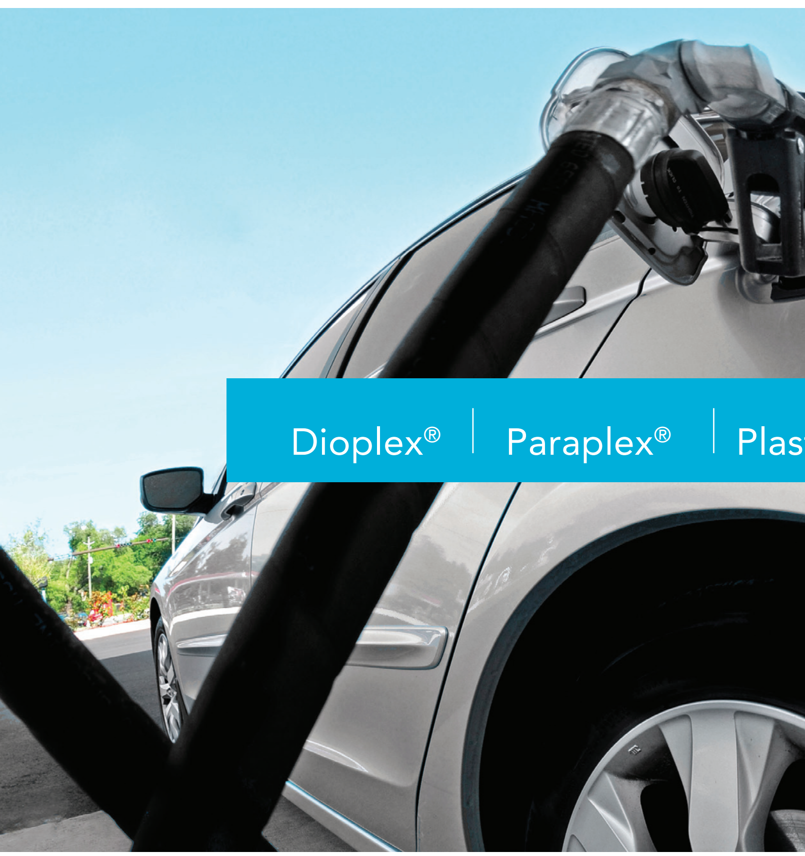
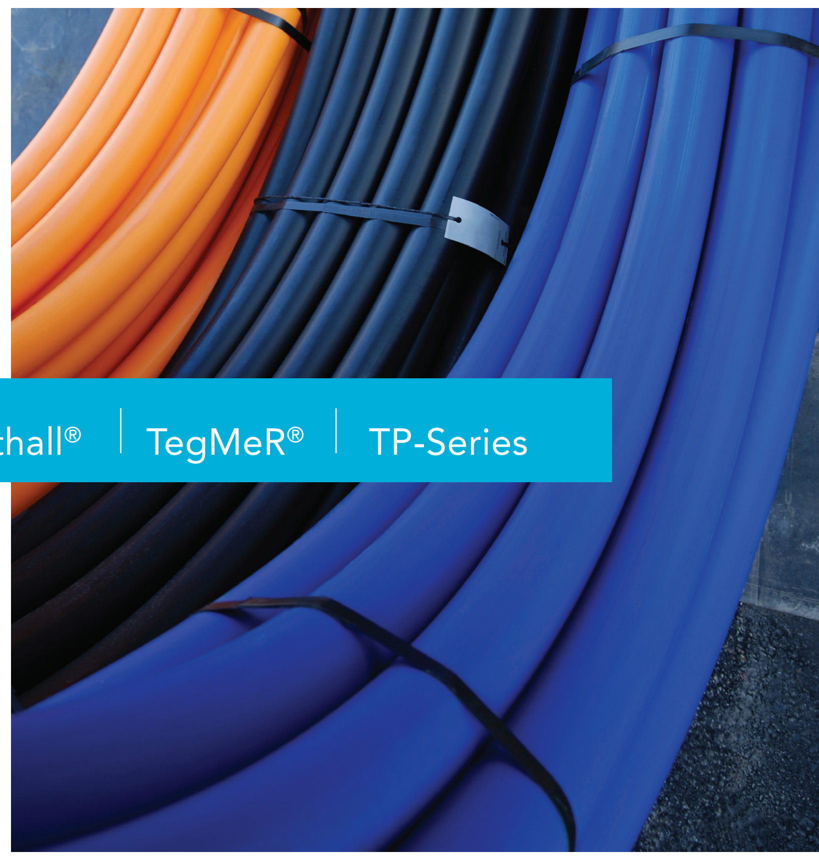
HALLSTAR

ESTER PLASTICIZERS FOR ELASTOMERS





Dioplex® | Paraplex® | Plasthall® | TegMeR® | TP-Series

Hallstar works collaboratively with companies around the world to deliver chemistry solutions that enhance next-generation products.

As manufacturers find themselves under pressure to innovate, their ability to compete globally depends increasingly on how well they can leverage the knowledge of technology suppliers.

Hallstar's expertise in polymer modification and optimization, coupled with our application knowledge across a wide range of industrial products, is unique in the specialty chemical industry. Our ability to continually invent and formulate chemistry solutions to meet the unmet needs of our customers—is based on years of specialized esterification experience.

This experience has led to the development of our proprietary molecular design, the Paraplex Approach. Choosing the right ester plasticizers can be difficult, but with the Paraplex Approach, our customers can quickly identify unique plasticizer solutions based on tightly defined performance requirements.

Taking a collaborative approach to new chemistry solutions is what Hallstar is all about. Together we can explore new approaches and possibilities, and anticipate what it takes to succeed tomorrow, next year and for years to come. Explore what our innovative plasticizers can do, then give us a call.

LET'S WORK WONDERS™

HOW TO SELECT A PLASTICIZER

Commonly used plasticizer categories include the following:

Standard Monomerics

are typically low molecular weight, general purpose products offering a good balance of performance properties for non-critical end-use applications. These plasticizers generally fall under our Plasthall® trade name, such as Plasthall® 226, 100 or 503.

Specialty Monomerics

are used in more critical applications that require more specialized performance for more demanding end-uses. Critical applications might include: retention of low-temperature properties after aging, under-the-hood applications requiring high and low temperatures, or fuel resistance. These products carry our Plasthall®, TegMeR® and TP-Series trade names.

Polymerics

are higher molecular weight products used for their permanence and low-migratory properties, often in combination with a monomeric plasticizer. These products typically fall under our Plasthall® P-Series, Paraplex® or Dioplex® trade names.

Phthalate Replacement

technology is at the forefront of Hallstar's product development efforts. On the subsequent pages that detail different elastomers, note that ALL of these ester plasticizers are truly phthalate replacements as they are all based on different types of non-phthalate chemistries. Specific to nitrile rubber (NBR), information on our Plasthall® PR-Series of phthalate replacement products (A126, A200, A217, LCOA and A610), can be found on pages 7-8.

When selecting an ester plasticizer, it is important to consider which elastomer is being used and the properties of that elastomer. Plasticizers and elastomers need to be compatible with each other based on having similar polarities.

The Plasticizer/Polymer Polarity Chart on page 22 graphically shows the relationship between compatibility and polarity for esters and elastomers.

CONTENTS

POLYMER INFORMATION

Nitrile elastomers (NBR) result from reactions of butadiene and acrylonitrile (ACN) monomers. ACN content ranges from a high of about 50 percent to a low of about 18 percent. Available grades have approximately 50, 40, 30 and 20 percent ACN. NBR blends well with many other polymers, such as polyvinyl chloride (PVC), styrene butadiene rubber (SBR) and chloroprene rubber (CR).

Oil and fuel resistance are the primary reasons for using NBR, but another important property is its abrasion resistance. Normal service temperatures are -40°C to 125°C, but special compounding can broaden this range to -55°C to 150°C for intermittent service. The elastomer requires antioxidants, antiozonants, fungicides, plasticizers, tackifiers and flame retardants as the occasion and severity of the application demands. It can be cured with sulfur or peroxide systems. High-ACN polymers require high-polarity plasticizers, low-ACN polymers require low-polarity plasticizers. Polymerics used at greater than 15 PHR are generally used in combination with monomerics.

