SI Group®

The Substance Inside

Technology for Adhesives

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Strong Pasts, Stronger Future

addivant™

SI Group®
The Substance Inside

Our History

Roots dating back to the 1890's

Founded in 1906 as the Schenectady Varnish Company

Global Growth

Excellence in manufacturing & innovation as Crompton, Great Lakes Antioxidants, and Chemtura

Acquisitions & intelligent expansion as Schenectady Chemicals, and Schenectady International

Strong Executive Leadership Team

Led by President and CEO **David Bradley**

stronger together

STRATEGIC
market focus

ACCELERATES
access to
technology

LEVERAGING
backward integration
capabilities

SI Group

Our Global Reach

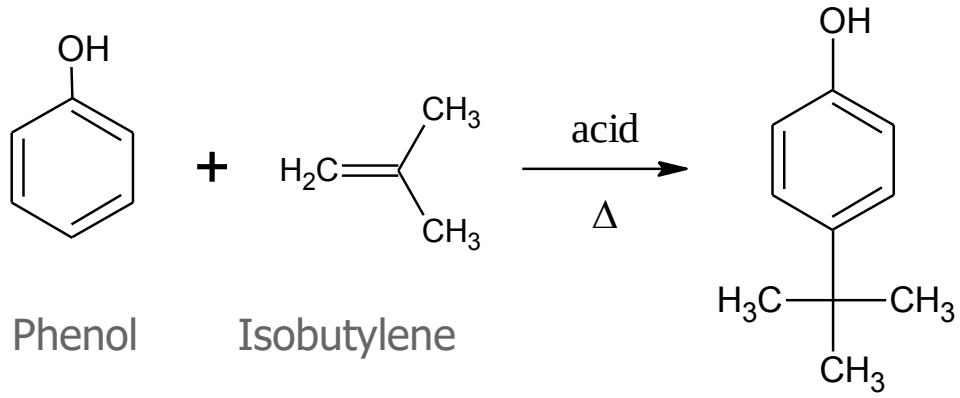
30
Manufacturing Facilities & 5 Joint Ventures

3,000
Global Workforce

$2+
Billion in Annual Sales

Phenol and Alkylphenol Chemistry

- Phenols, Alkylphenols and derivatives:
  - **Slightly acidic** – reaction with NaOH but not $NaHCO_3$
  - **Oxidize** at the exposure to air – colored products - ANTIOXIDANTS
    - Oxidation affects the color of phenol and derivatives – aged materials more colored
  - **Undergoes easily electrophilic aromatic substitution** – alkylation (with olefins, alkohols), nitration, sulfonation, halogenation, acylation, etc.



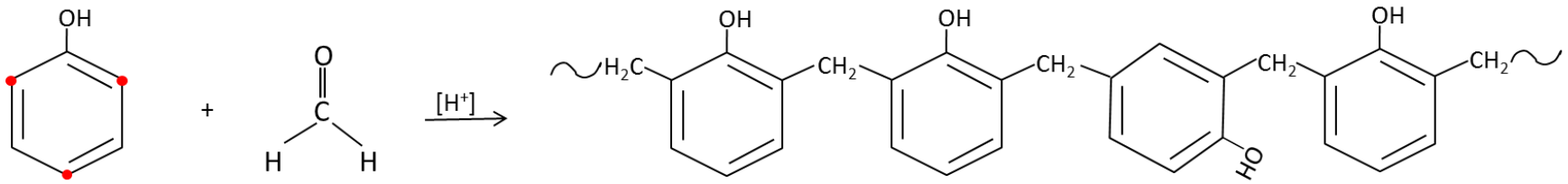
Phenol Isobutylene

Friedel-Crafts Alkylation

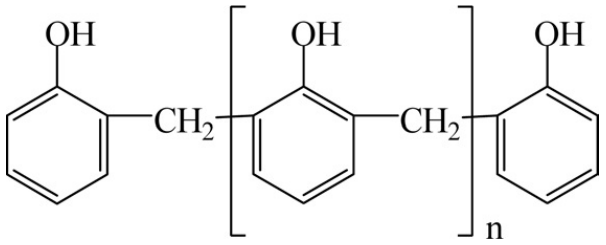
para-t-butylphenol – PTBP

Novolacs – Two-step Resins

- **1. Condensation of P/AP and F under acidic conditions**



- **Production Parameters:**
  - P:F ratio – 1: 0.6 – 0.9
  - Acidic catalyst
  - Solid material or diluted (solvents)



