Technical Data

JSR EP

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1. General Characteristics and Applications of JSR EP

1-1 What is JSR EP?

Since JSR EP has no double bonds in the main chain, it especially excels in such properties as heat resistance, ozone resistance, and weatherability in comparison with diene type rubbers. In addition, it excels in steam resistance, low temperature characteristics, and electrical characteristics.
Furthermore, since its high loading is possible, it is widely used for such applications as tires, tubes, belts, hoses, waterproof sheets, window seals, electric wires, and various automotive parts.

JSR EP Series can be roughly classified into the following 3 groups.

(A) Ethylene Propylene Copolymer (EPM)

This is polymerized with only ethylene and propylene.
It has no double bonds in the molecule. Therefore, peroxides are normally used for curing, and the vulcanizates especially excel in heat resistance.

(B) Ethylene-Propylene-Diene Terpolymer (EPDM)

In EPDM, an unsaturated compound possessing double bonds is introduced into the ethylene propylene copolymer as a third monomer, and normal sulfur cure is possible. In case of JSR EPDM, there are two types, namely, one using DCP (dicyclopentadiene) as the third monomer, and the other using ENB (ethylidene norbornene) as the third monomer.

- **DCP Type EPDM**

The cure rate is rather slow in case of sulfur cure. Instead of being used independently, it is blended with butyl rubber and used for roofing. It shows excellent weatherability in comparison with ENB type EPDM.

- **ENB Type EPDM**

The outstanding feature of this type of EPDM is that the cure rate is fast in comparison with EPDM using other third monomers.
Especially in case of the high diene type, the cure rate is approximately the same as SBR. Therefore, it is suitable for blending with diene type rubbers such as SBR.
The majority of the JSR EP series belongs to this group.

As mentioned above, although JSR EP series can be basically classified into 3 groups, they are further subdivided by Mooney Viscosity, Ethylene Content, Amount of Third Monomer, etc.
Since numerous grades with different quality design and special features are available, you can select the grade of your choice in accordance with the application and the processing conditions.

Table 1. List of JSR EP Properties

Items \ Grades		EP11	EP43	EP93	EP22	EP24	EP27	EP57C (EP57F)	EP103AF	EP107F	EP25	EP21	EP51
Raw Mooney Viscosity ML_{1+4} (100℃)		40	47	50	42	65	105	90	92*	75	90	38	38
Type of third monomer		—	ENB	ENB	ENB	ENB	ENB	ENB	ENB	ENB	ENB	ENB	ENB
Third monomer Content	(wt%)	—	1.5	2.5	4.5	4.5	4.5	4.5	4.5	4.5	5.0	6.0	6.0
Ethylene Content***	(wt%)	52	56	55	54	54	54	66	59	62	59	61	67
Ash Content	(%)	0.01	0.02	0.02	0.07	0.01	0.01	0.04	0.02	0.01	0.01	0.02	0.04
Volatile Matter	(%)	0.5	0.5	0.5	0.4	0.5	0.5	0.8	0.5	0.3	0.5	0.5	0.5
Specific Gravity		0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86
Oil Extension Amount	(PHR)	—	—	—	—	—	—	—	—	—	—	—	—
Stabilizer		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Properties of Vulcanizate (160℃×30min. Press)													
200% Modulus	(MPa)	3.9	3.4	4.9	6.4	6.9	7.4	7.4	7.4	7.8	7.4	5.9	6.4
Tensile Strength	(MPa)	20.6	17.2	16.7	13.7	15.7	18.1	20.6	19.6	21.1	18.1	12.7	13.7
Elongation	(%)	650	720	570	420	430	440	450	440	450	430	440	440
Hardness	JIS A	60	61	67	70	70	70	72	71	70	71	73	77

Items \ Grades		EP33	EP35	EP37F	EP65	T7141	EP75F	EP96	EP98	EP503EF	EP801E	T7501EF
Raw Mooney Viscosity ML_{1+4} (100℃)		45	83	100	74	42	85	53*	62*	74*	54*	52*
Type of third monomer		ENB	ENB	ENB	ENB	ENB	DCP	ENB	ENB	ENB	ENB/DCP	ENB
Third monomer Content	(wt%)	8.0	8.0	8.0	9.0	4.5	7.0	6.0**	4.5**	4.5**	7.5/2.5**	5.5**
Ethylene Content***	(wt%)	52	52	54	54	49	62	66**	66**	66**	53**	66**
Ash Content	(%)	0.04	0.02	0.07	0.01	0.02	0.01	0.02	0.02	0.01	0.01	0.02
Volatile Matter	(%)	0.5	0.5	0.1	0.5	0.5	0.4	0.4	0.4	0.4	0.4	0.5
Specific Gravity		0.86	0.86	0.86	0.86	0.86	0.86	0.87	0.87	0.87	0.87	0.87
Oil Extension Amount	(PHR)	—	—	—	—	—	—	50	75	20	20	40
Stabilizer		NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Properties of Vulcanizate (160℃×30min. Press)												
200% Modulus	(MPa)	7.4	7.8	8.3	8.3	5.6	7.4	9.3	5.4	8.7	9.3	9.4
Tensile Strength	(MPa)	13.7	15.7	17.7	15.7	13.5	21.6	23.0	18.1	23.0	17.6	21.1
Elongation	(%)	360	370	410	340	470	440	380	440	400	360	380
Hardness	JIS A	73	73	75	72	70	69	70	59	69	72	70

(N.B.)
*ML_{1+8}(120℃)
**Base Polymer
***Corrected Method

These data are only typical physical properties and are not product specifications.

