.6	1.75
Typical Properties							
Rheometer (ODR) at 150°C							
Scorch time ts2, min	3.25	3.25	3.25	3.12	3.0	2.5	2.3
Cure time t'90, min	10.25	10.58	9.0	11.0	8.5	8.2	7.0
Max. Torque, lb.in	48.0	46.5	30.0	56.0	45.0	43.0	53.0
Unaged physicals at optimum cure.							
Tensile Strength, MPa	8.0	8.5	8.5	10.0	14.3	11.5	13.0
Elongation at Break, %	350	300	300	350	400	350	450
300% Modulus, MPa	7.0	8.5	8.5	8.0	8.5	8.5	8.0
Hardness, IRHD	70	75	72	72	65	70	63
Tear Strength, kN/m	30	35	30	35	40	45	43

13. Oil & Fuel hose, High pressure Hydraulic Hose and LPG tubing Compounds				
Ingredients	Oil & Fuel Hose	High pressure Hydraulic hose	Oil & Fuel, Hydraulic hose	LPG Tubing
	Tube	Tube	Cover	
NBR (Medium ACN)	100	100	-	-
CR (W type)	-	-	100	100
Light MgO	-	-	4.0	4.0
Zinc oxide	5.0	5.0	5.0	5.0
Stearic acid	1.5	1.5	0.5	0.5
Pilflex 13	-	0.5	0.5	-
Pilnox TDQ	1.5	1.5	-	-
Pilnox SP	-	-	-	2.0
N 550 black	30	80	40	-
N 774 black	20	-	-	-
Ppt. Silica	15	15	15	20
Ppt. CaCO ₃	40	-	40	100
Aromatic Oil	7.5	-	10	-
Napthanic Oil	-	-	-	5.0
DOP	7.5	5.0	-	-
Factice	-	-	-	5.0
ETU	-	-	0.5	0.5
Pilcure MBTS	1.0	1.0	0.3	-
Pilcure TMT	1.0	1.0	-	0.5
Sulfur	1.0	1.0	-	-
TiO ₂ & Color	-	-	-	As req.
Typical Properties				
Rheometer (ODR) at 150°C				
Scorch time ts ₂ , min	2.85	2.15	3.0	2.5
Cure time t ₉₀ , min	3.75	3.75	22.0	12.5
Max. Torque, lb.in	104.0	144.0	53.0	72.5
Unaged physicals at optimum cure.				
Tensile Strength, MPa	14.0	18.0	14.5	10.0
Elongation at Break, %	400	230	350	600
300% Modulus, MPa	9.5	-	12.0	3.8
Hardness, IRHD	73	82	70	62
Tear Strength, kN/m	55	67	46	45

14. NR based compounds for Molded Products (Hardness 40 – 90 IRHD)						
Ingredients	Hardness, IRHD					
	40	50	60	70	80	90
NR (RSS 1)	100	100	100	100	100	65
Peptizer	0.1	0.1	0.1	0.1	0.1	0.1
High styrene resin	-	-	-	-	-	35
Zinc oxide	5.0	5.0	5.0	5.0	5.0	5.0
Stearic acid	1.5	1.5	1.5	1.5	1.5	1.5
Pilflex 13	0.5	0.5	0.5	0.5	0.5	0.5
Pilnox TDQ	1.0	1.0	1.0	1.0	1.0	1.0
N 330 black	5	10	10	40	55	45
China clay	-	35	35	-	-	-
Whiting	100	85	75	100	60	150
Naphthenic Oil	30	20	12	15	5	10
CI resin	2.0	2.0	2.0	2.0	2.0	2.0
Paraffin wax	1.0	1.0	1.0	1.0	1.0	1.0
Pilcure MBTS	1.3	1.3	1.3	1.3	1.3	1.0
Pilcure TMT	0.2	0.2	0.2	0.2	0.2	0.15
Sulfur	1.5	1.5	1.5	2.5	2.5	2.5
Typical Properties						
Rheometer (ODR) at 160°C						
Scorch time ts2, min	2.9	2.6	2.6	1.3	1.3	1.8
Cure time t'90, min	4.2	4.0	4.0	2.8	2.8	4.6
Max. Torque, lb.in	28.0	36.0	42.0	68.0	91.0	66.0
Unaged physical properties						
Tensile Strength, MPa	9.0	9.0	10.0	11.0	14.0	10.0
Elongation at Break, %	700	600	600	425	330	300
300% Modulus, MPa	1.8	2.2	3.0	6.3	12.0	10.0
Hardness, IRHD	39	50	59	69	80	89

15. NBR compounds for Molded Products (Hardness 60-80 IRHD)				16. CR compounds for Molded Products (Hardness 60-80 IRHD)			
Ingredients	Hardness, IRHD			Ingredients	Hardness, IRHD		
	60	70	80		60	70	80
NBR (Medium ACN)	100	100	100	CR (W type)	100	100	100
Zinc oxide	5.0	5.0	5.0	Light MgO	4.0	4.0	4.0
Stearic acid	1.5	1.5	1.5	Stearic acid	0.5	0.5	0.5
Pilflex 13	1.0	1.0	1.0	Pilflex 13	0.5	0.5	0.5
Pilnox TDQ	1.0	1.0	1.0	N 774 black	35	45	65
N 330 black	30	30	30	China clay	25	60	100
N 774 black	20	35	40	Aromatic oil	10	15	20
DOP	10	10	10	Paraffin wax	1.0	1.0	1.0
Cl resin	5.0	5.0	5.0	Cl resin	2.5	4.0	5.0
Paraffin wax	1.0	1.0	1.0	Pilcure MBTS	0.20	0.25	0.30
Aromatic oil	10	-	-	ETU	0.60	0.60	0.75
Pilcure MBTS	1.0	1.0	1.0	Zinc oxide	5.0	5.0	5.0
Pilcure TMT	1.0	1.0	1.0	-	-	-	-
Sulfur	1.0	1.0	1.0	-	-	-	-
Typical Properties				Typical Properties			
Rheometer (ODR) at 160°C				Rheometer (ODR) at 160°C			
Scorch time ts2, min	2.2	1.8	2.0	Scorch time ts2, min	2.0	2.25	2.25
Cure time t'90, min	4.2	3.7	4.0	Cure time t'90, min	13.5	13.75	19.25
Max. Torque, lb.in	45.0	71.0	73.0	Max. Torque, lb.in	57.0	62.0	71.0
Unaged physical properties				Unaged physical properties			
T.S. , MPa	11.5	16.0	15.5	T.S. , MPa	15.5	13.5	10.0
E.B. , %	450	375	375	E.B. , %	450	390	275
300% Mod., MPa	6.5	13.0	14.0	300% Mod., MPa	9.5	10.5	-
Hardness, IRHD	59	70	80	Hardness, IRHD	62	70	80
Tear Strength, kN/m	40	50	60	Tear Strength, kN/m	45	50	40

17. EPDM Compounds for Molded Products (Hardness 40-80 IRHD)					
Ingredients	Hardness, IRHD				
	40	50	60	70	80
EPDM (4.0-5.0 % ENB)	100	100	100	100	100
Brown Factice	25	-	-	-	-
Zinc Oxide	5	5	5		
Stearic Acid	1.0	1.0	1.0		
N 550 Black	-	80	100	100	100
N 774 Black	75	-	50	80	100
Naphthenic Oil	80	80	80	90	90
CI Resin	2.0	2.0	2.5	2.5	2.5
Pilcure MBT	1.5	1.5	1.5	1.5	1.5
Pilcure TMT	0.8	0.8	0.8	0.8	0.8
Pilcure ZDBC	2.5	2.5	2.5	2.5	2.5
Sulfur	2.0	2.0	2.0	2.0	2.0
Typical Properties					
Rheometer (ODR) at 160°C					
Scorch time ts2, min	1.7	1.6	1.5	1.63	1.5
Cure time t'90, min	12	11.0	10.0	11.0	11.0
Unaged physical properties					
T.S. , MPa	7.0	7.5	8.5	8.0	7.0
E.B. , %	450	350	210	190	160
Hardness, IRHD	41	52	62	72	80
Tear Strength, kN/m	20	25	30	25	20