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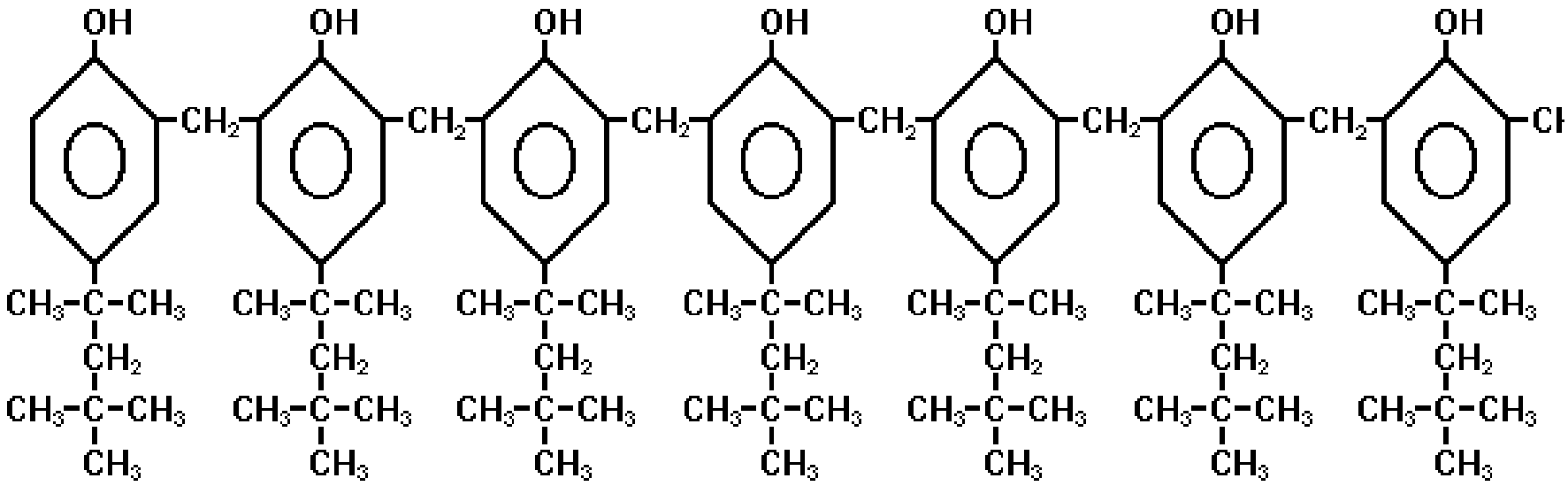
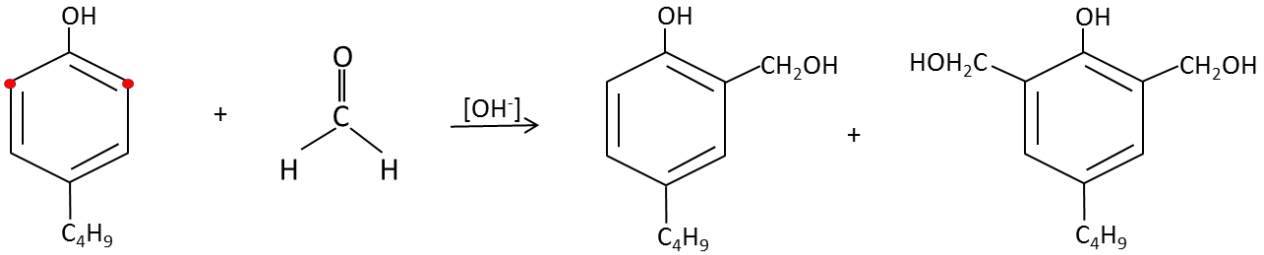
Chemical Properties of Akylphenol / Formaldehyde Tackifier Resins