APPLICATIONS

PRODUCTS THAT REQUIRE RESISTANCE TO OIL AND FUEL SUCH AS:

- Adhesives
- Bladders
- Conveyor belts and rollers
- Diaphragms
- Fuel cell liners
- Fuel lines and hoses (covers and tubes)
- Gaskets
- Grommets
- Kitchen mats
- O-rings
- Oil well parts
- Packings
- Print rolls and blankets
- Pump liners
- Seals
- Shoes and boots
- Waterproofing
- Wire/cable jackets and insulation

	PLASTICIZER									
	Plasthall®						TP-Series		TegMeR®	
	209	226 (DBEEA)	DIDA	7050	4141	TOTM	TP-95®	TP-90B®	804-S	DINP
Processing Properties **Viscosity and Curing Properties** **Mooney Viscosity @ 121°C**										
Minimum Viscosity	25.4	26.9	26.2	36.2	26.4	28.6	28.4	27.4	29.6	29.2
t5, minutes	7.2	5.3	5.2	2.3	5.3	8.5	4.3	3.3	3.3	8.1
t35, minutes	8.6	6.5	6.5	3.2	6.6	10.3	5.5	4.4	4.2	9.9
Oscillating Disc Rheometer @ 170°C										
M_L	5.1	5.5	5.5	7.0	5.6	5.9	5.9	5.8	6.1	6.2
M_H	46.3	47.7	40.2	52.2	45.3	42.3	48.2	47.6	50.9	47.2
t_s2, minutes	1.2	1.0	1.0	0.5	1.0	1.2	0.9	0.8	0.8	1.2
t'c(90), minutes	2.9	2.6	4.4	2.4	2.5	3.7	2.7	2.5	2.7	3.1
Original Physical Properties										
Stress @ 300% Elongation, MPa	10.4	10.7	10.0	11.2	9.7	9.9	9.6	10.0	10.4	9.2
Tensile Ultimate, MPa	14.0	15.1	14.9	13.9	14.2	14.4	13.8	14.2	13.0	13.1
Tensile Ultimate, psi	2035	2190	2165	2015	2055	2090	1995	2065	1890	1900
Elongation @ Break, %	440	440	475	490	500	510	495	490	415	500
Hardness, Shore A, pts	60	62	63	64	59	62	60	61	63	64
Specific Gravity	1.199	1.200	1.186	1.207	1.193	1.193	1.204	1.193	1.196	1.193
Low-Temperature Brittleness, °C	-42	-42	-39	-38	-42	-35	-42	-46	-43	-35
T_g, °C	-45.7	-45.2	-38.1	-42.3	-44.3	-33.6	-44.8	-49.2	-43.2	-36.7
Air Oven, 70h @ 125°C										
Tensile Change, %	24	11	13	19	21	9	16	23	24	22
Elongation Change, %	-26	-30	-27	-40	-25	-31	-36	-47	-13	-27
Hardness Change, %	8	10	11	8	10	4	8	20	9	8
Weight Change, %	-5.0	-3.5	-6.2	-3.4	-5.4	-0.8	-3.5	-10.5	-5.1	-4.0
IRM 901 Oil, 70h @ 125°C										
Tensile Change, %	27	12	9	14	17	10	13	11	22	28
Elongation Change, %	-28	-38	-45	-52	-49	-48	-51	-52	-40	-43
Hardness Change, pts.	11	8	11	6	10	5	9	13	8	8
Volume Change, %	-11.8	-11.7	-13.1	-9.7	-11.9	-12.4	-11.3	-12.1	-11.8	-12.3
Weight Change, %	-10.8	-10.9	-11.3	-9.4	-10.7	-11.4	-10.5	-10.9	-10.7	-11.0
IRM 903 Oil, 70h @ 125°C										
Tensile Change, %	18	-5	-7	0	-4	-6	1	-2	20	18
Elongation Change, %	-31	-43	-49	-54	-51	-51	-53	-53	-29	-40
Hardness Change, pts.	5	3	2	0	6	4	3	5	0	1
Volume Change, %	0.6	0.6	0.3	2.3	0.7	1.4	0.5	0.5	0.7	-0.2
Weight Change, %	-0.9	-0.8	-0.1	0.2	-0.2	0.0	-0.8	-0.5	-0.4	-0.9
Distilled Water, 70h @ 100°C										
Tensile Change, %	1	4	0	14	5	0	7	-8	-4	3
Elongation Change, %	-8	-24	-17	-4	-30	-31	-7	-30	-30	-31
Hardness Change, pts.	0	-4	-9	-3	-2	-4	-1	-4	-8	-6
Volume Change, %	4.4	4.8	7.5	0.2	6.8	7.7	5.5	6.4	6.8	7.0
Weight Change, %	3.7	4.2	6.5	0.2	6.0	6.6	4.8	5.7	6.0	6.2

First Choice **Second Choice**

Formulation: Krynac® 3345F - 100.0, Kadox® 920 - 5.0, Sulfur Spider® - 0.4, DQ - 1.0, Carbon Black N660 - 65.0, Stearic Acid - 1.0, Plasticizer - 20.0, MBTS - 2.0, Methyl Zimate - 1.5

Krynac® is a registered trademark of Lanxess. Kadox® is a registered trademark of Horsehead Corporation. Plasthall®, TP-95®, TP-90B®, TegMeR® and Sulfur Spider® are registered trademarks of Hallstar.

POLYMER INFORMATION

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Oil and fuel resistance are the primary reasons for using NBR, but another important property is its abrasion resistance. Normal service temperatures are -40°C to 125°C, but special compounding can broaden this range to -55°C to 135°C for intermittent service. The elastomer requires antioxidants, antiozonants, fungicides, plasticizers, tackifiers and flame retardants as the occasion and severity of the application demands. It can be cured with sulfur or peroxide systems. High-ACN polymers require high-polarity plasticizers, low-ACN polymers require low-polarity plasticizers. Polymerics used at greater than 15 PHR are generally used in combination with monomerics.

APPLICATIONS

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- Grommets
- Kitchen mats
- O-rings
- Oil well parts
- Packings
- Print rolls and blankets
- Pump liners
- Seals
- Shoes and boots
- Waterproofing
- Wire/cable jackets and insulation

	PLASTICIZER								
	Dioplex®						Paraplex®		
	100	195	430	904	7017	VLV	A-8000	A-8200	A-8600
Processing Properties **Viscosity and Curing Properties** **Mooney Viscosity @ 121°C**									
Minimum Viscosity	24.5	31.3	33.9	33.2	31.1	28.0	32.1	33.9	28.3
t5, minutes	7.1	7.7	7.7	7.1	7.4	7.4	4.8	4.8	5.4
t35, minutes	9.0	9.6	9.6	8.9	9.2	10.4	6.2	6.2	7.8
Oscillating Disc Rheometer @ 170°C									
M_L	5.0	5.0	5.4	5.3	5.0	4.5	5.3	5.0	5.4
M_H	29.7	35.0	35.0	37.7	37.9	37.8	35.4	29.7	25.1
t_s2, minutes	1.3	1.2	1.2	1.1	1.2	1.3	1.1	1.1	1.3
t'c(90), minutes	3.2	2.2	3.5	2.1	2.1	2.3	2.5	2.6	3.7