18. Low Cost EPDM Compounds for Molded Products		
Ingredients	<u>1</u>	<u>2</u>
EPDM (4.9-5.0 % ENB)	100	100
Zinc Oxide	5	5
Stearic Acid	1.5	1.5
N 774 Carbon Black	30	30
Hard Clay	250	-
Ppt. Calcium Carbonate	-	250
Naphthenic Oil	100	100
DEG	2.0	2.0
Pilcure MBTS	1.0	1.0
Pilcure TMT	1.0	1.0
Pilcure ZDBC	2.0	2.0
Sulfur	2.5	2.5
Typical Properties		
Cure @ 160°C, Minutes	15	15
T.S. , MPa	8.5	8.0
E.B. , %	600	575
300% Mod., MPa	0.3	0.25
Hardness, IRHD	61	60

19. Low Compression Set EPDM Compound for Molded Products	
Ingredients	<u>1</u>
EPDM (4.9-5.0 % ENB)	100
Zinc Oxide	10
Zinc Stearate	1.0
Pilnox TDQ	1.0
N 774 Carbon Black	50
Paraffinic Oil	5
Di-Cup 40C	8.0
TAC 75	2.0
Typical Properties	
Press Cure @ 160°C, 20 Minutes	
T.S. , MPa	14.5
E.B. , %	220
Hardness, IRHD	67
Compression Set (25% Deflection)	
@ 100°C 24 hr, %	5.0
@ 125°C 24 hr	7.5
@ 150°C 24 hr	12.0

20. NR Based Rollers				21. NBR Based Rollers			
Ingredients	Textile	Paper	Ebonite Core	Ingredients	Rice Rollers	Food Grade Rollers	Printing Rollers
NR (RSS 1)	100	100	100	NBR (Medium ACN)	100	100	100
Peptizer	0.2	0.2	0.2	S	5.0	0.5	2.2
Zinc oxide	5.0	5.0	5.0	Zinc oxide	5.0	4.0	5.0
Stearic acid	2.0	2.0	2.0	Stearic acid	1.5	1.0	1.0
Pilnox SP	2.0	2.0	-	Pilnox SP	-	2.0	-
Pilnox TDQ	-	-	1.5	Pilnox TDQ	1.0	-	1.0
Ppt. Silica	20	35	60	Ppt. Silica	65	50	30
China clay	140	80	-	DEG	3.0	-	-
Whiting	-	-	20	China clay	-	50	10
Naphthenic oil	5.0	10.0	5.0	PF resin (Hexamine Modified)	20	-	-
Cl resin	5.0	5.0	-	DOP	5	-	30
Pilcure MBTS	-	-	2.5	Cl resin	-	3.0	-
Pilcure F	1.0	1.2	-	Factice	-	-	50
S	6.0	6.0	35	TiO ₂ & Color	As req.	As req.	As req.
TiO ₂ & Color	As req.	As req.	As req.	Pilcure CBS	1.2	-	-
Triethanol amine	-	-	1.0	Pilcure MBTS	0.2	-	1.5
Light MgO	-	-	10.0	Acc. TBzTD	-	3.5	-
-	-	-	-	Acc. DPG	-	-	0.3
Typical Properties				Typical Properties			
Rheometer (ODR) at 150°C				Rheometer (ODR) at 150°C			
ts ₂ , min	4.25	4.50	-	ts ₂ , min	3.6	2.4	-
t' ₉₀ , min	47.0	44.0	-	t' ₉₀ , min	24.0	15.0	25.0
MH _R , lb.in	80.0	84.0	-	MH _R , lb.in	150	-	-
Unaged physical properties				Unaged physical properties			
T.S. , MPa	9.0	10.5	14.5	T.S. , MPa	18.0	7.0	2.2
E.B. , %	325	400	300	E.B. , %	200	600	750
300% Mod., MPa	8.0	7.5	-	Hardness, IRHD	97	68	26
Hardness, IRHD	72	62	90	Abrasion Loss, mm ³	150	-	-

22. Misc. Rubber products						
Ingredients	Rice Polisher	Hot Water Bottles	I.B. Caps	Stereo Rubber	NR-30 Hardness	NR-40 Hardness
NR (RSS 1)	100	100	-	100	-	-
NR (PLC IX)	-	-	100	-	100	100
Zinc oxide	5.0	5.0	3.0	5.0	2.0	5.0
Stearic acid	1.0	1.0	1.0	1.0	1.0	2.0
Pilnox SP	1.0	2.0	1.0	1.0	1.0	1.0
Ppt. CaCO ₃	25	40	60	50	5	-
Ppt. BaSO ₄	-	-	40	50	-	-
China clay	-	40	-	-	-	-
Whiting	50	-	-	-	-	15
Naphthenic oil	20	6.0	-	-	4	-
Paraffinic oil	-	-	5.0	-	-	-
Factice	-	-	-	-	-	20
Paraffin wax	1.0	1.0	1.0	-	1.0	1.0
Pilcure F	1.3	1.2	-	1.5	1.0	1.0
Pilcure TMT	0.05	0.10	0.2	-	-	-
Pilcure ZDC	-	-	0.4	-	-	-
TiO ₂ & Color	As req.	As req.	As req.	As req.	As req.	As req.
Sulfur	1.5	1.5	1.5	3.0	1.5	2.5
Typical Properties						
Rheometer (ODR) at 140°C						
ts ₂ , min	6.0	7.0	4.0	-	-	-
t' ₉₀ , min	11.5	14.0	8.5	8.5	10	10
MH _R , lb.in	40.5	63.5	35.5	-	-	-
Unaged physical properties						
T.S. , MPa	15.0	19.7	12.5	-	250	220
E.B. , %	650	620	670	-	750	700
Hardness, IRHD	42	52	48	-	31	40
Tear Strength, kN/m	-	25.0	32.0	-	-	-
Abrasion Loss, mm ³	290	-	-	-	-	-

23. NR Latex based products - Gloves				
Material	Gloves			
	Surgical Disposable	Surgical Sterilizable	Examination	Industrial
60% NR latex (LA)	167	167	167	167
20% Stabilizer solution	5.0	5.0	5.0	5.0
50% Sulfur dispersion	2.0	-	2.0	4.0
50% Pilcure ZDC dispersion	1.0	4.0	2.0	2.0
50% Pilcure ZDBC dispersion	1.0	-	-	
50% Zinc oxide dispersion	1.0	4.0	1.5	5.0
50% China clay dispersion	-	-	-	40
50% Pilcure TMT dispersion	-	5.0	-	-
50% Pilnox SP emulsion	-	-	-	2.0
50% Pilnox 22M46 dispersion	2.0	2.0	2.0	1.0
10% Thiourea solution	-	10.0	-	-
33% Color dispersion	-	As req.	-	As req.
<i>Cure (Hot air at 110°C), min.</i>	30	30	20	30

24. NR Latex based products - Gloves			
Material	Household General purpose	Household Detergent resistant	Electricians
60% NR latex (LA)	167	167	167
20% Stabilizer solution	5.0	5.0	5.0
50% Sulfur dispersion	2.5	2.5	2.0
50% Pilcure ZDC dispersion	2.0	1.0	2.0
50% Zinc oxide dispersion	2.0	3.0	1.5
50% Pilcure ZMBT dispersion	-	1.5	-
50% Pilcure DTDM dispersion	-	2.0	-
20% Acc. DPG dispersion	-	6.0	-
50% Pilnox SP emulsion	2.0	2.0	2.0
50% Pilnox 22M46 dispersion	1.0	1.0	1.0
33% Color dispersion	As req.	As req.	As req.
<i>Cure (Hot air at 110°C), min.</i>	40	40	40