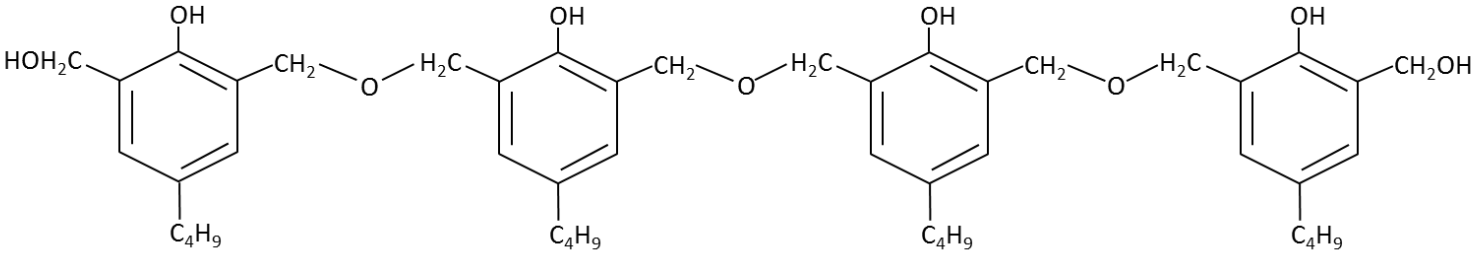
- Linear polymers – for easy dispersion and solution
- Thermoplastic - not sensitive to repeated heating
- Poly-functional in Aromatic Hydroxyls – which provide sites for hydrogen bonding to occur
- Contains high amount of olefinic character – to promote good solubility in and compatibility with various compounds



Heat Reactive Resins

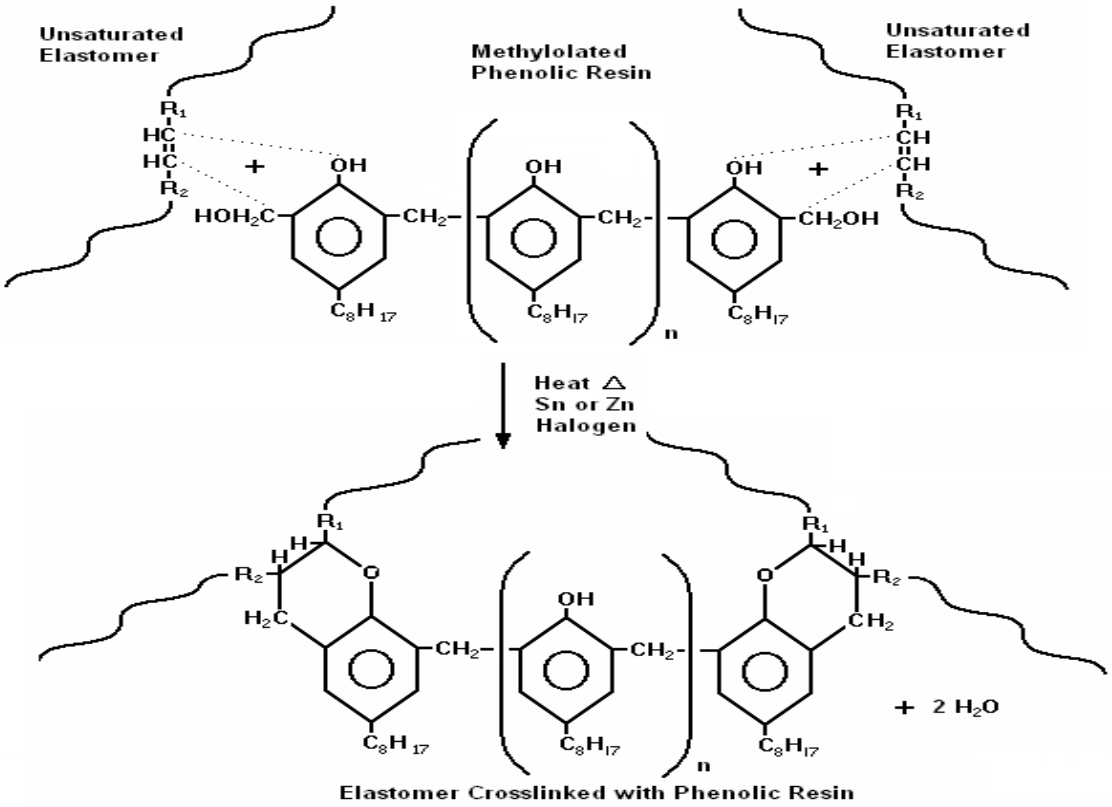
- Condensation process





Reactivity – Methylol end cap

Terminal Methylols have also feature that makes them useful:



They are able to react with unsaturated elastomers and are so classified as curing agents and are alternative to peroxide and sulfur

Adhesives and Sealants – SI Group Products

- Phenol-formaldehyde resins – adhesives on their own – wood market – plywood, etc.
- But PF resins modify other primary adhesive base polymer enhancing bonding properties

Why phenolic resins?