Compounds

	EP11	Non-Oil Type	Oil Extended Type
Polymer	100	100	100+x
ZnO #1	5	5	5
Stearic Acid	1	1	1
HAF Black (IRB %)	50	80	80
Naphthenic Process Oil	10	50	50−x
Accelerator TMTM	—	1	1
Accelerator MBT	—	0.5	0.5
Dicumyl Peroxide	2.7	—	—
Sulfer	2.3	1.5	1.5
	169.0	239.0	239.0

x: Oil Content
In case that oil content is 50phr or more, naphthenic process Oil is not added.

1-2 Comparison of JSR EP with Other Rubbers

Comparisons of characteristics of JSR EP and those of other rubbers are shown below.

■ **Comparison of Ozone Resistance: JSR EP and Other Polymers (Magnified by 5 times)**

JSR EP
20ppm X 11hrs

JSR EP/SBR
= 30/70
20ppm X 8hrs

NR
20ppm X 2hrs

SBR
20ppm X 2hrs

BR
20ppm X 2hrs

CR
20ppm X 2hrs

IIR
20ppm X 2hrs

■ **Comparison of Characteristics: JSR EP and Other rubbers.**

Excellent ←

	JSR EP	NR	SBR	BR	CR	NBR	IIR
Specific Gravity	0.86	0.92	0.94	0.91	1.23	0.98	0.92
Cure Rate	Fast–Slow	Fast	Fast	Fast	Fast	Fast	Slow
High Loadability	●	○	○	○	○	○	●
Weatherability (incl. Ozone Resistance)	⊙	○	○	○	○	○	●
Heat Aging Resistance	⊙	●	○	○	○	○	●
Steam Resistance	⊙	○	○	○	●	○	●
Acid Resistance	⊙	○	○	○	○	○	●
Alkali Resistance	⊙	○	○	○	○	○	●
Oil Resistance	●	●	●	●	○	⊙	●
Ethylene Glycol Resistance	●	●	●	●	●	○	●
Compression Set	○	○	●	○	○	○	○
Low Temperature Resistance	●	○	○	●	●	●	○
Abrasion Resistance	○	○	○	●	○	○	○
Tear Resistance	○	●	○	○	●	○	○
Dynamic Characteristics	○	●	○	●	○	○	●
Electrical Characteristics	⊙	○	○	○	○	●	●
Gas Retention	○	○	○	○	○	○	●
Flame Resistance	●	●	●	●	○	●	●
Tackiness	●	●	○	○	○	○	○
Adhesiveness	●	○	○	○	●	○	○

1-3 Processability, Physical Properties and Molecular Structure

(1) Milling Processability

The milling processability is influenced by the molecular weight (Mooney Viscosity), molecular weight distribution, and ethylene content.
Generally speaking, the processability will have a tendency to improve when the molecular weight is small, the molecular weight distribution is broad, and when the ethylene content increases following the increase of the molecular weight.

(2) Banbury Processability

Banbury processability will have a tendency to improve and the power consumption to be reduced, when the molecular weight is small and the molecular weight distribution is broad, and when the ethylene content increases following the increase of the molecular weight, just like in the case of the milling processability.

(3) Extrusion Processability

The extrusion processability will be influenced by the extruder and the extrusion conditions.
Generally speaking, polymers with high ethylene content and polymers whose ethylene content increases following the increase of the molecular weight will show a better tendency in all aspects such as stable feed of the compound to the extruder, extrusion speed, extrusion shape, etc.

Propylene Content 28%

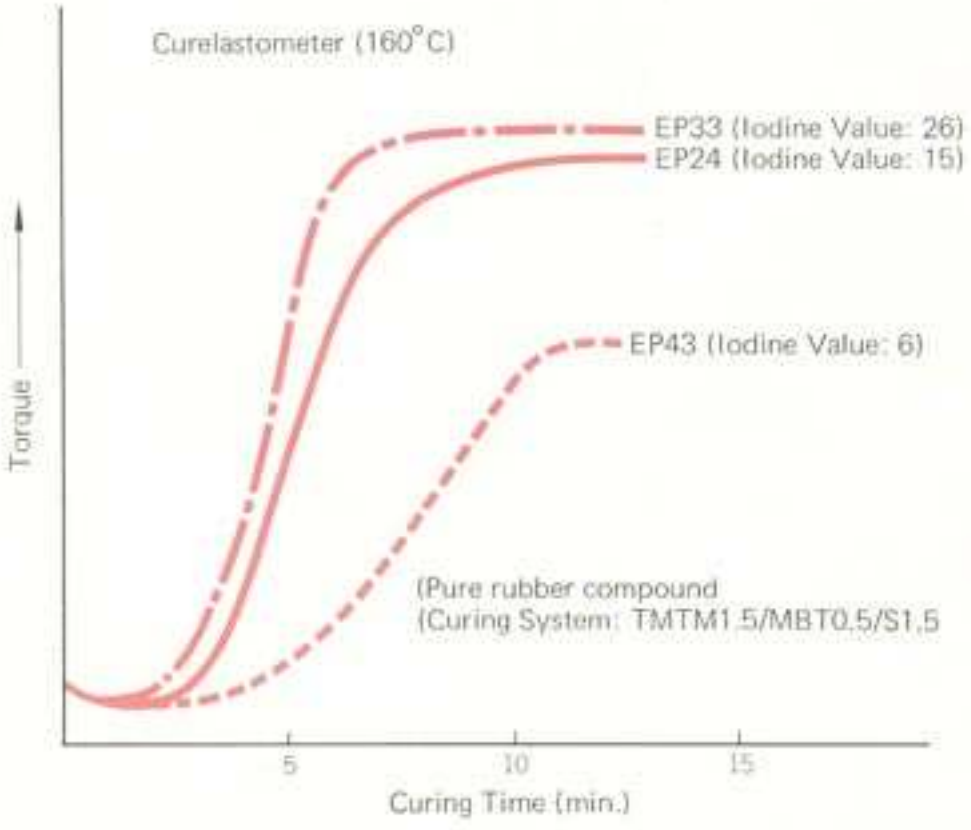
Propylene Content 43%

(4) Calendering Processability

The calendering processability is the same as other polymers.
The smaller the molecular weight, the less the shrinkage, and the smoother the surface.
Furthermore, the effect will be greatly influenced by the roll temperature.
In other words, the shrinkage will become smaller when the roll temperature is high.