	PLASTICIZER								
	Dioplex®						Paraplex®		
	100	195	430	904	7017	VLV	A-8000	A-8200	A-8600
Original Physical Properties									
Stress @ 300% Elongation, MPa	7.7	7.7	8.2	8.0	7.7	7.6	8.9	8.5	8.5
Tensile Ultimate, MPa	14.3	15.3	14.8	15.5	15.3	15.5	12.7	12.9	11.9
Tensile Ultimate, psi	2070	2225	2145	2245	2220	2250	1840	1875	1730
Elongation @ Break, %	525	585	545	565	595	600	465	490	435
Hardness, Shore A, pts	62	60	61	58	60	60	61	60	61
Specific Gravity	1.205	1.212	1.216	1.214	1.203	1.201	1.208	1.213	1.214
Low-Temperature Brittleness, °C	-27	-29	-29	-29	-35	-41	-37	-34	-35
T_g, °C	-32.6	-28.7	-26.3	-31.0	-34.3	-36.3	NT	NT	NT
Air Oven, 70h @ 125°C									
Tensile Change, %	0	9	3	9	10	5	18	6	12
Elongation Change, %	-41	-34	-39	-34	-38	-41	-32	-42	-33
Hardness Change, pts.	6	5	7	7	4	9	4	6	6
Weight Change, %	-1.1	-1.1	-1.0	-1.0	-1.9	-3.5	-1.3	-0.8	-0.6
IRM 901 Oil, 70h @ 125°C									
Tensile Change, %	-2	-3	0	9	7	4	17	14	14
Elongation Change, %	-35	-44	-35	-32	-42	-44	-32	-36	-31
Hardness Change, pts.	13	5	4	7	9	11	4	5	4
Volume Change, %	-3.3	-2.7	-0.6	-2.2	-6.2	-8.8	-4.1	-3.3	-1.8
Weight Change, %	-3.2	-2.9	-1.3	-2.9	-6.0	-8.0	-4.1	-3.0	-2.4
IRM 903 Oil, 70h @ 125°C									
Tensile Change, %	-8	-2	-9	0	-5	1	8	1	4
Elongation Change, %	-32	-34	-33	-33	-40	-36	-29	-36	-26
Hardness Change, pts.	-5	-5	-6	-3	0	2	-3	-4	-6
Volume Change, %	10.0	9.2	13.0	9.7	3.7	1.5	7.6	11.0	14.0
Weight Change, %	6.7	6.4	9.4	6.4	2.0	0.3	4.6	7.1	9.1
Distilled Water, 70h @ 100°C									
Tensile Change, %	3	-2	0	1	-7	-12	6	4	7
Elongation Change, %	-13	-24	-20	-19	-29	-31	-23	-25	-10
Hardness Change, pts.	5	-2	4	1	-2	-2	-1	0	-1
Volume Change, %	5.2	8.5	7.1	7.0	6.3	6.1	6.3	6.6	7.7
Weight Change, %	4.5	7.3	5.8	6.0	5.7	5.5	5.3	5.4	6.4
ASTM Fuel C, 70h @ 23°C									
Tensile Change, %	-63	-64	-60	-64	-54	-56	-56	-59	-58
Elongation Change, %	-59	-59	-56	-58	-52	-53	-57	-58	-56
Hardness Change, pts.	-28	-28	-28	-25	-24	-25	-28	-29	-31
Volume Change, %	65	52	59	53	45	42	50	56	60
Weight Change, %	43	33	39	34	28	27	32	36	40
ASTM Fuel C Dry Out, 22h @ 70°C									
Hardness Change, pts.	3	4	2	7	8	9	9	7	5
Volume Change, %	-3.4	-6.3	-2.4	-6.0	-9.8	-11.0	-11.0	-6.5	-5.8
Weight Change, %	-4.0	-6.9	-3.4	-6.5	-9.7	-10.0	-10.0	-6.8	-6.0

First Choice | Second Choice | NT = Not Tested

Formulation: Krynac® 3345F - 100.0, Kadox® 920 - 5.0, Sulfur Spider® - 0.4, DQ - 1.0, Carbon Black N660 - 65.0, Stearic Acid - 1.0, Plasticizer - 20.0, MBTS - 2.0, Methyl Zimate - 1.5

POLYMER INFORMATION

Hallstar's innovative Plasthall® PR-Series of plasticizers is on the leading edge of phthalate replacement technology. As environmental and toxicity concerns rise, the desire to transition away from phthalates to non-regulated plasticizers is ever increasing. Once the EU banned DOP, DBP and BBP in 2015, this became more urgent. The typical progression for most compounders was to replace DOP with DINP, DIDP, DOTP, DPHP and/or DINCH.

The PR-Series is a full line of commercially available phthalate replacements, for use in all types of elastomer applications. Our philosophy is not just to offer a phthalate alternative, but to provide our customers with products that will improve their physical properties. These products meet or exceed the performance and economic demands of the marketplace without the environmental problems.

	PLASTICIZER									
	Plasthall® PR-Series									
	A126	A200	A217	A610	LCOA	DPHP	DOTP	DIDP	DINP	DOP
Processing Properties **Viscosity and Curing Properties** **Mooney Viscosity @ 121°C**										
Minimum Viscosity	26.9	28.0	31.1	24.7	32.9	26.8	26.6	27.6	28.6	27.4
t5, minutes	5.3	7.4	7.4	6.7	4.6	10.7	8.5	5.7	5.6	6.9
t35, minutes	5.5	4.5	5.0	3.7	5.8	4.2	3.8	5.0	5.0	3.9
Oscillating Disc Rheometer @ 170°C										
M_L	5.5	4.5	5.0	3.7	5.8	4.2	3.8	5.0	5.0	3.9
M_H	47.7	37.8	37.9	34.8	41.6	32.2	34.1	34.3	34.2	41.1
t_s2, minutes	1.0	1.3	1.2	1.2	1.0	1.5	1.3	1.2	1.3	1.1
t'c(90), minutes	2.6	2.3	2.1	2.2	2.7	25	2.4	2.6	2.8	2.2
Original Physical Properties										
Stress @ 300% Elongation, MPa	10.7	7.6	7.7	9.1	7.8	8.3	8.1	7.3	7.1	9.0
Tensile Ultimate, MPa	15.1	15.5	15.3	15.5	14.8	15.6	16.1	14.6	14.3	16.0
Tensile Ultimate, psi	2190	2250	2220	2255	2145	2260	2340	2115	2070	2320
Elongation @ Break, %	445	600	595	515	595	575	605	620	615	555
Hardness, Shore A, pts	62	60	60	61	60	62	60	58	58	62
Specific Gravity	1.200	1.201	1.206	1.201	1.203	1.191	1.195	1.189	1.191	1.195

	PLASTICIZER									
	Plasthall® PR-Series									
	A126	A200	A217	A610	LCOA	DPHP	DOTP	DIDP	DINP	DOP
Low-Temperature Brittleness, °C	-42	-41	-35	-32	-33	-32	-35	-38	-36	-32
Air Oven, 70h @ 125°C										
Tensile Change, %	11	5	10	13	8	1	12	2	16	15
Elongation Change, %	-30	-41	-38	-35	-32	-49	-40	-39	-29	-41
Hardness Change, pts.	10	9	4	8	5	9	12	9	8	14
Weight Change, %	-3.5	-3.5	-1.9	-3.5	-1.0	-4.1	-5.4	-2.2	-2.7	-8.2
IRM 901 Oil, 70h @ 125°C										
Tensile Change, %	12	4	7	18	10	8	6	7	17	22
Elongation Change, %	-38	-44	-42	-34	-31	-43	-44	-44	-33	-43
Hardness Change, pts.	8	11	9	4	3	14	16	12	14	13
Volume Change, %	-12	-8.8	-6.2	-1.1	-3.2	-13	-12	-11	-11	-13
Weight Change, %	-11	-8.0	-6.0	-0.5	-3.1	-11	-11	-9.4	-9.4	-11
IRM 903 Oil, 70h @ 125°C										
Tensile Change, %	-6	1	-5	-2	-2	-7	-6	0	5	-2
Elongation Change, %	-44	-36	-40	-34	-35	-38	-39	-44	-31	-38
Hardness Change, pts.	3	2	0	5	-3	12	5	2	2	4
Volume Change, %	0.6	1.5	3.7	0.9	9.8	-13	0.4	3.7	4.0	4.6
Weight Change, %	-0.8	0.3	2.0	-0.6	6.7	-11	-0.6	2.2	3.0	3.3
Distilled Water, 70h @ 100°C										
Tensile Change, %	4	-12	-7	10	5	1	1	-4	4	1
Elongation Change, %	18	-31	-29	-7	-20	-23	-19	-31	-21	-15
Hardness Change, pts.	-4	-2	-2	3	-2	-3	0	-1	-3	0
Volume Change, %	4.8	6.1	6.3	3.4	6.3	5.2	4.6	3.8	3.9	2.6
Weight Change, %	4.2	5.5	5.7	3.1	5.3	4.7	4.2	3.3	3.5	2.6
ASTM Fuel C Immersion, 70h @ 23°C										
Tensile Change, %	-59	-56	-54	-46	-59	-52	-51	-53	-52	-49
Elongation Change, %	-51	-53	-52	-47	-64	-54	-50	-59	-56	-50
Hardness Change, pts.	-21	-25	-24	-24	-26	-27	-23	-26	-27	-25
Volume Change, %	40	42	45	38	54	39	38	47	48	38
Weight Change, %	25	27	28	24	35	26	24	31	32	24
ASTM Fuel C Dry Out, 22h @ 70°C										
Hardness, pts.	73	69	68	74	68	74	75	70	72	74
Hardness Change, pts.	15	9	8	13	8	12	15	12	14	12
Volume Change, %	-12	-11	-9.8	-12	-9.2	-13	-13	-13	-13	-12
Weight Change, %	-11	-10	-9.7	-11	-8.7	-12	-11	-11	-11	-11