25. NR Latex based products				
Material	Feeding Bottle Teats	Toy Balloons	Latex Threads	
			General Purpose	Heat Resistant
60% NR latex (LA)	167	167	167	167
20% Stabilizer solution	5.0	5.0	5.0	5.0
50% Sulfur dispersion	2.0	1.0	3.5	-
50% Pilcure ZDC dispersion	2.0	1.5	-	-
40 % Zinc oxide dispersion	0.5	5.0	6.0	8.0
50% Pilnox SP emulsion	2.0	2.0	-	-
50% Pilnox 22M46 dispersion	-	-	3.0	4.0
50% Pilcure ZMBT dispersion	-	-	2.5	3.0
50% Pilcure ZDBC dispersion	-	-	0.5	1.0
50% Acc. DPTT dispersion	-	-	-	3.5
50% TiO ₂ & Color dispersion	-	As req.	As req.	As req.
<i>Cure (Hot air at 110°C), min.</i>	<i>20</i>	<i>30</i>	<i>30</i>	<i>30</i>

26. NR Latex based products...Cont.				
Material	Latex Foam	Coir Spray	Carpet backing	Cast Products
60% NR latex (LA)	167	167	167	167
Soft water for viscosity adjustments	-	As req.	-	-
50% Sulfur dispersion	4.0	5.0	4.0	2.0
20% Potassium Oleate solution	5.0	-	-	-
20% KOH solution	-	-	1.5	2.0
20% Emulsifying agent	-	8.0	-	-
20% Dispersing agent	-	-	3.0	0.2
50% Pilcure ZDC dispersion	2.0	2.0	2.0	1.0
50% Pilcure ZMBT dispersion	2.0	2.0	2.0	-
50% Pilnox SP emulsion	2.0	2.0	2.0	2.0
20% Pilnox TDQ dispersion	2.0	5.0	-	-
50% China clay dispersion	15	-	100	50-250
25% Aluminum sulfat	-	-	-	30-40
33% Color dispersion	As req.	-	-	-
50% Zinc oxide dispersion	10	6.0	7.5	2.0
20% Sodium silicofluoride dispersion	6.0	-	-	-
10% Thickener solution	-	-	-	10
<i>Cure (Hot air at 110°C), min.</i>	<i>30</i>	<i>30</i>	<i>30</i>	<i>30</i>

USEFUL INFORMATION



Elastomers: Comparative Properties

Properties	Natural Rubber	High Cis Poly isoprene	Styrene Butadiene Rubber	Poly-Butadiene Rubber	Ethylene Propylene Rubber	Butyl Rubber	Nitrile Rubber	Polychloroprene Rubber
ISO 1629 Designation	NR	IR	SBR	BR	EPM /EPDM	IIR	NBR	CR
ASTM-D2000 / SAE-J200	AA	AA	AA,BA	AA	BA ,CA , DA	AA, BA	BF, BG, BK, CH	BC, BE
Specific gravity	0.93	0.90-0.94	0.91-0.96	0.90-0.93	0.86-0.89	0.92-0.93	0.96-1.01	1.23
Operating temp. , °C	-45 to 70	-45 to 70	-28 to 80	-70 to 80	-35 to 120	-35 to 100	-25 to 120	-25 to 90
Glass transition temp. , °C	-72	-72	-50	-112	-55	-66	-20 to -45	-45
Hardness range, Sh A	30-98	30-98	35-95	45-80	30-95	35-95	35-98	35-90
Gum Tensile strength, MPa	> 25.0	> 25.0	< 6.0	< 3.0	< 7.0	< 10.5	< 7.0	< 20.0
Reinforced T.S. , MPa	> 25.0	> 25.0	< 20.0	< 20.0	< 18.0	< 18.0	< 21.0	< 22.0
Tear Strength	VG	VG	F-G	F	F	G	F	G
Comp. Set Resistance	G-VG	G	G	F	F-G	F	F-V	F-G
Resilience (Low temp.)	E	E	G	E+	G	P	F	G
Resilience (High temp.)	E	E	G	E	VG	VG	F	VG
Flame Resistance	P	P	P	P	P	P	P	G
Heat ageing Resistance	F	F	F-G	F	E+	VG	G-VG	G
Oxidation resistance	G	G	F	G	E+	E	G	G
Ozone Resistance	P	P	P	P	E+	E	P	G-VG
Sunlight ageing Resistance	P	P	P	P	E+	VG	P	VG
Electrical resistivity	E	E	E	E	E	E	F	F
Impermeability to gases	F-G	F-G	F	F-G	F	E+	G	F-G
Adhesion to metals	E	E	E	E	F	G	E	E
Adhesion to fabric	E	E	E	G	F	G	G	E
<u>Resistance to:</u>								
ASTM Oil No. 1	P	P	P	P	P	P	G	F-G
ASTM Oil No. 3	P	P	P	P	P	P	G	F
Oil and Gasoline	P	P	P	P	P	P	G	F
Lubricating Oils	P	P	P	P	P	P	VG	G
Vegetable Oils	P	P	P	P	P	P	E	G
Aliphatic hydrocarbons	P	P	P	P	P	P	E	F-G
Aromatic hydrocarbons	P	P	P	P	P	P	F-G	P-F
Halogenated hydrocarbons	P	P	P	P	P	P	F-G	P
Oxygenated solvents	G	G	G	G	VG-E	G-VG	P	F
Dilute acids	F-G	F-G	F-G	F-G	E	E	G	G
Concentrated acids	F-G	F-G	F-G	F-G	G	G	G	F
Alkali	F	F	F	F	G-E	E	G-E	F
Water	VG	VG	VG	VG	E	VG	G	G

Note: E+ = Outstanding, E = Excellent, VG = Very good, G = Good, F = Fair, P = Poor.



Elastomers: Comparative Properties....Cont.