(5) Cure Rate

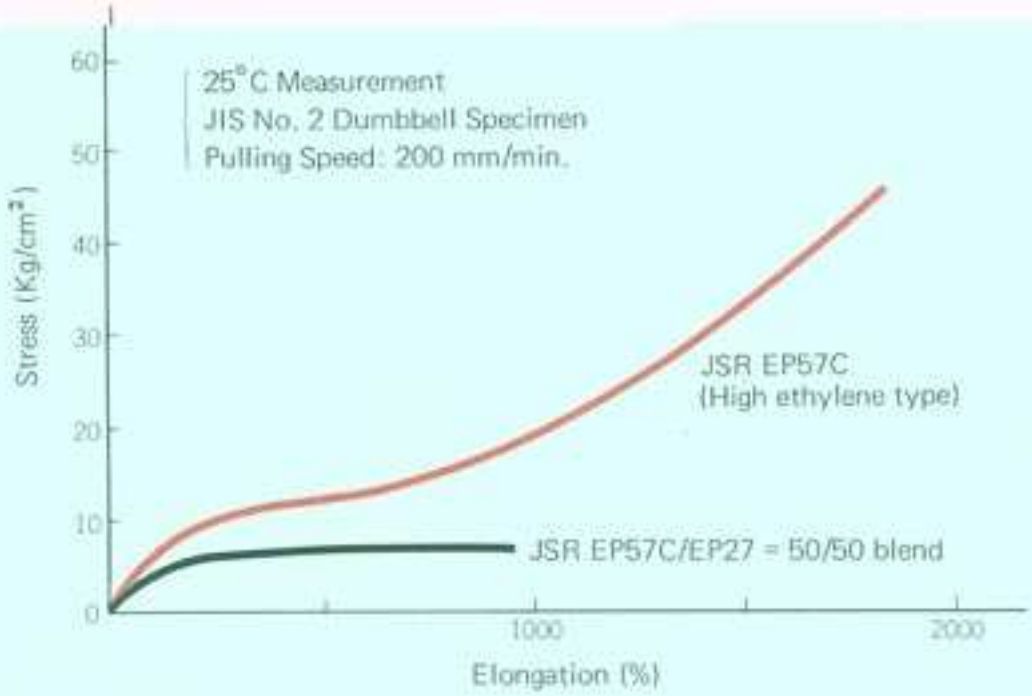
The cure rate (especially sulfur cure) will be greatly influenced by the type and content of the third monomer.
In other words, cure rate of ENB type is faster than that of DCP type, and in case of the same third monomer, the cure rate will become faster as its content (Iodine Value) increases.



(6) Green Strength

The green strength is influenced by the ethylene content, molecular weight, and molecular weight distribution. Especially, the effect of ethylene content is great, and when the ethylene content is high, the tensile strength at around room temperature will grow high.

S–S Curves of JSR EP57C



(7) Characteristics of Cured Rubber

Generally speaking, the tensile characteristics will be improved when the Mooney Viscosity becomes higher and the ethylene content becomes greater.
There is a tendency for the compression set to improve when the third monomer content (Iodine Value) increases.

(8) Thermal Aging Resistance

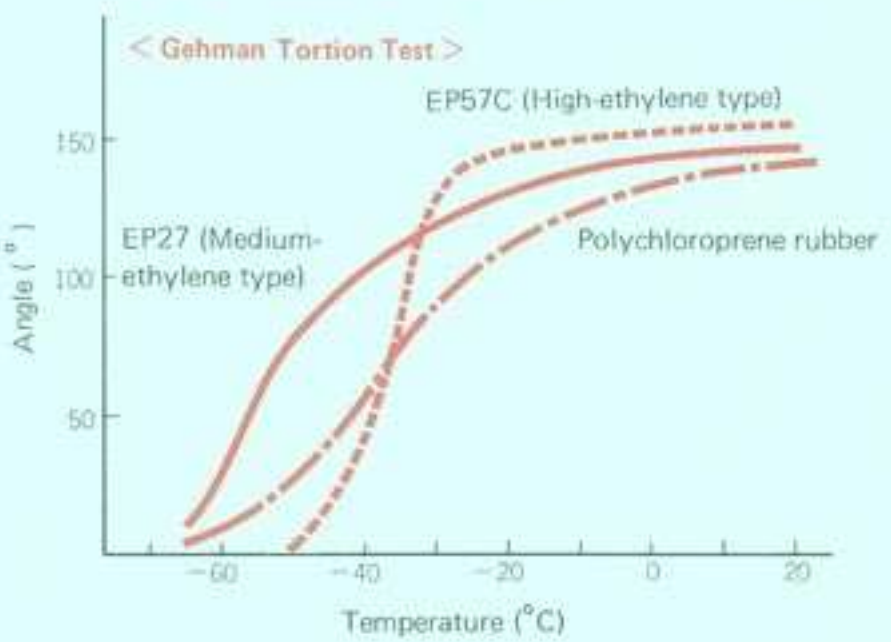
There is a tendency for the thermal aging resistance to improve as the third monomer content (Iodine Value) decreases. However, even in the case of grades having high third monomer content, the thermal aging resistance is far better than polychloroprene rubber.

(9) Weatherability, Ozone Resistance

When comparing DCP type EPDM and ENB type EPDM, the DCP type EPDM tends to show rather better characteristics. However, even in the case of ENB type EPDM, it is far better than butyl rubber or polychloroprene rubber.