First Choice Second Choice

Formulation: Krynac® 3345F - 100.0, Kadox® 920 - 5.0, Sulfur Spider® - 0.4, DQ - 1.0, Carbon Black N660 - 65.0, Stearic Acid - 1.0, Plasticizer - 20.0, MBTS - 2.0, ZDMC - 1.5

Krynac® is a registered trademark of Lanxess. Kadox® is a registered trademark of Horsehead Corporation. Plasthall® and Sulfur Spider® are registered trademarks of Hallstar.

POLYMER INFORMATION

Acrylic elastomers, some of which were once identified as polyacrylate elastomers (AEM/ACM), are used for applications requiring 150-177°C continuous service with intermittent exposure to 205°C. Acrylic elastomers have a saturated backbone with aliphatic pendant groups such as ethyl, n-butyl and 2-methoxy ethyl groups. These pendant groups are introduced through the use of base monomers, which account for 95-99% of the weight of normal polyacrylate elastomer. Acrylic elastomer also have a small amount of carboxyl, chlorine and/or epoxide pendant groups which serve as cure sites introduced through the use of cure-site monomers such as acrylic or methacrylic acid, vinyl chloroacetate and/or glycidyl methacrylate monomers.

Curing occurs through a reactive halogen, epoxy or carboxyl that is part of a pendant group. No cure systems are universal to all of the reactive groups. Many acrylics require an (oven) post cure at 150–163°C, especially if low compression set is a requirement.

Most of the acrylics require a plasticizer to achieve low-temperature performance. Many monomerics are too volatile to be of value because of the post cure requirement; therefore low-temperature performance can best be achieved with polymerics as well as TP-759® and TegMeR® 812.

APPLICATIONS

PRODUCTS THAT REQUIRE RESISTANCE TO OIL AND FUEL SUCH AS:

- Adhesives
- Belting
- Cable jacket
- Crankshaft seals
- Gaskets
- Hose tubing
- Hoses
- Lip seals
- Metal clad shaft seals
- O-rings
- Pan seals
- Spark plug boots
- Transmission seals
- Valve stem oil deflectors
- Wires and cables

TegMeR® 812 provides the broadest useful temperature range from -50°C to 190°C.

	PLASTICIZER		
	TP-Series TP-759®	TegMeR® 812	Paraplex® A-8000
Processing Properties Viscosity and Curing Properties Mooney Viscosity @ 121°C			
Minimum Viscosity	22	22.7	25.1
Oscillating Disc Rheometer @ 177°C			
M_L	6.5	1.6	1.8
M_H	46.7	42.7	35.9
t_s2, minutes	6.9	8.4	6.6
1.25* t'c(90), minutes	8.6	10.5	8.2
Sheets Cured, 5m @ 175°C, Post Cured, 4h @ 175°C			
Weight Loss After Post Cure, %	-3.1	-1.4	-1.8
Original Physical Properties			
Tensile, Ultimate, psi	2065	2255	2270
Elongation @ Break, %	205	205	230
Hardness, Shore A, pts	76	76	75
Specific Gravity	1.232	1.228	1.232
T_g, °C	-44	-44	-39
Low-Temperature Brittleness, °C	-42	-42	-36
Compression Set, % 22h @ 100°C	32	29	37
Air Oven, 168h @ 177°C			
Low-Temperature Brittleness, °C	-31	-38	-36
Tensile Change, %	-8	-14	-16
Elongation Change, %	-5	-5	-2
Hardness Change, pts.	5	0	0
Weight Change, %	-5.4	-2.5	-1.8
T_g, °C	-38	-41	-38
IRM 901 Oil, 1wk @ 150°C			
Hardness Change, pts.	1	1	-1
Volume Change, %	0.2	-0.8	3.1
Weight Change, %	-1.2	-1.9	1.4
IRM 903 Oil, 1wk @ 150°C			
Hardness Change, pts.	-24	-22	-25
Volume Change, %	50	46	52
Weight Change, %	37	33	38
ASTM SF 105, 1wk @ 150°C			
Hardness Change, pts.	-11	-10	-11
Volume Change, %	17	15	19
Weight Change, %	11	9.3	13
Transmission Fluid, 1wk @ 150°C			
Hardness Change, pts.	70	70	68
Volume Change, %	11	9	13
Weight Change, %	6	5	8

First Choice | Second Choice

Formulation: Vamac® G - 100.00, Carbon Black N-550 - 68.00, Naugard® 445 - 2.00, Armeen® 18D - 0.50, Vanfre® VAM - 1.00, Plasticizer - 20.00, Stearic Acid - 1.50
Mill Addition: Vulcofac® ACT 55 - 1.80, Diak® 1 - 1.50

Monomeric Ester Plasticizers for Polychloroprene (CR)

POLYMER INFORMATION

Polychloroprene (CR) is created through the conversion of unsaturated linear C4 compound to 2-chloro-1, 3-butadiene. Polymerization of chloroprene to polychloroprene today is primarily by free radical emulsion.

Important polychloroprene elastomer variables are crystallization rate, mercaptan modifications, sulfur modifications and precrosslinked versions. The end-use helps direct which of those four variables are best suited to the particular application. Polychloroprene provides limited oil resistance, reasonable weather resistance, good resilience, broad chemical resistance and some flame resistance.

APPLICATIONS

- Adhesives (solvent, solid, dry-film) and mastics
- Calendered sheeting
- Coated fabrics
- Conveyor belts
- Escalator handrails
- Expansion joints
- Grommets
- Hose cover stocks for industrial hoses
- Ignition wire jackets
- Isolation (bridge) pads
- Mattresses
- Packers
- Roof flashing
- Shoe soles
- Spark plug boots
- Sponge gaskets
- Steering boots
- Tank linings
- V-belts
- Various mechanical goods
- Water seals
- Wire and cable jackets