Properties	Chlorosulfonated polyethylene	Poly Sulfide Rubber	Poly Urethane Rubber	Poly Acrylic Rubber	Epichlorohydrine Rubber	Silicon Rubber	Fluoro Silicon Rubber	Fluoro Carbon Rubber
ISO 1629 Designation	CM / CSM	TM	AU / EU	ACM	CO / ECO	MQ / VMO / PVMQ	FMQ / FVMQ	FKM
ASTM-D2000 / SAE-J200	CE	AK	BG	DF, DH	CH	FC,FE,GE	FK	HK
Specific gravity	1.1-1.16	1.28-1.34	1.03-1.24	1.03-1.10	1.24 -1.38	1.06-1.38	1.10-1.45	1.50-1.70
Operating temp. , °C	-10 to110	-45 to 90	-30 to 80	-20 to150	-25 to 130	-85 to 180	-50 to 200	-10 to 225
Glass transition temp. , °C	-25	-45	-35 to -55	-20 to -40	-26 to -45	-120	-70	-20 to -50
Hardness range, Sh A	35-95	25-80	15-98	40-95	40-90	25-90	25-90	55-95
Gum Tensile strength, MPa	< 18.0	< 3.5	> 20.0	< 2.0	< 6.0	< 3.0	> 10.0	< 12.0
Reinforced T.S. , MPa	< 20.0	< 11.0	> 22.0	< 15.5	< 15.0	< 10.0	< 10.0	< 15.0
Tear Strength	G	P-F	VG	P-F	F-G	P	P	F
Comp. Set Resistance	F-G	P-F	VG	G	F-G	G-VG	G	G-VG
Resilience (Low temp.)	G	F	G	P	F	E	E	F
Resilience (High temp.)	VG	G	G	P	F	E	E	G
Flame Resistance	G	P	F-G	P	F-G	F-G	F-G	G-VG
Heat ageing Resistance	G	VG	G	E	VG	E	F	E+
Oxidation resistance	G	VG	VG	E	G	E+	E+	E+
Ozone Resistance	G-VG	VG	E	E	E	E	E	E+
Sunlight ageing Resistance	VG	VG	VG	G	G	E	E	E+
Electrical resistivity	F	G	F	F	F	E	G	G
Impermeability to gases	F-G	E	P-F	F-G	E	P-F	P-F	G-VG
Adhesion to metals	E	G	E	VG	F-G	E	E	F-G
Adhesion to fabric	E	G	G	VG	F-G	E	E	G
<u>Resistance to:</u>								
ASTM Oil No. 1	F-G	G	G	G	G	F-G	G-VG	VG-E
ASTM Oil No. 3	F	G	G	G	G	F-G	VG-E	VG-E
Oil and Gasoline	F	G	G	F	E	F	E	E
Lubricating Oils	G	VG	G	E	E	F	E	E
Vegetable Oils	G	G-E	F	G	E	G	E	E
Aliphatic hydrocarbons	F-G	E	G	E	VG-E	P-F	E	E
Aromatic hydrocarbons	P-F	VG-E	P-F	P-F	G	P-F	VG-E	E
Halogenated hydrocarbons	P	G	F	P	VG-E	F	G	G
Oxygenated solvents	F	VG-E	P	P	P-F	G	P	P
Dilute acids	G	G	F	F	F-G	E	E	G-E
Concentrated acids	F	P-F	P	P	F	F	F	E
Alkali	F	G	P	P	F	F	F	P-F
Water	G	F	P	G	G	E	E	VG

Note: E+ = Outstanding, E = Excellent, VG = Very good, G = Good, F = Fair, P = Poor.

Carbon Blacks used for Rubber Compounding (Basis of classification) :

The first character in the ASTM D 1765 nomenclature system indicates the effect of the cure rate and letter 'S' indicates slower cure rate. The second character is a digit which indicates average surface area of the carbon black as measured by 'Nitrogen surface area (NSA)' divided into 10 arbitrary groups as follows. The third and fourth characters are arbitrarily assigned digits.

Group Number	Avg. Nitrogen surface area, m ² /g	Typical avg. particle size, nm
0	> 150	1 - 10
1	121 - 150	11 - 19
2	100 - 120	20 - 25
3	70 - 99	26 -30
4	50 - 69	31 - 39
5	40 - 49	40 -48
6	33 - 39	49 - 60
7	21 - 32	61 - 100
8	11 - 20	101 - 200
9	0 - 10	201 - 500

Test Methods and their significance

Property	ASTM Test Method	Significance
Particle Size	Iodine Adsorption (D 1510) Nitrogen Adsorption (D 3037)	- Iodine & Nitrogen adsorption tests are related to surface area but include pores area on carbon black surface.
	CTAB Adsorption (D 3765)	- Measures surface area available for rubber and excludes pores area on the carbon black surface
Structure	DBP absorption No. (D2414), Compressed DBP (D3493)	- Measures both primary and secondary structures. Structure of carbon black is Related to processing & vulcanizate properties of rubber compounds.
Aggregate Size	Tint Strength (D 3265)	- Indication of particle size, structure and aggregate size distribution. May reflect differences other than particle size.
Surface Activity	Toluene discoloration (D 1618)	- Estimates toluene soluble discoloring residues present in the carbon black sample.
Pellet Properties	Crush Strength (D 3313)	- Higher crush strength may affect the quality of dispersion.
	Fines Content (D 1508)	- Related to bulk flowability, dustiness & quality of dispersion in rubber compounds.
	Pour Density (D 1513)	- Related to weight- to- volume relationship for automatic batch loading system.
	Pellet attrition (D 4324)	- Related to pellet break down or attrition created during handling and shipment.
	Pellet size distribution (D 1511)	- Related to quality of dispersion in rubber compound and handling properties of carbon black.
Moisture Content	Heating loss (D 1509)	- Moisture content is related to the surface area of the black, humidity, temperature and time of exposure to humidity.
pH Value	pH value (D 1512)	- Related to influence on cure rate of rubber compound.
Non-black content	Sieve Residue (D 1514)	- Related to dirt content etc. which affects the surface finish and quality of rubber goods.
Non-black content after combustion	Ash content (D 1506)	- Related to inorganic impurities generally coming from carbon black feed stock / process water used during carbon black manufacturing.
Sulfur Content	Sulfur content (D 1619)	- Total sulfur content in carbon black is useful for rubber compound modification with respect to sulfur levels.

Carbon Blacks: Summary of Typical Properties							
Common Name	ASTM Designation	Iodine Adsorption mg/g	Nitrogen Adsorption mg/g	CTAB Adsorption mg/g	DBP Absorption cm ³ /100g	Compre-ssed DBP Absorption cm ³ /100g	300% Mod (diff. from IFB#6) MPa
SAF	N 110	145	143	126	113	98	-
ISAF-LS	N 210	118	120	113	78	75	- 2.8
ISAF-HM	N 220	121	119	111	114	100	+ 0.9
ISAF-LM	N 231	121	117	108	92	86	- 1.4
-	N 234	120	126	119	125	100	+ 2.3
GPT	N 299	106	106	104	124	106	+ 3.3
HAF-LS	N 326	82	84	83	72	69	- 1.7
HAF	N 330	82	83	83	102	88	+ 1.7
-	N 339	90	96	95	120	101	+ 3.4
HAF-HS	N 347	90	90	88	124	100	+ 3.1
-	N 351	68	73	74	120	97	+ 3.7
-	N 358	84	87	88	150	112	+ 5.4
-	N 375	90	100	96	114	97	+ 2.9
FEF-LS	N 539	43	41	41	111	84	+ 1.4
FEF	N 550	43	42	42	121	88	+ 1.7
GPF-HS	N 650	36	38	38	122	87	+ 1.7
GPF	N 660	36	35	35	90	75	- 0.1
SRF-LS	N 762	27	28	27	65	57	- 2.6
SRF-HS	N 765	31	31	33	115	86	+ 1.2
SRF-HM	N 774	29	29	29	72	62	- 1.4

Tread grade Carbon Blacks: Summary of Typical Properties in NR-BR Tread compounds.								
Base Formulation: NR-60, BR-40, Carbon Black-60, Aromatic Oil-25, ZnO-4, St.acid-2.5, 6PPD-2, MBS-1.2, S-2.3.								
ASTM Designation	T.S., MPa	E.B., %	300% Mod. MPa	Tear Energy., kJ/m ²	Goodrich Heat Buildup, °C	Fatigue Life, kc	Tan δ X 1000	Resilience %
N 220	22.3	560	9.4	26.5	51.5	140.8	171	62.0
N 234	22.5	540	10.1	18.1	54.7	155.1	179	61.0
N 299	21.7	570	10.6	15.1	51.7	163.0	170	63.2
N 330	21.4	560	9.2	12.2	45.0	169.0	148	65.7
N 339	22.0	500	11.7	15.1	51.6	174.8	162	63.6
N 347	21.7	510	11.0	13.6	50.7	188.1	158	64.6
N 351	20.5	500	11.0	14.9	45.0	123.7	143	66.2
N 375	22.6	550	9.9	21.9	49.7	266.2	161	63.5