(10) Cold Resistance

All of the JSR EP series show good cold temperature characteristics.
There is a tendency for cold resistance to improve as the ethylene content lowers.



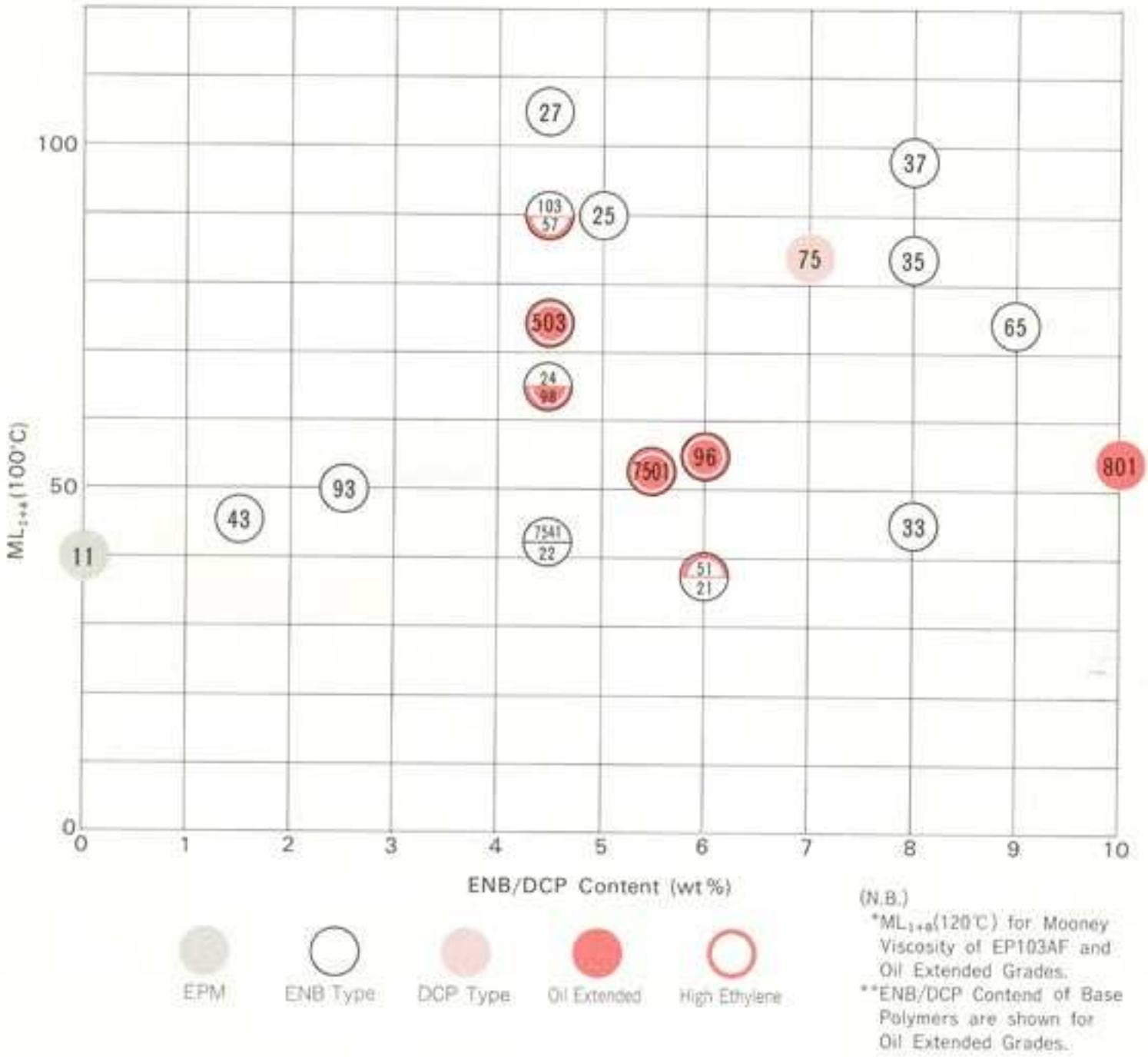
1-4 Typical Characteristics and Main Applications of JSR EP

	Weather-ability	Ozone Resist-ance	Thermal Aging Resist-ance	Steam Resist-ance	Chemical Resist-ance	Electrical Characte-ristics	Low Tempera-ture Char-acteristics	Impact Resist-ance
≪ Tire Tube ≫								
Passenger Car Tire, Cover Strip, Sidewall	●	●	●				●	
Off-Road Tire	●	●	●				●	
Tube	●	●	●					
≪ Hose ≫								
Radiator Hose	●	●	●		●			
Heater Hose	●	●	●					
Steam Hose	●	●	●	●				
≪ Belt ≫								
Heat Resistant Belt	●	●	●					
Chemical Resistant Belt	●				●			
≪ Electrical Wire ≫								
Cable Insulation	●	●	●			●		
≪ Industrial & Mechanical Goods ≫								
Window Seal, Gasket	●	●						
Lamp Seal	●	●						
Door Stopper Rubber	●	●						
Mud Guard	●	●						
Bumper	●	●						
Shock Absorber Bellows	●	●						
Roofing	●	●						
Flooring	●	●						
Tank Lining					●			
O Ring		●	●				●	
Packing	●	●	●					
Diaphragm	●			●				
Roll			●	●	●			
Rubber for Bridges	●	●					●	
Flexible Container	●	●	●					
≪ Others ≫								
Leisure Boat	●	●					●	
Air Mat	●	●					●	
Flippers (Diving Fins)	●	●					●	
Polyolefin Modifier								●

2. Characteristics and Applications of JSR EP Series

2-1 Quality Design of JSR EP

Each grade of JSR EP series is compared in relation to Mooney Viscosity and Iodine Value.