- great mechanical properties – hard and tough materials, excellent structural element
- high temperature resistant materials
- blend well with other materials
- adhere to different substrates
- excellent flame, smoke, and toxicity properties
- versatile applications – thermoplastic, thermoset, modified
- reasonable cost/benefit ratio

Adhesives and Sealants – SI Group products

- Our product offerings to Adhesive industry overlap with products to Rubber industry
- Similar terminology, products, performance, base polymers (NR, IIR, SBR, NBR, …)

- 4 groups of products:

  - **Tackifiers** – used to increase the tack of the base polymer, thermoplastic
  - **Reinforcing resins** – used to increase the hardness, toughness, stiffness, thermoset
  - **Curing resins** – phenolic resin rubber cure – increases thermal stability, thermoset
  - **Adhesion resin** – used to promote the bonding of rubber parts to non-rubber (rubber compounding) – thermoset, thermoplastics

Adhesives and Sealants – SI Group products

- **Thermoplastic** – Tackifiers, viscosity modifiers, initial strength
  - p-tert-octylphenol tackifiers – PTOP tackifiers – *SP-1068, HRJ-2765*
  - p-tert-butylphenol tackifiers – PTPB tackifiers – *SMD 31144*
  - straight or modified phenol-formaldehyde novolaks – *Elaztobond™ T6000, SP-1077*
  - terpene-phenolics – solid, water based – *SP-553, SP-560, HRJ-11112*

- **Thermoset, Reactive** – heat resistance, co-reactants, curing agents, bond strength
  - PTBP reactive resins – solid – *FRJ-551, HRJ-1367, HRJ-10416*
  - PTOP reactive resins – solid – *SP-1045, HRJ-10518, SP-1056*
  - straight or modified resols – in solution – *BRJ-473*

Adhesives and Sealants – SI Group products

Phenolic resins / phenolic derivatives are used in Adhesives and Sealants in:

- Combination with other base polymers to improve the properties of the final adhesive

- **Contact cements** – curing resins, tackifiers – bond strength, heat resistance
- **Rubber PSA, tapes** – curing resins, tackifiers – bond strength, heat resistance
- **Hot melts** – tackifiers – bond strength
- **Nitrile rubber adhesives** – curing resins, additional supporting matrix, tackifiers
- **Modification of Epoxy based adhesives** – hardeners, viscosity modifiers
- **Modification of PU based adhesives** – hardeners, tackifiers
- **Sealants** (PVC, butyl, etc.) – additional supporting matrix (strength, thermal resistance, low smoke/fume, flammability ratings), curing, etc.

Adhesives – Contact Cements

- The group of adhesives which provide **instant, high-strength, permanent bonding between two surfaces**, after both surfaces are coated with the adhesive and put in contact without much pressure. The high initial bonding is formed due to auto-adhesion (cohesive strength).

- **Different types**: **Polychloroprene rubber (PCR)**, Nitrile rubber (NBR), Styrene butadiene rubber (SBR), polyurethane (PU)

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Adhesives - Contact Cements

- **Phenolic resins** are used to:
  - increase tackiness – green strength
  - adhesive and cohesive strength
  - lower viscosity – surface wetting, application
  - high-temperature resistance

- **PTBP Reactives** – Heat resistance, overall bonding properties
  - SP-103, FRJ-551, HRJ-1367, SP-134, HRJ-11331, SP-154, Rezilite™ 888, SFP 121H

- **Tackifiers** – Open time, initial grab
  - Terpene phenolics: SP-558, SP-553, SP-560
  - PTOP: SP-1068, HRJ-2765