Non-Black Fillers: Summary of Typical Properties							
<u>Non-Black Fillers</u>	<u>Properties</u>						
	Specific Gravity	Avg. Particle Size, nm	Surface Area m ² /g	pH	Ignition loss, %	Moisture at 105°C %	Oil Absorption g / 100g
<u>Silica's</u>							
Anhyd. fumed silica, very fine	2.1	8	300-380	3.9-4.0	< 1.0	1.5	200
Anhyd. fumed silica, fine	2.1	15	200	3.9	< 1.0	1.0	150
Ppt. Hydrated silica, very fine	1.95	16	170	5.7	6.0	6.0	240
Ppt. Hydrated silica	2.05	20	150	6.7	4.0	6.0	200
Amorphous ground silica	1.93-2.0	40-100	40-60	7.0-9.5	4.0-6.0	6.0	160-165
<u>Silicates</u>							
Ppt. Calcium silicate	2.1	85	35	10.0	7.0	6.0	110
Sodium Aluminum silicate	2.1	30	72	10.0	6.0	4.0	130
Aluminum silicate	2.1	25	130	10.0	5.0	5.0	140
<u>China clays</u>							
Soft China clay	2.62	1500	14	4.1	13.8	< 1.0	29
Hard China clay	2.62	300	22	4.1	13.8	< 1.0	45
Calcined China clay	2.68	1200	8	5.2	0.6	0.5	52
Mercaptosilane treated clay	2.4	25	32	6.5	-	1.0	35
<u>Precipitated Calcium carbonates</u>							
Colloidal calcium carbonate	2.42	50	74	-	-	-	-
Calcium carbonate, fine	2.71	60	28	9.4	< 1.0	< 1.0	50
Calcium carbonate, medium	2.71	600-700	8.0-8.5	9.4	< 1.0	< 1.0	30-60
<u>Mineral Calcium carbonates</u>							
Dry ground, air floated	2.71	14000	0.9	9.4	< 1.0	< 1.0	5-6
Wet ground, medium	2.71	5000	1.2	9.4	< 1.0	< 1.0	5-6
Wet ground, fine	2.71	2500	2.5	9.4	< 1.0	< 1.0	14-16
<u>Metallic oxides</u>							
Aluminum oxide	3.7	20	100	4.5	-	-	-
Titanium dioxide	3.8	30	50	3.5	-	-	-
Zinc oxide, American process (Nodular)	5.6	270	4.0	-	-	-	14
Zinc oxide, French process (Nodular)	5.6	140	8.0	-	-	-	12
<u>Mineral ground talc's</u>							
Calcium silicates	2.9	6000	1.3	10	-	-	-
Magnesium silicates	2.8	1500	17	9.3	5.5	1.0	80

Non-Black Fillers: In NR based compound.										
Base formulation: NR-100, ZnO-5, St.acid-3, TMQ-1, MBTS-1.0, TMTD-0.1, S-2.75.										
Filler, (pbw)	ML ₁₊₄ at 100°C units	Opt. cure @141°C min	T.S. MPa	E.B. %	300% Mod MPa	Hard-Ness Sh A	Tear strength kN/m	Comp. Set %	Abrasion Index (D 1630)	Resilience %
<u>Gum Rubber</u>	22.0	15.0	25.0	700	2.1	42	-	-	-	-
<u>Ppt. Silica</u>										
40	63.0	10.0	27.5	650	5.5	59	35.7	30.0	56	75
60	78.0	10.0	25.5	600	9.0	74	50.5	35.0	60	70
80	87.0	10.0	24.0	500	13.0	80	40.0	38.0	80	54
<u>Al. Silicate</u>										
40	23.0	10.0	22.8	675	3.5	50	12.0	13	45	69
60	64.0	10.0	19.5	625	5.2	53	13.5	16	38	66
80	63.0	10.0	18.0	550	7.7	63	13.5	34	58	66
<u>Ppt. CaCO₃</u>										
80	37	15	19.0	590	5.0	52	13.0	18	42	76
130	45	15	15.0	540	6.0	58	13.0	21	32	74
<u>Hard Clay</u>										
80	30	25	20.0	500	9.5	55	14.0	45	55	68.5
130	32	25	18.5	375	15.0	65	18.5	48	44	68
<u>Soft Clay</u>										
80	35	25	18.0	525	7.0	50	13.0	32	45	76
130	40	25	16.5	400	12.0	57	17.5	38	37	78
<u>Gr. Whiting</u>										
80	30	20	15.0	650	2.0	50	12.0	18	24	80.5
130	38	15	10.5	600	1.9	55	12.5	20	22	80

Effect of Fillers on Processing and Vulcanizate Properties of Rubber Compounds					
<u>Carbon Blacks</u>				<u>Mineral Fillers</u>	
Property	Effect	Particle size	Structure	Property	Fillers
		Fine → Coarse	Low → High		
Processing	Improves	→	→←	Good Reinforcement	Silica, Hard clay, Platy talc.
Reinforcement	Increases	←	→	Good Mill Mixing	Silicates, Calcined clay, Platy talc.
Optimum Loading	Increases	→	→	Good Extrusion	Silica, Calcined clay, Platy talc.
Mooney Viscosity	Increases	←	→	Good Internal Mixing	All except Whiting.
Modulus	Increases	←	→	Lowest Viscosity	Platy Talc, Whiting.
Hardness	Increases	←	→	Highest Hardness	Silica, Silicates
Mooney Scorch	Increases	→	←	Highest Modulus	Silica, Platy talc.
E.B., %	Increases	→	←	Highest Tear	Silica, Silicates.
Resilience	Increases	→	←	Low Compression Set	Soft clay, whiting
Compound Cost	Increases	←	←	Good water resistance	Calcined clay, Soft clay, Platy talc

Estimation of Shore A Hardness of Rubber Compounds	
Procedure: To the base polymer hardness; add/subtract hardness change for each filler or softener.	
<u>Material</u>	<u>Hardness, Shore A</u>
<u>Base polymers</u>	
CR & NBR	44
NR, SBR, BR	40
Hot polymerized Synthetic Rubbers	37
Butyl	35
25 parts Oil Extended Synthetic Rubbers	31
37.5 parts Oil Extended Synthetic Rubbers	26
<u>Fillers / Softeners</u>	<u>Hardness change per phr loading, Shore A</u>
FEF, HAF, Channel Blacks	+ 0.5
ISAF	+ 0.5 and add 2.0
SAF	+ 0.5 and add 4.0
SRF	+ 0.35
Thermal Black & Hard clay	+ 0.25
Whiting (in NR)	+ 0.15
Factice & Mineral Rubber	- 0.20
Most Liquid Softeners	- 0.5

Typical Properties of Rubber Processing Oils			
<u>Properties</u>	<u>Paraffinic Oil</u>	<u>Naphthenic Oil</u>	<u>Aromatic Oil</u>
Aniline Point, °C	96	75	38.2
Specific gravity at 15°C	0.861	0.932	1.018
Viscosity at 40°C, cSt	19.7	110.2	763.5
Viscosity at 100°C, cSt	4.0	8.0	17.0
Viscosity Gravity constant (VGC)	0.809	0.885	0.980
Refractive Index	1.4751	1.5167	1.5804
<u>Carbon Type analysis</u>			
C _A , %	3.5	21.0	45.0
C _N , %	31.0	37.0	18.0
C _P , %	65.5	42.0	37.0
<u>Molecular Type analysis, weight %</u>			
Asphaltenes	0	0	0
Polar compounds	0.4	2.8	7.8
Aromatics	12.1	42.8	80.0
Saturates	87.5	54.4	12.2