(N.B.)
*ML_{1+4}(120°C) for Mooney Viscosity of EP103AF and Oil Extended Grades.
**ENB/DCP Contend of Base Polymers are shown for Oil Extended Grades.

2-2 Characteristics and Main Applications

JSR EP11

[Characteristics] This is an EPM with low Mooney viscosity and low ethylene content. It excels in heat resistance, weather resistance and ozone resistance. It is especially suitable for applications requiring heat resistance.

[Main Applications] Heat resistance belts, electric wires, other heat-resistant products.

JSR EP43

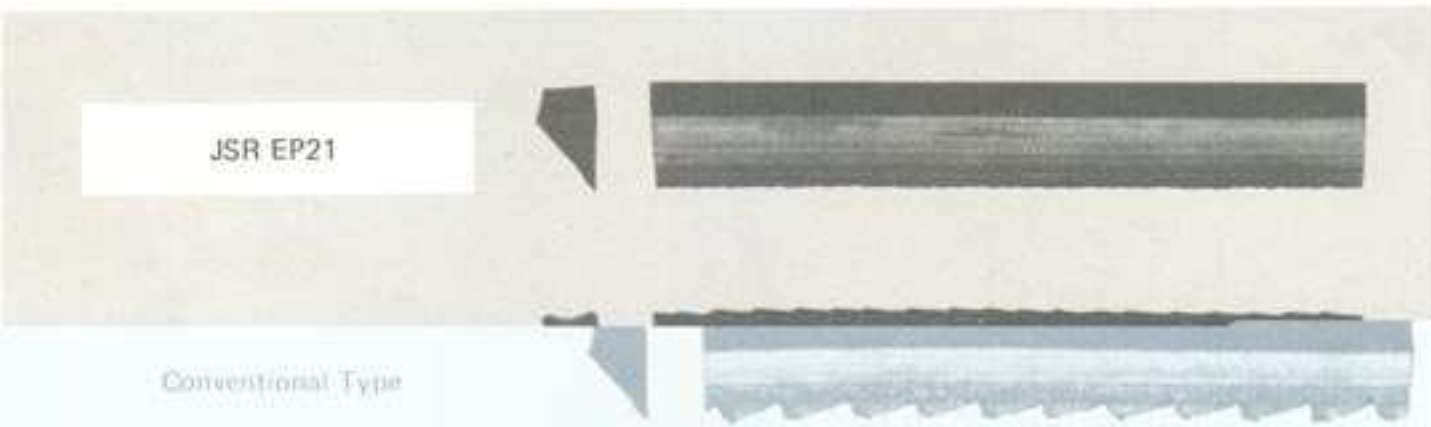
[Characteristics] The third monomer content (ENB) is low, and its cure rate is adjusted so that it would be suitable for blends with butyl rubber (especially, JSR Butyl 268).
Furthermore, since the third monomer content is low, the heat resistance is very good.
[Main Applications] Tire tube blends, waterproof sheets.

JSR EP93

[Characteristics] This is a low Mooney viscosity EPDM having cure rate which lies between those of EP43 and EP24.
It is a product which is well-balanced in processability and physical properties, even in blends with butyl rubber.
[Main Applications] Tire tube blends, waterproof sheet, rubberized cloth.

JSR EP21

[Characteristics] This is a low Mooney viscosity EPDM which has high cure rate and good extrusion.
It has good extrusion properties even in low loading, low oil compounds, and the physical properties of the vulcanizates are good.
Furthermore, since the molecular weight distribution is made broad, the milling processability is especially good.
[Main Applications] Electric wires, electric cables, window seals (weather strips), and extruded automotive parts.



JSR EP25

[Characteristics] This is an EPDM having high cure rate and good extrusion. It exhibits excellent extrusion performance even for compounds using high loading of white fillers.
[Main Applications] Various automotive parts and various extrusion products.

JSR EP51

[Characteristics] This is a product that improved the extrusion of EP21 even more. It shows an excellent extrusion surface for non-filler systems also.

JSR EP22, EP24, EP27

[Characteristics] These grades have high cure rate.
Furthermore, it is a general type EPDM which has medium ethylene content.
It excels in low temperature characteristics. EP22 has low Mooney viscosity.
EP24 has medium Mooney viscosity, and even if it is used independently, it offers well-balanced processability and physical properties.
EP27 has high Mooney viscosity, and it can be highly loaded with carbon black and oil without losing its mechanical properties.
[Main Applications] Various automotive parts, hoses, industrial goods.

JSR EP103AF

[Characteristics] This product enables high filler loading without sacrificing the physical properties.
The low temperature characteristics are good, and they can be used over a broad range of temperature.
EP103AF comes in friable bales so the processability is very good.
[Main Applications] Window seals (Weather strips) and other extruded products.

JSR EP107F

[Characteristics] EP107F is a high mooney viscosity EPDM which has fast cure rate. It comes in friable bales so the processability is very good.
[Main Applications] Window seals and other extruded products.

JSR EP57C, EP57F

[Characteristics] EP57F(C) is a high ethylene content, high Mooney viscosity type EPDM which has the same third monomer content level as EP24 and EP27.
Since its ethylene content is high, the green strength is extremely high.
Furthermore, it excels in extrudability and high loading properties.
Since EP57F(C) is in crumb form, the polymer dispersion at time of mixing is very good.
[Main Applications] EP57F(C): Radiator hose, heater hose, window seal, other extruded goods.