Adhesives – Contact Cements

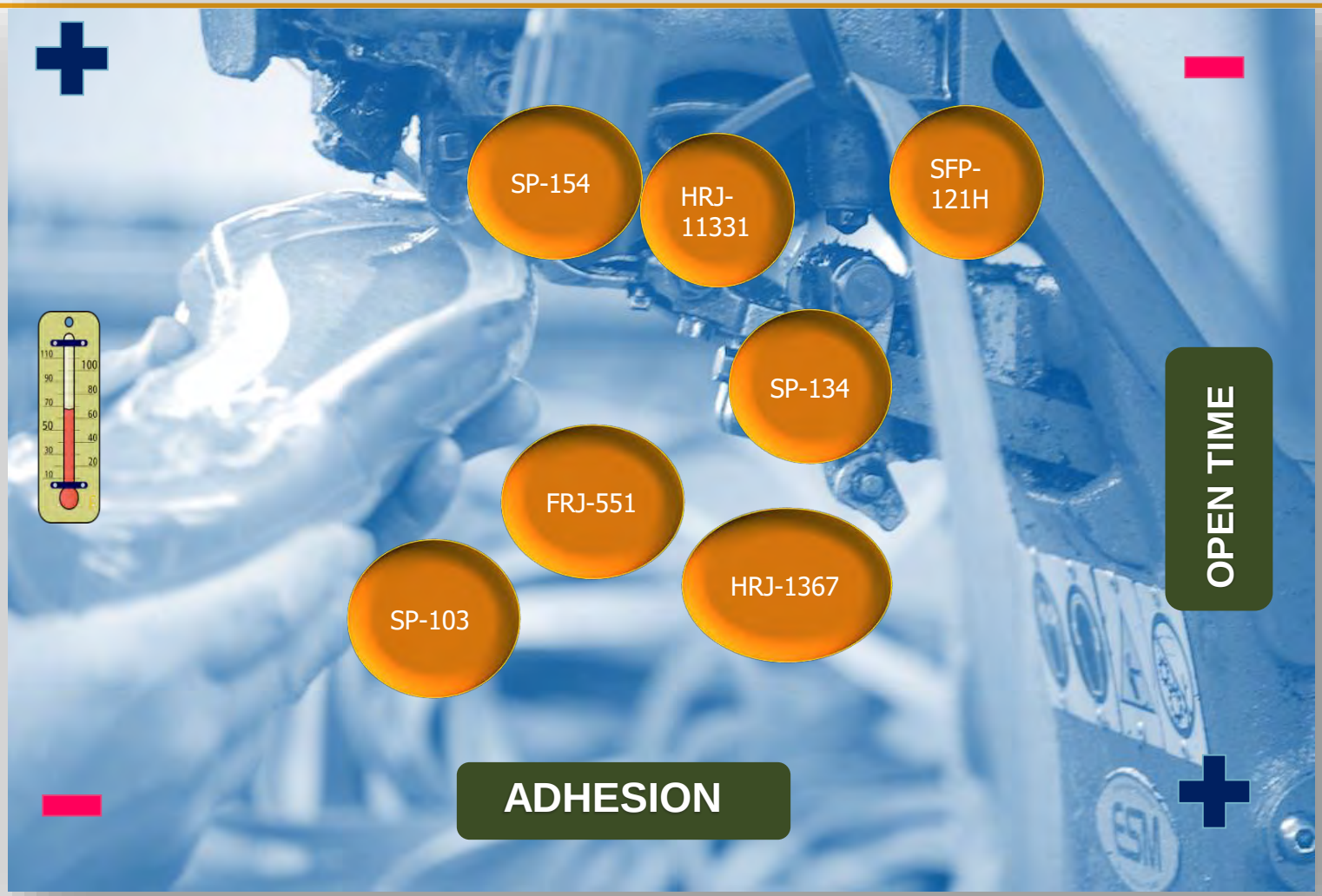
Properties that resin impart to the adhesive depend on:

- Amount added
- Molecular weight – higher Mw, higher overall bonding, shorter open time
- Methylol content – better initial and overall bonding
- Free monomer content

SP-103: Longest Open Time
FRJ-551: General Purpose
SP-134: General Purpose
HRJ-1367: General Purpose, Highest Reactivity
HRJ-11331: Short Open Time, High Bond Strength
SP-154: High Heat Resistance
Rezilite™ 888: Lighter in color, less prone to phasing version of SP-134