	PLASTICIZER												
	Plasthall®												TegMeR®
	100	207 (DBES)	226	503	4141	DIDA	DOA	DOP	DOZ	DOS	8-10TM	TOTM	804S
Processing Properties Viscosity and Curing Properties Mooney Viscosity @ 121°C													
M_L @ 125°C	30.0	32.0	29.0	26.0	29.0	35.0	32.0	38.8	31.0	32.1	36.8	35.0	31.5
t5, 125°C, minutes	14.0	13.0	11.3	14.5	12.8	14.0	13.5	13.0	14.8	15.4	14.5	14.5	11.0
Cure Time, 150°C, minutes	51.0	46.0	41.0	51.0	43.0	50.0	51.0	51.0	55.0	52.0	59.0	55.0	44.0
Original Physical Properties													
Stress @ 100% Elongation, psi	375	400	350	50	400	400	425	425	400	400	450	350	425
Tensile Strength, psi	1500	1500	1600	1500	1650	1500	1550	1650	1600	1525	1700	1700	1600
Elongation @ Break, %	270	250	260	290	260	250	270	260	270	260	270	290	240
Hardness, Shore A, pts	66	68	68	65	68	69	68	71	68	69	71	70	68
Specific Gravity	1.436	1.465	1.483	1.451	1.478	1.456	1.454	1.474	1.455	1.453	1.471	1.483	1.474
Tear Resistance, ppi	82	87	79	77	76	88	87	96	78	87	101	104	81
Compression Set, %, 22h @ 100°C	26	290	31	33	35	30	28	30	29	30	29	32	30
Low-Temperature Brittleness, °C	-54	-53	-48	-57	-49	-48	-48	-39	-51	-50	-43	-39	-46
Low-Temperature Modulus, T2, °C	-27	-28	-24	-24	-14	-25	-26	-23	-29	-27	-20	-17	-23

	PLASTICIZER												
	Plasthall®												TegMeR®
	100	207 (DBES)	226	503	4141	DIDA	DOA	DOP	DOZ	DOS	8-10TM	TOTM	804S
Low-Temperature Modulus, T100, °C	-65	-61	-57	-66	-60	-58	-62	-52	-61	-61	-50	-47	-59
Air Oven, 70h @ 100°C													
Elongation Change, %	-15	-16	-8	-35	-12	-5	-33	-17	-11	-14	-4	-14	0
Hardness Change, pts.	5	5	3	16	6	5	10	5	4	4	4	3	2
Weight Change, %	-1.5	-0.7	-1.0	-7.7	-2.0	-1.2	-5.4	-2.8	-1.1	-0.6	-0.3	-0.1	-0.9
Brittle Point, °C	-46	-48	-45	-26	-45	-47	-34	-35	-45	-48	-38	-35	-44
IRM 901, 70h @ 100°C													
Elongation Change, %	-23	-16	-15	-21	-12	-5	-26	-17	-22	-20	-17	-24	13
Hardness Change, pts.	11	7	6	10	8	7	7	6	9	8	6	4	4
Volume Change, %	-9.5	-7.2	-5.5	-9.7	-7.1	-8.9	-8.8	-7.6	-8.4	-8.9	-7.1	-7.5	-6.6
Brittle Point, °C	-31	-30	-31	-30	-30	-30	-30	-28	-29	-30	-22	-29	-28
IRM 903, 70h @ 100°C													
Elongation Change, %	-19	-20	-23	-28	-23	-23	-22	-22	-22	-18	-26	-21	-21
Hardness Change, pts.	-19	-21	-19	-22	-21	-19	-19	-19	-18	20	-26	-24	-19
Volume Change, %	41	43	43	45	43	39	41	40	40	40	41	43	42
Brittle Point, °C	-42	-39	-42	-39	-39	-42	-41	-38	-42	-40	-35	-40	-43
Transmission Fluid, Dextron-II Type, 70h @ 100°C													
Elongation Change, %	0	-8	-8	-14	-8	-5	-11	-13	-15	-5	-14	-14	4
Hardness Change, pts.	-7	-10	-9	-7	-10	-7	-9	-7	-7	-7	-9	-9	-8
Volume Change, %	4.2	7.5	9.8	5.1	8.4	5.7	5.6	7.2	5.7	5.3	7.2	6.6	8.1
Brittle Point, °C	-40	-34	-37	-37	-36	-34	-35	-34	-37	-35	-38	-34	-37
Distilled Water, 70h @ 100°C													
Elongation Change, %	-15	-12	-12	-14	-23	-14	-19	-13	-19	-16	-9	-17	-13
Hardness Change, pts.	-6	-11	-6	-10	-11	-9	-6	-7	-8	-7	-7	-10	-8
Volume Change, %	15	21	21	17	22	16	15	14	16	15	13	15	21
Brittle Point, °C	-52	-43	-29	-54	-41	-44	-49	-36	-47	-49	-38	-36	-43
Diffusion Stain Resistance													
Sunlamp Exposure‡	G	F	F	F	P	E	E	E	E	E	G	E	F

First Choice **Second Choice** **E = Excellent, no yellowing; G = Good, minimal yellowing; F = Fair, slight yellowing; P = Poor, moderate yellowing**

‡Uncured polychloroprene samples with white Ditzler® acrylic lacquer. Rating based on yellowing of acrylic topcoat after 32 hours of sunlamp exposure.

Formulation: Neoprene WK - 100.0, Stearic Acid - 0.5, Stabiwhite Powder - 3.0, Maglite® D(RX) - 4.0, Carbon Black N-774 - 67.0, Crown Clay - 35.0, Plasticizer - 32.0
Mill Additions: Kadox® 930 - 5.0, END 75P - 0.75, TMTD - 0.50

Ester Plasticizers for Chlorinated Polyethylene Elastomers (CPE)

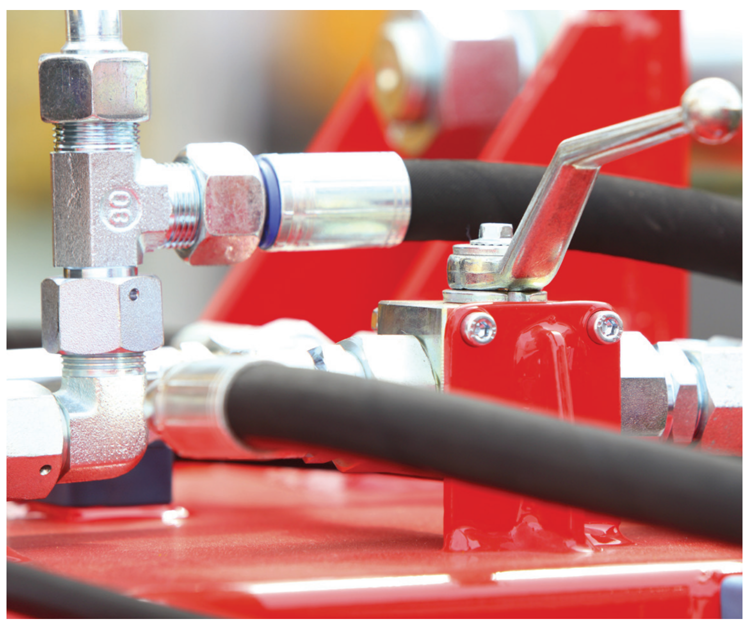
POLYMER INFORMATION

Chlorinated polyethylene elastomers (CPE) are produced from HDPE that is randomly chlorinated in an aqueous slurry. Polymers are differentiated by chlorine content, molecular weight and crystallinity. Chlorine contents generally range from 25 to 42 percent. Advantages of using CPE include very good resistance to ozone, oxidation, abrasion and flex cracking. CPE also has good resistance to alcohols, alkalis and acids. Limitations for CPE include moderate resistance to aromatic oxygenated solvents.

Since CPE is a saturated elastomer, typical sulfur cure systems are ineffective for vulcanization. The cure systems for CPE are thus divided into the thiourea, peroxy, thiadiazole, and triazoledimercaptoamine salt systems. CPE is usually peroxide-cured and some plasticizers may affect cure rate and degree of cure. Plasticizers containing double bonds (oleates and tallates) can rob curative effectiveness, as can naphthenic oils.

APPLICATIONS

- Gaskets
- Hydraulic hoses
- Injection molding
- Linings
- Mechanical goods and extrusions
- Roofing
- Sheet and sponge
- Wire and cable insulation



Plasthall® P-670 provides the best combination of heat aging as well as oil and fuel resistance.