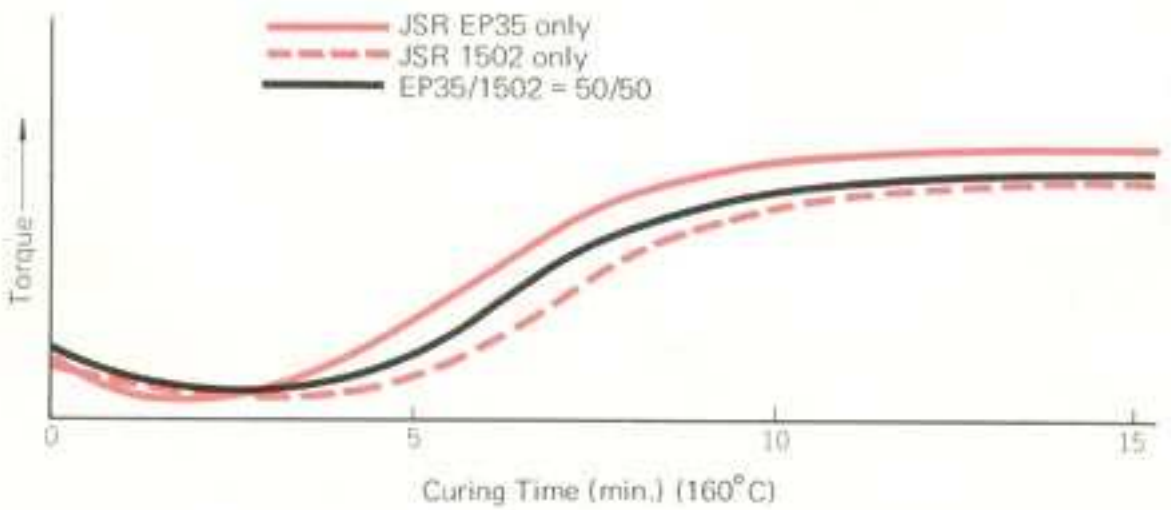
JSR EP33, EP35

[Characteristics] These grades are super fast cure rate EPDM, and they have the same cure rate as SBR.
EP33 is a low Mooney viscosity grade produced by emphasizing the processability.
EP35 is a high Money viscosity grade produced by emphasizing the physical properties.
When blended with diene type rubbers such as SBR, these grades will show hardly any drop in physical properties of the cured rubber, and they can be used to improve the ozone resistance, weather resistance, and heat resistance of diene type rubbers.
In addition, these grades are also suitable for high temperature, short period continuous vulcanization for manufacturing sponges.
[Main Applications] White side walls, cover strips, sponges, weatherstrips, packings.

JSR T7141

[Characteristics] T7141 is a EPDM which has good processability and excels in low temperature characteristics.
[Main Applications] Window seals and other extruded products.

Comparison of the Cure Rate of JSR EP35, JSR1502, EP35/1502 (Curelastometer)



Compound (Polymer: 100, Zinc Oxide: 5, Stearic Acid: 1, HAF Black: 70, Naphthenic Process Oil: 35
Accelerator OBS: 0.85, Accelerator DPG: 0.40, Sulfur: 1.75)

JSR EP96, EP98, EP503EF, T7501EF

[Characteristics] These are an oil extended (EP503EF, T7501EF, EP96 and EP98 are added 20phr, 40phr, 50phr and 75phr of paraffinic oil respectively) EPDM which has fast curing properties. Since base polymers having super high Mooney viscosity and high ethylene content are used, they are suitable for extrusion and high loading. Furthermore, they retain good physical properties when blended with diene type rubbers such as SBR.

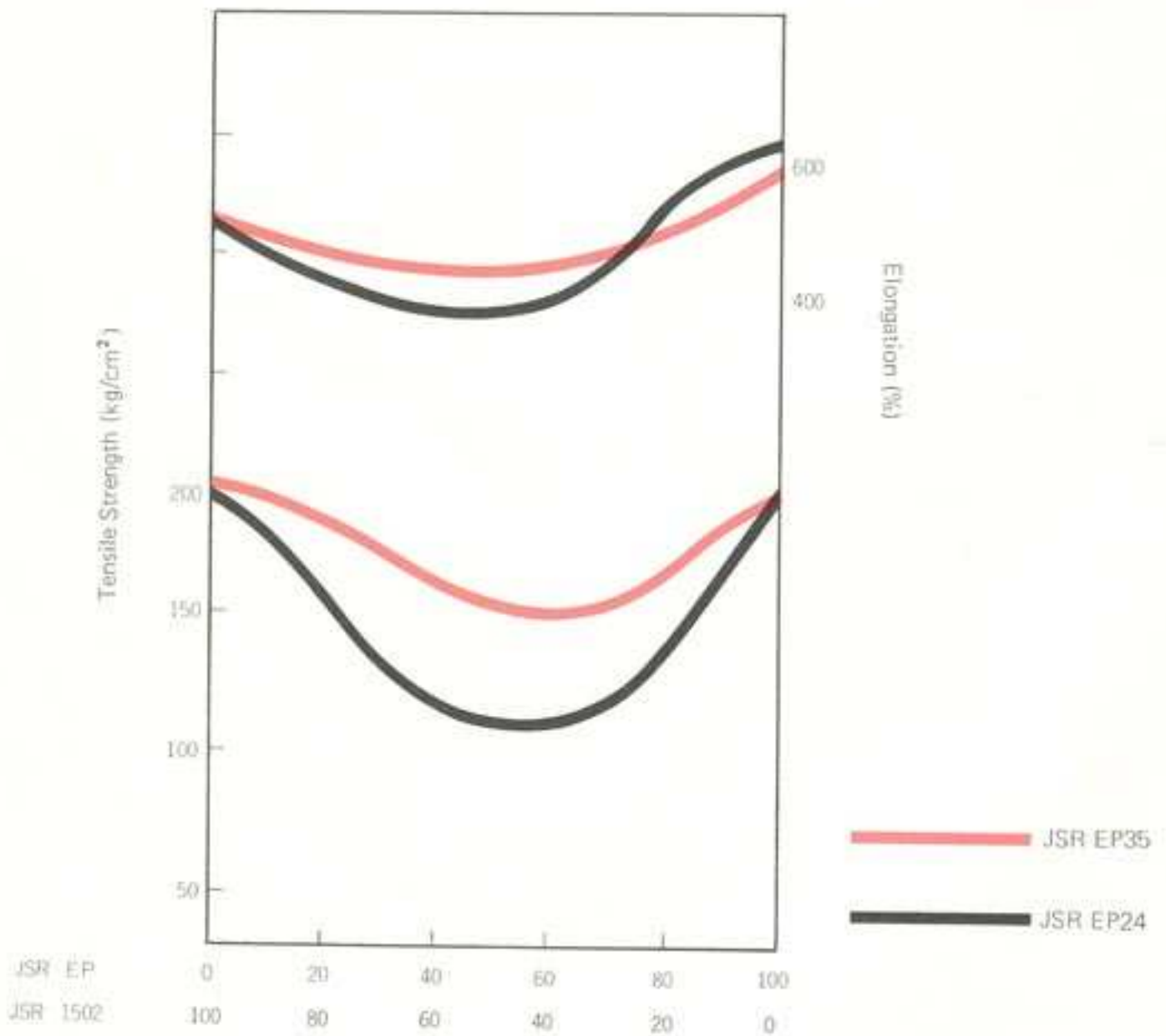
[Main Applications] Weatherstrips, sponges, shock absorbing rubber, heat resistant hoses.