SFP-121H: Improved Heat Resistance & Adhesion (Made in France)

Adhesives – Contact Cements



Adhesives – Contact Cements

Water based contact cements

- Mostly regulatory driven, elimination of the solvent
- Performance wise still have not reached solvent-based contact cements
- Reactive resins in water-based adhesives – not performance enhancers, not used
- pH value important

- HRJ-11112 – pH = 9-10

Adhesives - PSA

- **Rubber based PSA and phenolic resins**
  - When necessary to increase heat resistance and improvement of the cohesive strength
- Where are rubber PSA used generally:
  - **Masking tapes**
  - **Duct work tapes**
  - **Reinforcing**
  - **Splicing**
  - **Electrical insulation tapes**
  - **Dampening** - NVH systems – Noise Vibration Harshness reducers
  - Etc.

Adhesives – Rubber PSA

SI Group products for PSA

- **Curing resins:**
  - PTOP reactive
    - SP-1044, SP-1045, HRJ-10518, SP-1055, SP-1056 – increasing reactivity
  - PTBP reactive
    - HRJ-1367 – primer treatment
- **Tackifying resins**
  - Terpene phenolics
    - SP-558, SP-553, SP-560 – increasing softening point
  - PTOP tackifiers
    - SP-1068, HRJ-2765, SP-1077 (modified)

Adhesives – Rubber PSA

Contact Adhesives - Tack Enhancement

Adhesives – Nitrile Rubber Adhesives

Nitrile-phenolic adhesives

- Thermal resistance, withstand high temperatures
- Good mechanical properties
- Chemical resistance – oils
- Good adhesion to metals and many other different substrates
- High shear strength and excellent peel resistance
- Automotive, aerospace
- Thermal cure

Form:

- In solution – Friction (brake lining to brake shoes)
- Film – supported or unsupported

Adhesives – Nitrile Rubber Adhesives

Phenolic resins:

- Reactive – PTBP, PTOP , mixed AP – SP-134, SP-1045, HRJ-11041
- Resoles – modified resoles – BRJ-473, SP-6943C
- Powder Novolacs with hexa – modified with CNSL – SP-6600
- Tackifiers – terpene phenolic or PTOP

Applications:

- Friction area – linings to brake shoes, clutch discs
- Adhesion between metal-rubber - industrial
- Adhesion between rubber-fabric - industrial
- Honeycomb structures

Adhesives – Epoxy Adhesives

Epoxy adhesives

- Very versatile group of adhesives

Properties:

- Good adhesion on different substrates
- Excellent strength – structural adhesives
- 100% solids
- Low shrinkage
- Cure at low or higher temperatures
- High-performance adhesives, automotive body structure
- Moderate to high cost
- Toxicity of the low molecular weight components
- Brittle

Adhesives – Epoxy Adhesives

Where do **phenolic derivatives** touch this area?

- Mostly used liquid Bis-Epi resin – made with Bisphenol A (other phenols as well)
- Epoxy novolaks – Novolaks with different phenols are reacted with epichlorhydrine
- Epoxy-phenolic adhesives – thermoset, Structural Adhesives
  - Similar to nitrile-phenolic adhesives
  - Higher temperature range operation
  - Supported or non-supported films – aerospace application
  - Assembly of the car body – lower weight, lower fuel consumption
- Reactive diluents – viscosity modifiers, incorporate within the structure – PNP, PTBP