	PLASTICIZER		
	Plasthall®		Paraplex®
	P-670	TOTM	G-62
Processing Properties Viscosity and Curing Properties Mooney Viscosity @ 121°C			
M_L	15.1	23.2	22.8
M_H	30.1	60.1	52.3
ts2, minutes	3.7	2.9	2.8
t'c(90), minutes	10.5	10.5	9.8
Original Physical Properties			
Stress @ 100% Elongation, psi	200	300	200
Tensile, Ultimate, MPa	14.4	17.1	16.1
Tensile, Ultimate, psi	2100	2500	2350
Elongation @ Break, %	340	440	500
Hardness, Shore A, pts	73	75	74
Specific Gravity	1.346	1.323	1.327
Tear Resistance, lbf/in.	118	184	200
Low-Temperature Brittleness, °C	-34	-42	-35
Air Oven, 70h @ 150°C			
Tensile Change, %	2	-10	-2
Elongation Change, %	-6	-30	-20
Hardness Change, pts.	5	7	9
Weight Change, %	-2.6	-3.9	-1.8
IRM 902, 70h @ 150°C			
Tensile Change, %	-12	-22	-30
Elongation Change, %	-9	-32	-20
Hardness Change, pts.	-30	-29	-35
Volume Change, %	58	49	61
Weight Change, %	43	41	41
ASTM Fuel C, 70h @ 23°C			
Tensile Change, %	-76	-74	-77
Elongation Change, %	-56	-61	-54
Hardness Change, pts.	-40	-38	-46
Volume Change, %	104	91	106
Weight Change, %	60	52	61
ASTM Fuel C Dry Out, 22h @ 70°C			
Hardness Change, pts.	8	12	11
Volume Change, %	-12	-19	-16
Hardness Change, pts.	-10	-15	-14

Best Choice

Formulation: Tyrin® CM0136 - 100.0, Carbon Black N-330 - 50.0, Hi-Sil™ 233 - 10.0, Agerite® Resin D - 0.2, DAP - 10.0, Plasticizer - 35.0, Trigonox® 17/40 - 2.0, Vul-Cup® 40KE - 6.0

POLYMER INFORMATION

Hydrogenated nitrile butadiene rubber (HNBR) is produced by hydrogenating the double bonds of the butadiene component of nitrile butadiene rubber (NBR). This reduces the number of double bonds which causes the backbone of the polymer to become linear hydrocarbon chains with pendant nitrile groups. The saturation level of HNBR typically ranges from 94 percent to 100 percent.

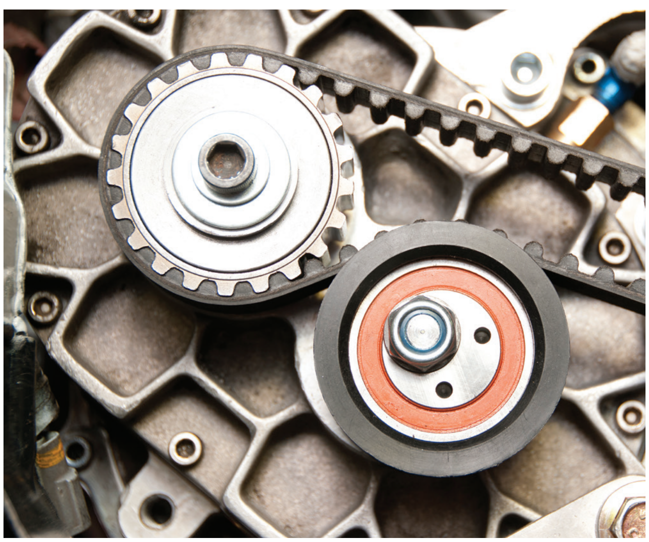
Some of the effects of reducing the double bonds of the butadiene component are:

- The elastomer is less polar.
- The elastomer becomes more plastic in character than the NBR from which it was produced.
- The elastomer is less susceptible to attack by oxygen and ozone.
- The elastomer is more heat resistant.
- Fully-saturated HNBR is peroxide curable only.
- Lower-saturated HNBR is both sulfur and peroxide curable.

APPLICATIONS

PRODUCTS THAT REQUIRE RESISTANCE TO OIL AND FUEL SUCH AS:

- Fuel cell liners
- Fuel lines and hoses (covers and tubes)
- Gaskets
- Grommets
- O-rings
- Oil well parts
- Packings
- Seals
- Timing belts



Plasthall® RP-1020 is a reactive plasticizer that provides excellent resistance to oils and fuels. It also provides low-temperature performance equal to that of TOTM, but with superior volatility resistance in high-temperature applications.

	PLASTICIZER			
	Plasthall®		Paraplex®	
	TOTM	RP-1020	A-8210	A-8600
Original Physical Properties				
Stress @ 100% Elongation, MPa	6.0	4.5	5.5	5.6
Tensile, Ultimate, MPa	23.2	20.2	24	22.4
Tensile, Ultimate, psi	3360	2930	3480	3255
Elongation @ Break, %	395	525	445	390
Hardness, Shore A, pts	72	69	70	72
Specific Gravity	1.17	1.16	1.17	1.17
Low-Temperature Brittleness, °C	-64	-68	-62	-60
Compression Set, %, 70h @ 135°C	48	58	48	48
Air Oven, 14d @ 135°C				
Tensile Change, %	-11	2	-7	-3
Elongation Change, %	-19	-26	-22	-17
Hardness Change, pts.	6	10	9	8
Weight Change, %	-2.9	-4.5	-3	-2.4
IRM 901 Oil, 168h @ 135°C				
Tensile Change, %	6	10	1	6
Elongation Change, %	-6	-16	-20	-18
Hardness Change, pts.	4	3	6	3
Volume Change, %	-5.9	-2.8	-2.6	-1
Weight Change, %	-5.5	-2.7	-2.8	-1
Distilled Water, 168h @ 100°C				
Tensile Change, %	-2	-1	0	6
Elongation Change, %	9	-6	-11	-8
Hardness Change, pts.	-1	1	1	0
Volume Change, %	1.7	3.1	5	6.2
Weight Change, %	1.8	3	4.6	5.6
Synthetic Motor Oil 5W-30, 960h @ 140°C				
Tensile Change, %	7	13	0	4
Elongation Change, %	-43	-51	-46	-45
Hardness Change, pts.	7	7	7	5
Volume Change, %	-4.1	-0.8	-0.7	1.5
Weight Change, %	-3.1	-0.1	-0.4	1.5
ASTM Fuel C, 70h @ 23°C				
Tensile Change, %	-45	-46	-48	-46
Elongation Change, %	-44	-58	-51	-59
Hardness Change, pts.	-25	-31	-22	-21
Volume Change, %	56	67	61	65
ASTM Fuel C Dry Out, 22h @ 70°C				
Hardness Change, pts.	2	2	2	1
Volume Change, %	-5.7	-3.3	-3.7	-1.7
Weight Change, %	-5.4	-3.2	-3.8	-2.7

First Choice Second Choice

Formulation: Zetpol® 2000 - 100.0, Carbon Black N-550 - 50.0, Kadox® Zinc Oxide - 5.0, Naugard® 445 - 1.5, Vanox® ZMTI - 1.0, Plasticizer – 10.0, Peroxide 8.0

Monomeric Ester Plasticizers for Epichlorohydrin Rubber (ECO)

POLYMER INFORMATION

Epichlorohydrins are touted as possessing a combination of many of the desirable properties of polychloroprene and nitrile. A potential drawback to epichlorohydrin is its lack of resistance to oxygenated solvents, steam and acid. The mode of failure is reversion (devulcanization). Advantages to epichlorohydrins include good resistance to ozone and oxidation. Unlike the copolymer, the terpolymer can be readily blended with SBR and nitrile, and can be sulfur-cured.