Effect of Accelerator Dosage Variations on the Properties of NR based compound.										
Base Formulation: NR-100, ZnO-5, St.acid-2, TMQ-0.5, 6PPD-0.5, N 330 Black-50, Aromatic Oil-5, Sulfur-2.5, Accelerator- As given below.										
Accelerator	phr	MS at 121°C		Rheometer at 150°C			Unaged physical properties at OCT			
		t ₅ , min	t ₃₅ , min	t _{S2} , min	t' ₉₀ , min	MH _R , lb.in	T.S. MPa	E.B. %	300%Mod MPa	Hardness Sh A
MBT	0.5	10.08	13.88	2.15	14.30	66.0	26.3	600	10.2	60
	1.0	7.80	10.48	1.80	9.20	71.0	26.6	590	10.1	61
	1.5	7.10	9.80	1.70	7.50	73.0	26.5	600	10.2	62
MBTS	0.5	14.48	19.00	2.70	13.60	68.0	27.7	610	10.3	62
	1.0	12.48	16.48	2.50	10.00	76.0	29.0	600	10.7	64
	1.5	11.00	15.00	2.50	8.50	80.6	29.2	600	11.4	65
ZMBT	0.5	10.80	16.48	2.40	14.50	62.0	24.4	570	9.3	61
	1.0	9.08	12.64	2.00	10.90	68.0	27.0	570	10.1	62
	1.5	8.72	11.72	1.80	8.75	70.0	29.0	580	11.4	62
F	0.5	13.53	15.64	2.30	12.40	76.0	29.6	540	13.0	65
	1.0	10.16	12.88	2.07	8.10	90.0	30.1	520	14.9	67
	1.5	8.32	10.80	2.00	6.90	99.6	30.5	510	15.8	69
CBS	0.5	25.00	28.48	3.50	12.85	77.0	29.5	600	12.0	66
	1.0	25.48	29.00	3.90	8.90	92.0	31.2	570	14.5	70
	1.5	25.00	28.00	4.00	7.85	102.4	29.2	490	16.7	73
TBBS	0.5	31.00	35.40	3.40	13.20	86.0	28.4	530	12.7	67
	1.0	28.48	33.00	4.30	10.45	101.0	30.3	530	15.5	72
	1.5	28.00	32.00	4.60	9.45	111.6	29.5	480	17.8	75
MBS	0.5	28.48	35.00	2.90	13.80	75.4	29.0	590	12.5	65
	1.0	34.48	41.30	3.30	10.80	92.0	30.0	540	14.8	68
	1.5	34.00	40.48	3.60	9.95	100.0	30.0	510	16.4	70
DCBS	0.5	41.00	54.50	3.70	21.20	73.4	28.3	580	11.0	63
	1.0	33.00	43.00	3.70	17.20	88.4	28.5	560	12.8	65
	1.5	30.00	38.50	3.60	14.90	95.4	29.5	540	13.9	67
TMTD	0.5	6.64	7.64	2.00	4.23	104.0	31.0	530	15.9	67
	1.0	5.40	6.72	1.70	3.40	113.0	26.8	430	17.7	72
	1.5	4.80	6.08	1.60	3.25	120.0	23.1	340	20.0	75
ZDEC	0.5	3.56	4.48	1.05	4.55	82.0	29.7	590	13.3	63
	1.0	2.72	3.48	1.00	3.05	89.0	29.9	540	15.7	65
	1.5	2.08	2.88	0.80	2.45	94.0	29.1	500	16.4	68
ZDBC	0.5	5.08	6.32	1.40	5.80	73.6	29.8	590	12.5	62
	1.0	4.0	4.8	1.15	3.70	81.0	29.9	570	13.5	64
	1.5	3.24	4.16	1.00	3.10	86.0	29.6	540	14.6	67

Effect of Accelerator Dosage Variations on the Properties of SBR based compound.										
Base Formulation: SBR 1502-100, ZnO-3, St.acid-1, TMQ-0.5, 6PPD-0.5, N 330 Black-50, Sulfur-1.75, Accelerator- As given below.										
Accelerator	phr	MS at 121°C		Rheometer at 150°C			Unaged physical properties at OCT			
		t ₅ , min	t ₃₅ , min	t _{S2} , min	t' ₉₀ , min	MH _R , lb.in	T.S. MPa	E.B. %	300%Mod MPa	Hardness Sh A
MBT	0.5	34.50	55.00	5.42	41.34	83.2	22.6	650	8.6	65
	1.0	26.00	40.50	4.32	35.06	94.8	25.0	620	10.0	66
	1.5	20.00	35.00	4.04	32.19	98.4	22.5	500	11.5	68
MBTS	0.5	26.00	55.50	4.33	40.94	87.9	29.0	730	10.2	65
	1.0	19.50	29.00	3.52	28.97	104.5	29.0	620	12.0	66
	1.5	17.00	25.00	3.32	25.97	109.4	25.0	450	16.0	68
ZMBT	0.5	35.0	57.0	6.68	43.52	78.5	24.0	740	7.5	64
	1.0	28.0	44.5	5.35	36.57	90.8	28.0	650	10.5	66
	1.5	24.50	39.00	4.72	33.27	95.7	28.0	640	11.4	68
F	0.5	24.00	42.00	4.22	32.15	94.9	24.0	500	12.5	67
	1.0	16.00	23.00	3.37	15.16	109.8	23.0	450	15.0	68
	1.5	14.00	18.50	2.84	10.89	121.0	20.7	420	13.5	69
CBS	0.5	36.00	56.00	6.42	33.65	83.9	27.4	620	10.4	64
	1.0	33.00	40.50	5.78	17.07	108.2	30.3	610	12.9	67
	1.5	31.50	38.00	5.32	12.77	118.4	29.0	520	15.4	69
TBBS	0.5	37.50	54.00	6.63	35.62	99.6	27.0	540	13.2	68
	1.0	32.50	46.50	5.53	18.07	115.7	28.5	450	18.3	68
	1.5	28.00	36.30	5.08	13.43	122.4	29.1	420	20.5	69
MBS	0.5	60.00	76.00	8.22	37.13	98.5	29.0	600	12.9	67
	1.0	48.50	57.00	7.82	21.13	115.5	30.4	560	15.5	68
	1.5	42.50	50.50	7.27	16.92	127.3	30.0	470	18.6	70
DCBS	0.5	75.00	105.00	9.82	41.50	91.3	25.0	540	10.8	65
	1.0	62.00	86.00	8.60	32.26	101.4	24.3	580	10.6	65
	1.5	56.00	77.00	7.70	23.57	111.1	25.6	540	12.5	66
TMTD	0.5	10.80	12.50	2.88	8.75	106.5	25.8	520	17.7	71
	1.0	8.00	10.60	2.43	7.50	117.6	24.0	310	23.2	73
	1.5	7.00	9.00	2.00	6.75	126.0	19.5	200	-	77
ZDEC	0.5	13.40	17.40	2.82	12.53	109.4	20.0	400	13.6	67
	1.0	9.40	13.40	2.32	10.32	109.5	19.0	330	16.0	67
	1.5	8.20	11.70	2.07	9.58	128.1	17.5	290	-	69
ZDBC	0.5	16.70	23.50	3.42	16.57	93.1	21.0	450	11.5	67
	1.0	14.50	20.40	3.16	15.34	99.9	22.3	460	13.0	68
	1.5	10.50	15.20	2.37	12.44	112.4	19.6	350	16.2	70