JSR EP801E

[Characteristics] EP801E is an oil extended (20phr of paraffinic oil added) EPDM which uses ENB and DCP as third monomers. It has good processability, and it is well-balanced in both vulcanization and blowing of the polymer.

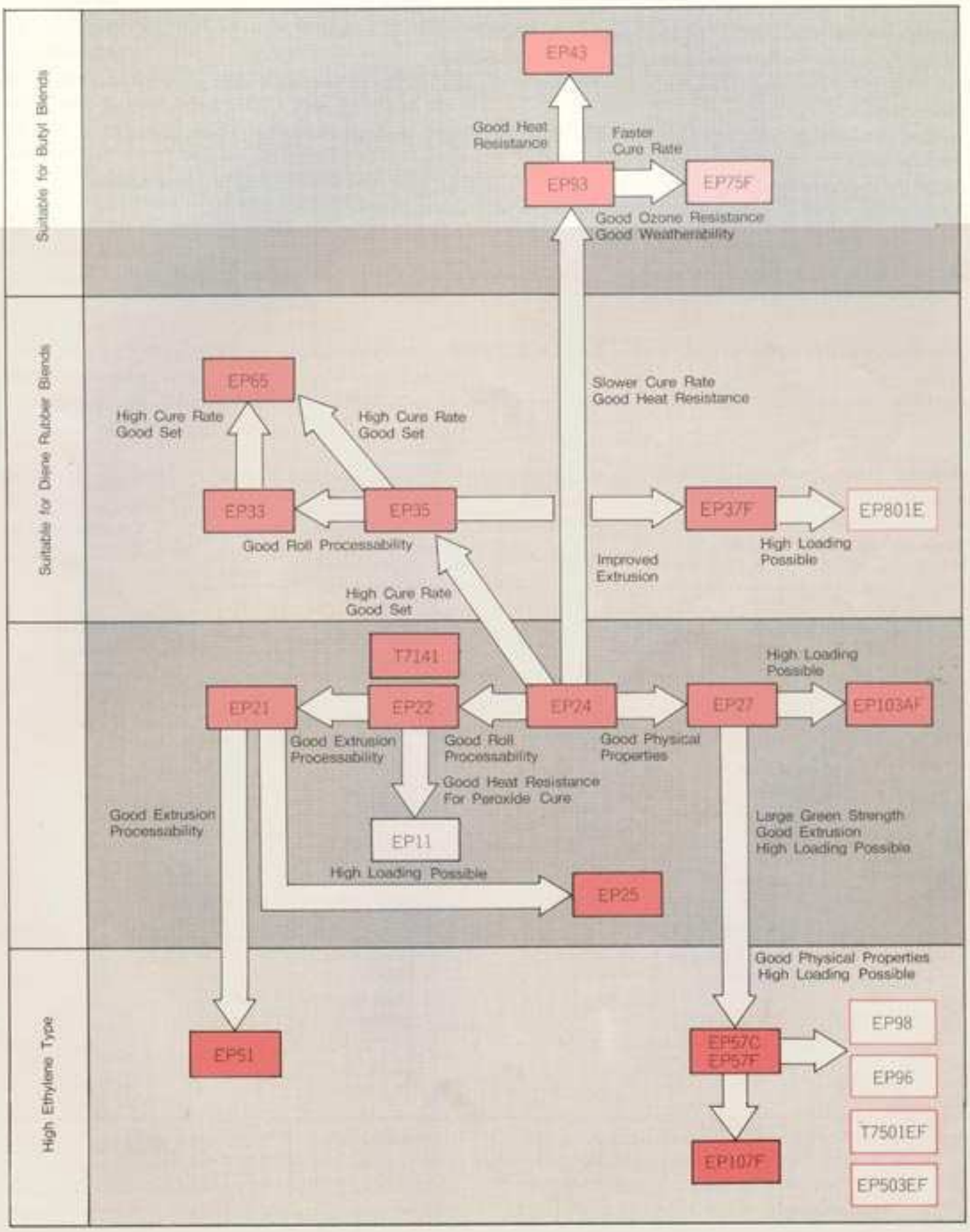
[Main Application] Sponges.