APPLICATIONS

- Fuel pump diaphragms
- Fuel, oil and gas hoses
- Gaskets
- Motor mounts
- O-rings
- Vibration isolators

	PLASTICIZER			
	Plasthall®			TP-Series
	7006	7050	226 (DBEEA)	TP-759®
Processing Properties **Viscosity and Curing Properties** **Mooney Viscosity @ 121°C**				
Minimum Viscosity	42.3	41.3	39.2	40.6
t5, minutes	8.3	7.3	7.7	7.7
t35, minutes	12.5	10.8	11.5	11.2
Oscillating Disc Rheometer @ 160°C				
M_L	10.1	10.1	9.6	10.1
M_H	39.1	45.0	44.5	51.1
t_S2, minutes	2.8	2.8	2.8	2.8
t'c(90), minutes	19.5	21.8	22.8	24.3
Original Physical Properties				
Stress @ 100% Elongation, MPa	2.8	2.4	2.6	2.8
Tensile, Ultimate, MPa	10.3	10.5	10.0	11.5
Elongation @ Break, %	365	405	375	395
Hardness, Shore A, pts	64	61	63	64
Tear Resistance, ppi	236	250	237	249
Specific Gravity	1.378	1.389	1.379	1.391
Compression Set, %, 70h @ 125°C	55	46	52	53

	PLASTICIZER			
	Plasthall®			TP-Series
	7006	7050	226 (DBEEA)	TP-759®
Low-Temperature Brittleness, °C	-46	-45	-50	-47
Air Oven, 70h @ 150°C				
Tensile Change, %	-3.3	-16	-3.4	-25
Elongation @ Break, %	205	200	200	200
Elongation Change, %	-44	-51	-47	-49
Hardness Change, pts.	16	10	12	7
Weight Change, %	-10.0	-5.9	-9.2	-4.4
IRM 901 Oil, 70h @ 150°C				
Tensile Change, %	15	8	24	10
Elongation Change, %	-49	-54	-45	-48
Hardness Change, pts.	11	14	13	11
Volume Change, %	-13	-11	-12	-12
Weight Change, %	-9.6	-9.4	-9.9	-9.6
IRM 903 Oil, 70h @ 150°C				
Tensile Change, %	-3.3	-6.6	1.7	-19.0
Elongation Change, %	-41	-49	-41	-53
Hardness Change, pts.	6	8	7	9
Volume Change, %	-3.8	-3.3	-4.2	-3.4
Weight Change, %	-3.6	-4.1	-4.1	-4.0
Distilled Water, 70h @ 100°C				
Tensile Change, %	-37	-31	-26	-31
Elongation Change, %	-47	-53	-45	-47
Hardness Change, pts.	-13	-13	-10	-15
Volume Change, %	33	38	32	40
Weight Change, %	25	28	24	30
ASTM Fuel C Immersion, 70h @ 23°C				
Tensile Change, %	-28	-33	-28	-42
Elongation Change, %	-41	-54	-47	-56
Hardness Change, pts.	-14	-13	-11	-10
Volume Change, %	15.3	24.5	23.2	23.1
Weight Change, %	12.4	12.7	12.5	12.1
ASTM Fuel C Dry Out, 22h @ 70°C				
Hardness Change, pts.	11	11	12	12
Volume Change, %	-17.3	-13.2	-13.9	-13.9
Weight Change, %	-12.6	-10.5	-10.4	-10.6

Formulation: Hydrin® T5010 - 100.0, Carbon Black N-550 - 40.0, Carbon Black N-330 - 20.0, Talc - 15.0, Vanox® CDPA - 1.0, Vanox® MTI - 0.5, Stearic Acid - 1.0, Struktol® WB 222 - 2.0, Atomite® - 15.0, Maglite® D - 0.3, Plasticizer - 8.0, Zisnet® F-PT 0.8, Vanax® DPG - 0.5, Vulkalent® E/C - 0.3

Polymeric Ester Plasticizers for Epichlorohydrin Rubber (ECO)

POLYMER INFORMATION

Epichlorohydrins are touted as possessing a combination of many of the desirable properties of neoprene and nitrile.
A potential drawback to epichlorohydrin is its lack of resistance to oxygenated solvents, steam and acid. The mode of failure is reversion (devulcanization). Advantages to epichlorohydrins include good resistance to ozone and oxidation. Unlike the copolymer, the terpolymer can be readily blended with SBR and nitrile, and can be sulfur-cured.

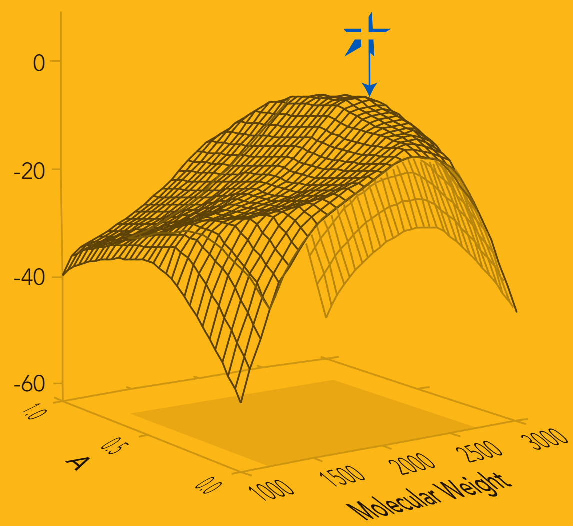
APPLICATIONS

- Fuel pump diaphragms
- Fuel, oil and gas hoses
- Gaskets
- Motor mounts
- O-rings
- Vibration isolators

	PLASTICIZER				
	Plasthall®	Paraplex®			
	P-670	G-50	A-8000	A-8200	A-8600
Processing Properties Viscosity and Curing Properties Mooney Viscosity @ 121°C					
Minimum Viscosity	62	62.4	64.3	66.8	68.1
t10, minutes	6.6	7.1	6.7	6.4	6.1
t35, minutes	11	12.1	10.9	10.7	10.2
Oscillating Disc Rheometer @ 180°C					
M_L	11.3	10.6	11	11.6	11.4
M_H	53.9	49.2	49.5	51.3	48.7
t_s2, minutes	1.7	1.6	1.7	1.7	1.6
t'c(90), minutes	35.5	32	31.5	33.2	32.3
Original Physical Properties					
Stress @ 100% Elongation, MPa	4.9	4.7	4.8	4.6	4.6
Tensile Ultimate, MPa	10.8	11.9	13	12.7	12.1
Elongation @ Break, %	310	320	365	375	365
Hardness, Shore A, pts	73	72	72	72	72
Specific Gravity	1.475	1.472	1.471	1.473	1.473
T_g, °C	-44	-42.9	-44.3	-43.4	-42.3
Compression Set, %, 22h @ 100°C	20	21	20	22	29
Low-Temperature Brittleness, °C	-34	-34	-37	-37	-34
Air Oven, 70h @ 150°C					
Stress Change, %	43	44	41	43	42
Tensile Change, %	4	-4	-11	-6	-1
Elongation Change, %	-42	-31	-45	-40	-40
Hardness Change, pts.	6	5	7	5	4
Weight Change, %	-2	-1.8	-1.8	-1.6	-1.5
T_g, °C	-42.8	-42.6	-43.3	-42.9	-42.7

	PLASTICIZER				
	Plasthall®	Paraplex®			
	P-670	G-50	A-8000	A-8200	A-8600
IRM 901 Oil, 70h @ 150°C					
Tensile Change, %	10	14	2	0	9
Elongation Change, %	-44	-36	-45	-49	-44
Hardness Change, pts.	9	11	10	9	9
Volume Change, %	-7.7	-7.8	-8.4	-7	-7
Weight Change, %	-5.6	-5.4	-6	-4.9	-5.4
IRM 903 Oil, 70h @ 150°C					
Tensile Change, %	5	-8	-18	-16	-7
Elongation Change, %	-34	-38	-45	-48	-41
Hardness Change, pts.	2	2	3	1	2
Volume Change, %	1	1.8	0.3	2.8	2.9
Weight Change, %	0.1	0.6	-0.3	1.3	0.6
Distilled Water, 70h @ 100°C					
Tensile Change, %	-1	-5	-6	-4	2
Elongation Change, %	-32	-34	-33	-35	-32
Hardness Change, pts.	-12	-11	-13	-11	-11
Volume Change, %	31	31	29	30	30
Weight Change, %	22	22	21	21	21
ASTM Fuel C Immersion, 70h @ 23°C					
Tensile Change, %	-42	-36	-39	-34	-33
Elongation Change, %	-48	-36	-42	-41	-41
Hardness Change, pts.	-20	-20	-19	-20	-20
Volume Change, %	32	33	31	35	35
Weight Change, %	17	18	17	19	19
ASTM Fuel C Dry Out, 22h @ 70°C					
Hardness Change, pts.	6	8	9	4	7
Volume Change, %	-9.1	-8.2	-9.4	-7.3	-7.6
Weight Change, %	-6.5	-6	-6.7	-5.2	-5.5
80% Diesel/20% Biodiesel, 1wk @ 100°C					
Tensile Change, %	-26	-38	-37	-34	-35
Elongation Change, %	-42	-47	-53	-49	-48
Hardness Change, pts.	-6	-8	-5	-8	-8
Volume Change, %	4.6	5.3	4	6.6	6.3
Weight Change, %	9	10	8	12	12