Effect of Accelerator Dosage Variations on the Properties of NBR based compound.										
Base Formulation: NBR (Med ACN)-100, ZnO-3, St.acid-1, TMQ-0.5, 6PPD-0.5, N 774 Black-50, Sulfur-1.5, Accelerator- As given below.										
Accelerator	phr	MS at 121°C		Rheometer at 150°C			Unaged physical properties at OCT			
		t ₅ , min	t ₃₅ , min	t _{S2} , min	t' ₉₀ , min	MHR, lb.in	T.S. MPa	E.B. %	300%Mod MPa	Hardness Sh A
MBT	0.5	19.50	30.50	3.92	26.98	51.1	17.8	770	6.2	62
	1.0	11.50	17.50	2.83	22.10	53.8	17.6	700	6.6	63
	1.5	8.50	12.50	2.18	19.98	56.1	17.7	680	6.9	64
MBTS	0.5	41.00	59.00	6.30	29.50	53.1	18.2	740	6.6	63
	1.0	36.00	46.00	5.57	19.32	56.5	19.3	710	7.1	64
	1.5	31.00	41.50	5.28	14.57	60.5	19.3	670	8.4	65
ZMBT	0.5	25.50	39.00	4.95	31.05	51.8	17.8	790	5.8	61
	1.0	20.00	27.50	3.82	22.13	54.6	18.3	770	6.6	63
	1.5	16.00	22.00	3.37	18.75	57.0	19.1	760	6.7	63
F	0.5	16.50	22.50	3.35	29.68	67.4	20.1	610	8.9	65
	1.0	11.50	14.00	2.58	24.30	75.1	17.1	490	10.4	67
	1.5	10.50	13.00	2.33	19.0	79.3	17.0	450	11.7	68
CBS	0.5	33.50	39.50	5.85	24.15	63.2	19.2	590	8.8	65
	1.0	30.50	34.00	5.33	14.40	69.2	19.1	560	9.7	66
	1.5	28.50	32.00	5.18	11.35	81.4	17.5	460	11.9	68
TBBS	0.5	37.00	43.50	6.37	29.73	71.2	19.5	590	9.6	66
	1.0	37.00	42.00	6.33	18.35	78.6	19.5	500	11.3	68
	1.5	36.50	43.00	6.33	14.90	83.9	20.4	440	13.5	70
MBS	0.5	43.00	51.00	7.87	26.33	65.1	18.9	620	8.7	65
	1.0	36.00	41.50	6.93	19.17	73.0	20.8	550	10.8	67
	1.5	32.00	37.50	6.47	14.67	78.6	19.9	480	12.0	68
TMTM	0.5	44.50	48.50	6.78	13.90	76.7	15.3	355	13.3	69
	1.0	48.00	53.50	7.05	14.25	82.9	16.4	330	15.0	72
	1.5	49.00	56.50	7.22	14.80	88.2	17.6	320	16.1	73
TMTD	0.5	22.00	25.00	5.28	13.00	85.2	17.1	380	14.1	71
	1.0	16.50	21.50	3.08	12.52	93.9	16.0	315	15.8	72
	1.5	13.50	18.50	2.75	12.40	99.5	15.6	240	-	73
ZDEC	0.5	10.00	12.00	2.43	15.22	74.9	15.8	415	11.8	68
	1.0	7.50	8.50	1.75	11.95	77.1	16.1	390	12.2	68
	1.5	6.00	7.00	1.57	10.27	78.2	15.4	360	12.7	69
ZDBC	0.5	14.00	17.50	3.17	18.40	66.7	16.9	515	9.8	66
	1.0	10.50	12.00	2.43	15.30	68.9	16.9	500	10.2	67
	1.5	9.00	10.00	2.03	13.25	69.8	16.8	470	10.4	67

EPDM (Medium ENB) Cure systems				
Base Compound: EPDM-100, ZnO-5, Stearic acid-1, N 330 Black-80, Naphthenic Oil-50, Curatives- As follows				
Compounds	A (Control)	B (Non Blooming)	C (Non Blooming & Nitrosamine free)	D (Non Blooming & Nitrosamine free)
Pilcure MBT	0.5	-	-	-
Pilcure CBS	-	1.0	1.0	2.5
Pilcure ZDBC	-	1.25	-	-
Pilcure TMT	1.0	0.5	-	-
Accelerator DPG	-	-	0.5	0.5
Sulfur	1.5	1.5	1.5	1.5
Properties:				
<u>Mooney Scorch at 121°C</u>				
Scorch time t ₅ , min	11.5	13.3	23.5	23.5
Cure time t ₃₅ , min	17.0	17.3	31.0	32.5
<u>Rheometer (MDR) at 160°C</u>				
Scorch time tS ₁ , min	1.44	1.59	2.08	2.48
Cure time t'90, min	10.78	8.29	20.9	13.68
Maximum Torque, dN.m	18.57	17.68	16.47	17.95
<u>Unaged Physical Properties</u>				
Tensile Strength, MPa	14.2	14.6	14.5	14.2
Elongation at Break, %	490	530	560	490
300% Modulus, MPa	7.7	7.3	6.3	6.8
Hardness, Shore A	63	63	60	62
Comp. Set (RT – 72 hr), %	8.5	8.3	14.0	12.0

Capacities of Mixing Mills			Capacities of Refiner Mills & Cracker Mills		
Roll Size, inch Diameter x Length	Approx. Batch Wt. S.g. = 1.0, kg	Drive Motor HP	Roll Size, inch Diameter x Length	Approx. Output S.g. = 1.0, kg / hr	Drive Motor HP
6 x 13	0.5 – 0.9	7.5	<u>Refiner Mills</u>		
8 x 16	1.1 – 1.8	10 - 15	14 – 17 x 24	30	50
10 x 20	2.3 – 3.6	15 - 20	17 – 20 x 28	50	60
12 x 24	4.5 – 8.2	30 – 40	21 – 24 x 36	115	120
14 x 30	9.1 – 13.6	40 – 50	<u>Cracker Mills</u>		
16 x 42	13.6 – 22.7	70 - 75	18 x 28	400 - 500	100
18 x 48	20.4 – 31.7	75 – 100	22 x 32	600 - 800	175
22 x 60	34.0 – 56.7	125 – 150	26 x 38	1000 - 1200	215
24 x 72	56.7 – 90.7	150 – 200	<u>Mold Shrinkage calculations for rubber Mold Design.</u>		
26 x 84	68.0 – 113.4	150 – 200	% Shrinkage = [0.0205-(100-X) M] x ΔT		
28 x 84	79.4 – 136.0	200 - 250	where,		
Source: Farrel.			X = Rubber Content by volume (include oil, factice etc.)		
			ΔT = Difference between curing temperature & room temperature in °C		
			M = Constant depending on filler (Usually, 0.00025 – 0.00030)		

Capacities: Banbury Mixers						
Banbury Mixer	Mixer Chamber Net Volume, ltr	Approx. Batch Wt. kg	Mixing Speed Range, RPM	Torque rating Compact Drive kW / RPM	Torque rating Uni Drive kW / RPM	Approx. Machine Weight, MT
F 50	50	50	40 - 120	2.2	4.6	13.2
F 80	80	60	30 - 105	3.7	6.3	16.1
F 120	120	90	30 - 90	5.6	9.0	19.5
F 160	160	120	20 - 80	7.5	12.0	30.2
F 200	200	165	20 - 60	8.9	12.7	30.5
F 270	270	202	20 - 60	13.1	24.6	43.0
F 370	414	310	20 - 60	-	37.3	54.0
F 620	672	500	20 - 50	-	52.2	110.5

Source: Farrel

Typical Data : Hot Feed Extruders					
Extruder Size (diameter), mm	Length to Diameter Ratio	Drive Motor, kW	Screw Speed, RPM	Maximum Output kg / hr	Max. advisable Die Diameter mm
60	6 : 1	8.5	12 - 70	45 - 100	25
90	6 : 1	15.5	9 - 54	100 - 320	50
120	6 : 1	27.0	10 - 44	200 - 640	75
150	6 : 1	44.0	9 - 38	340 - 1000	100
200	6 : 1	58.0	7 - 31	500 - 1600	140
250	6 : 1	75.0	6 - 27	700 - 2200	175
300	6 : 1	100.0	6 - 24	1000 - 3000	210