EPDM/SBR Blend Ratio and Characteristics at Break



2-3 Grade Selection of JSR EP

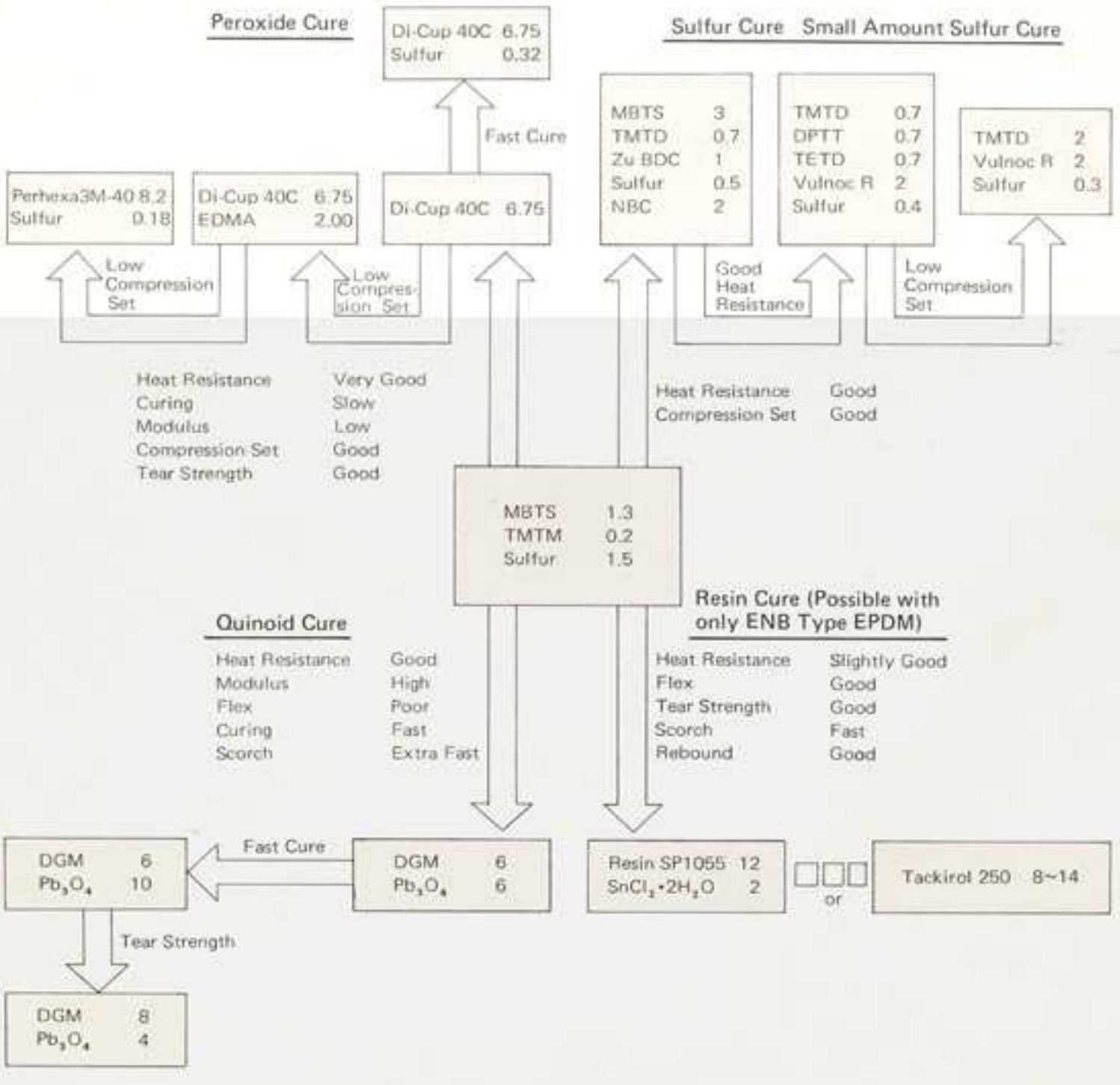
The relations among various grades of the JSR EP series are as shown below.
Please select the optimum grade which matches the processing method and the required performances.



3. Processing Method of JSR EP

3-1 Compounding Chemicals

Just like BR and SBR, JSR EP requires reinforcing fillers.
Especially, carbon black shows excellent reinforcing properties.
Although JSR EP is easy to process originally, the processability can be improved even more by adding various plasticizers.
In case of aiming at reduction of cost, it may be highly loaded with oil and carbon black, and still not lose its characteristics.
As for the curing system, in general, peroxide curing is used for EPM, and sulfur curing is used for EPDM.
A systematic drawing of various standard curing systems is shown below.



3-2 Processing Operation

(1) Roll Operation

In case of performing mixing on the rolls, the following method of operation is recommended.

(1) Keep the roll temperature low.

(2) Keep the roll nip narrow, and keep the bank small.

(3) When JSR EP bands on the roll, commence introduction of powdered chemicals even if there are holes in the rubber.
Generally speaking, add the reinforcing fillers first, then add the oil with the non-reinforcing fillers later.

(4) When JSR EP bands on the back roll, raise the back roll temperature (by 15 ~ 20°C higher than the front roll.

(2) Banbury Operation

Generally speaking, it is used when making compounds of high loading.

In this case, increase the charge amount by 5 ~ 10% in comparison with the SBR compounds.

In case of the mixing operation, the upside-down method not only gives good dispersion but also raises the efficiency effectively.

In case of normal loading compound, mixing can be done in almost the same conditions as the general mixing methods.

(3) Extrusion and Calendering Operation

Extrusion: By keeping the die head temperature about 120 ~ 130°C, compounds would be extruded with small die swell, smooth surface and good processability.

Calendering: By keeping calender temperature at higher side, compounds would be calendered with less shrinkage and smooth surface.

(4) Adhesion

Although the adhesion between uncured rubber is very good, in case of adhering the rubber to fibers or metals, or adhering uncured rubber with cured rubber, use of isocyanate type adhesive or modified olefin type adhesive is recommended.

These data are only typical information obtained in our laboratory tests.

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