Formulation: Hydrin® T5010 - 100.0, Carbon Black N-550 - 40.0, Carbon Black N-330 - 20.0, Talc - 15.0, Vanox® CDPA - 1.0, Vanox® MTI - 0.5, Stearic Acid - 1.0, Struktol® WB 222 - 2.0, Atomite® - 15.0, Maglite® D - 0.3, Plasticizer - 8.0, Zisnet® F-PT - 0.8, Vanax® DPG - 0.5, Vulkalent® E/C - 0.3



THE PARAPLEX APPROACH

The above three-dimensional Response Surface Diagram is generated as part of the Paraplex Approach. The image illustrates the optimized chemical composition of a custom-designed plasticizer with the best combination of properties for the application in question. The Hallstar star next to the arrow indicates the optimal solution point.

With decades of experience formulating specialty plasticizers, Hallstar is recognized as a premier producer of ploymer modifiers. Our Paraplex® brand is the benchmark for high-performance plasticizers and continues to be strengthened through our innovative approach to customized plasticizer formulation, which combines cutting-edge technology with our broad expertise.

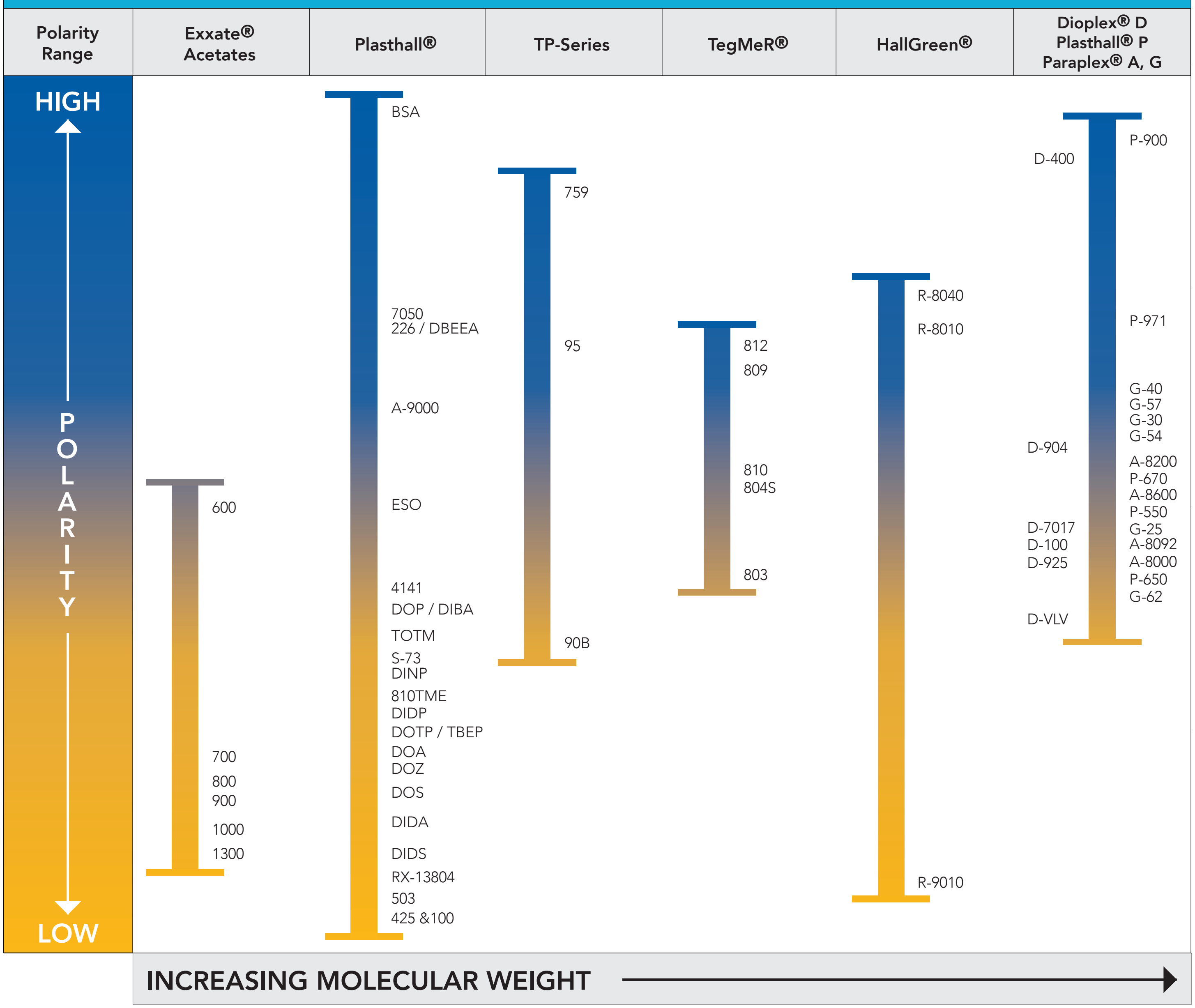
The Paraplex Approach is a molecular design system developed by Hallstar to characterize and synthesize chemistry solutions for well-defined customer performance requirements. Through the use of existing performance data, application knowledge and the latest in computer simulation technology, raw materials can be rapidly adjusted in precise combinations to create a plasticizer that solves critical performance issues.

Our targeted approach helps reduce product qualification time, improve speed to market for new product development and meet the continuously changing needs of your customers.

HALLSTAR POLARITY CHART

Plasticizer Brand Names	Exxate®	Plasthall®	TP-Series	TegMeR®	HallGreen®	Dioplex® D Plasthall® P Paraplex® A, G
Description	Acetate Ester Solvents	Monomeric Esters	Monomeric Ether/Ester	Monomeric Ether-Esters	Biobased Esters	Polyester
Applications	Coatings AgChem (EC/EW/OD) Pigment Dispersions	Automotive Underhood Vinyl Film Adhesives Wire & Cable Tires	Automotive Underhood E-Coat	Paints & Coatings Automotive Underhood	Process Aid Biodegradeable Resins Adhesives	Vinyl Automotive Interior Wire & Cable Automotive Underhood Adhesives Tapes/Decals
Performance Features	EPA 48 (Organic) Low Hazard Low Odor	Range of Polarity Low Temp. Flexibility	Low Temp. Flexibility Heat Resistance E-Coat Film Build	Nucleating Agent Water Resistance Low Temp. Flexibility	USDA Certified Biobased ASTM D-6400	Improved Durability Extraction Resistance Migration Resistance
Compatible Polymer Systems	Acrylic Epoxy PMMA Polyester Polyurethane	CPE CR EPDM (H)NBR NBR Nylon PV(Ac) PVC	AEM/ACM (H)NBR NBR	AEM/ACM (H)NBR NBR PET PV(Ac)	Cellulose Acetate NBR PHA PLA PVC Starch	(H)NBR NBR PVC

PLASTICIZER POLARITIES



The higher a plasticizer is placed on the chart above, the higher its polarity; the further to the right of the chart, the higher its molecular weight. Plasticizer polarity does not necessarily guarantee compatibility in a polymer/formulation but can be used as a general selection guideline. Please consult a Hallstar Technical Expert for additional guidance.

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