Typical Data : Cold Feed Extruders			
Extruder Size (diameter), mm	Length to Diameter Ratio	Drive Motor, kW	Max. advisable Die Diameter, mm
60	10 : 1	14 - 19	25
90	12 : 1	32 - 44	50
120	14 : 1	55 - 75	75
150	16 : 1	130	100
200	18 : 1	270	140
250	18 : 1	425	175

Sieve Sizes Comparison					
British Standard		U.S. Standard		German Standard	
Mesh Size Meshes / Inch	Mesh Width micron	Mesh Size Meshes / Inch	Mesh Width micron	Mesh Size Meshes / Inch	Mesh Width micron
300	53	400	37	100	60
240	66	325	44	80	75
200	76	270	53	70	90
150	104	230	62	60	100
120	124	200	74	50	120
100	152	140	105	40	150
60	251	100	149	30	200
44	353	60	250	20	300
30	500	40	420	16	400
16	1003	30	590	8	750
10	1676	20	840	6	1000
8	2057	10	2000	5	1200
7	2411	8	2380	4	1500

Selected Conversion Factors			
Acceleration	$m/s^2 \times 0.3048 = ft/s^2$		$kg \times 9.842 \times 10^{-4} = ton$
Adhesion, Peel	$N/m \times 0.025 = kgf/2.5\ cm$	Mass	$kg \times 2.2046 = lb$
Adhesion, Tensile	$MPa \times 0.0069 = lb/in^2$		$kg \times 3.5274 = oz$
Angle	$rad \times 0.017 = deg$	Moment of force	$N.m \times 0.113 = lbf.in$
Area	$m^2 \times 0.040 = acre$		$N.m \times 1.356 = lbf.ft$
	$m^2 \times 0.8361 = yd^2$	$kW \times 1.341 = hp$	
	$m^2 \times 0.0929 = ft^2$	$kW \times 56.92 = btu/min$	
Density	$kg/m^3 \times 16.02 = lb/ft^3$	Power	$kW \times 14.34 = kcal/min$
	$kg/m^3 \times 1000 = g/cm^3$		$kWh \times 860 = kcal$
	$kg/m^3 \times 119.8 = lb/gal$		$kWh \times 3.413 \times 10^3 = btu$
Energy	$J \times 10^7 = erg$	Pressure	$Pa \times 10^{-5} = bar$
	$J \times 2.389 \times 10^{-4} = kcal$		$Pa \times 9.87 \times 10^{-6} = atm$
	$J \times 2.78 \times 10^{-7} = kWh$		$Pa = N/m^2$
	$J \times 9.486 \times 10^{-4} = btu$		$atm \times 1.0333 = kg/cm^2$
Force	$N \times 9.81 = kgf$	Tear strength	$kN/m \times 1.02 = kgf/cm$
	$N \times 4.45 = lbf$	Tensile Strength & Modulus	$MPa \times 10.19 = kgf/cm^2$
	$N \times 10^5 = dyn$		$N/mm^2 \times 10.19 = kgf/cm^2$
	$N \times 1.02 \times 10^{-4} = Mp$	Temperature	$^{\circ}K = ^{\circ}C + 273.15$
	$N \times 102 = p$		$^{\circ}F = 1.8 \times ^{\circ}K - 459.7$
Length	$m \times 5.4 \times 10^{-4} = nau.\ mile$	Viscosity-Dynamic	$^{\circ}F = 1.8 \times ^{\circ}C + 32$
	$M \times 6.214 \times 10^{-4} = mile$		$^{\circ}C = (^{\circ}F - 32) \times 0.556$
	$m \times 1.094 = yd$	Viscosity-Kinematic	$MPa.s = cp\ (centi\ poise)$
	$m \times 3.281 = ft$		$S\ (Stocks) = m^2/s \times 10^{-4}$
	$m \times 39.37 = in$	Volume	$M^3 \times 264.2 = gal\ (US, liquid)$

Specific Gravity of Compounding Materials					
<u>Materials</u>	<u>Typical Sp.Gr.</u>	<u>Materials</u>	<u>Typical Sp.Gr.</u>	<u>Materials</u>	<u>Typical Sp.Gr.</u>
NR	0.93	Lithophone	4.15	MBT	1.52
NR Latex (62%)	0.95	Magnesium oxide	3.20	MBTS	1.54
IR	0.90-0.94	Mica powder	2.95	ZMBT	1.70
SBR 1502	0.94	Alumin. Hydroxide	2.42	F	1.39
SBR 1712	0.95	Aluminum oxide	3.14-4.00	CBS	1.28
High Styrene Resin	0.94	Dolomite	2.34	TBBS	1.28
BR	0.90-0.93	Graphite	2.25	MBS	1.36
EPM / EPDM	0.86-0.89	Wood flour	1.25	DCBS	1.23
IIR	0.92-0.93	Paraffinic oil	0.86-0.90	TMTM	1.40
CIIR	0.92	Naphthenic oil	0.89-0.91	TMTD	1.42
BIIR	0.93	Aromatic oil	0.96	ZDMC	1.70
NBR (Low ACN)	0.96	Highly Aromatic oil	1.00	ZDEC	1.48
NBR (Medium ACN)	0.99	Castor oil	0.96	ZDBC	1.27
NBR (High ACN)	1.00	Pine tar	1.08	ZBEC	1.42
NBR-PVC (70:30)	1.08	Dibutyl phthalate	1.04	SDBC (50%)	1.05
NBR-PVC (50:50)	1.33	Di octyl phthalate	0.98	DTDM	1.30
CR	1.23	Dibutyl sebacate	0.94	DHTS	1.39
CM/CSM	1.10-1.16	Tricresyl phosphate	1.13	PVI (CTP)	1.30
TM	1.28-1.34	Di octyl adipate	0.92	DPG	1.19
AU/EU	1.03-1.24	Cl resin	1.07-1.15	DOTG	1.18
ACM	1.03-1.10	Factice	1.04-1.08	DPTT	1.50
CO/ECO	1.24-1.38	Mineral rubber	1.04	HMT	1.02
MQ/VMQ/PVMQ	1.06-1.38	Wood rosin	1.08	SP	1.08
FMQ/FVMQ	1.10-1.45	Shellac	1.10	22M46	1.04
FKM	1.50-1.70	Paraffin wax	0.90	TDQ	1.10
Reclaim Rubber (WTR)	1.10	Carbowax	1.20	IPPD	1.10
Carbon Black	1.85	Carnauba wax	0.99	6PPD	0.99
Ppt. Hydrated Silica	1.93-2.00	Microcrystalline wax	0.92-0.95	DTPD	1.26
Calcium Silicate	2.10	Casein	1.26	ODPA	0.98
Aluminum Silicate	2.10	Diethylene glycol	1.12	Pept. PCTP	2.33
Ppt. Calcium carbonate	2.71	Stearic acid	0.85	Pept. DBD	2.00
China Clay	2.62	Zinc oxide	5.57	DNPT Blowing agent	1.43
Calcined Clay	2.68	Zinc Stearate	1.05	Titanium dioxide	3.90
Whiting	2.71	Zinc sulfide	3.92	Ultramarine blue	2.35
Blanc Fixe	4.20	Light MgO	3.20	Red oxide	5.10
Barytes (Ground)	4.45	Litharge	9.53	Salicylic acid	1.44
Diatomaceous earth	2.15	Red Lead	8.62	Petroleum ether	0.60
French Chalk	2.72	Calcium oxide	2.20	Hexane	0.66
Magnesium carbonate	2.22	Triethanol amine	1.12	Toluene	0.87
Soap stone	2.72	Sulfur	2.07	MEK	0.83
Ppt. Zinc carbonate	3.30	Insol. Sulfur (20%OT)	1.61	Trichloroethylene	1.47