SI Group Resins for Adhesives

	SP 103	SP 134	Rez 888	SPL 212	FRJ 551	HRJ 1367	SPL 218	SP 154	*SFP 121*	R 7522H	R 7529H	HRJ 11331 / R 7522E
Physical Properties												
Nature	Reactive	Reactive	Reactive	Reactive	Reactive	Reactive	Reactive	Reactive	Reactive	Reactive	Reactive	Reactive
Melting Point, °C	65-75	60-74			77-100			70-100	62-80	-	-	-
Softening Point,°C	-	-	105-125	85-105	-	92-100	90-100	-	-	100-110	95 -105	110-120
Methylol, %	8-11	12-17	12-15,5	12-16	10-15	14-18	14-17	8-12	10-15	10-15	8-13	10-14
Gardner Color	4	6	2	16	8	8	6	6	13	-	-	7
Compatibility												
PCP	•	•	•	•	•	•	•	•	•	•	•	•
PU/SBS/SIS	•	•	•	•	•	•	•	•	•	•	•	•
NBR/NR/IIR	•	•	•	•	•	•	•	•	•	•	•	•
Solubility												
Aromatic	•	•	•	•	•	•	•	•	•	•	•	•
Aliphatic	•	•	•	•	•	•	•	•	•	•	•	•
Ketones	•	•	•	•	•	•	•	•	•	•	•	•
Technical Properties												
Heat resistance	★☆☆☆	★★☆☆	★★☆☆	★★☆☆	★★★☆	★★★☆	★★★☆	★★★★	★★★★	★★★☆	★☆☆☆	★★★☆
Open Time	★★★★	★★★☆	★★★☆	★★★☆	★★★☆	★★★☆	★★★☆	★☆☆☆	★☆☆☆	★★★☆	★★★★	★★★☆
Prereaction MgO	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

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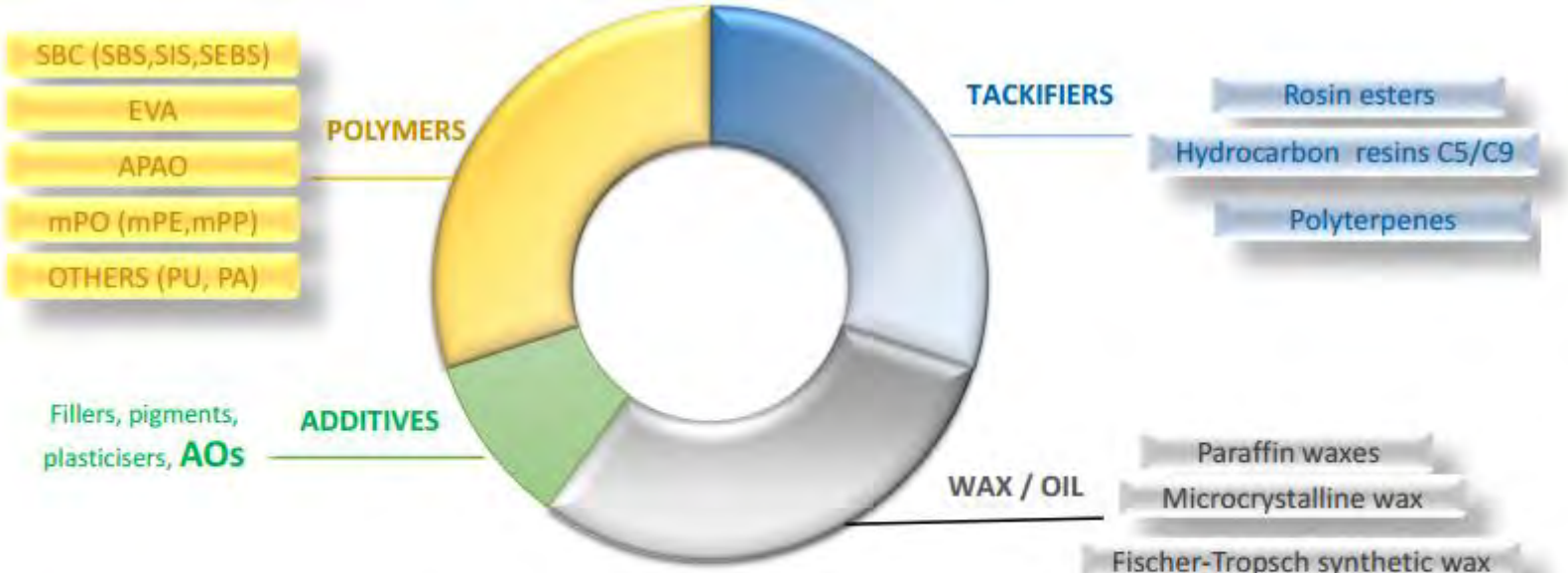
SI Group Resins for Adhesives

	SP 1044	*SP 1045*	*HRJ 10518*	*SP 1055*	*SP 1056*	*HRJ 11331*	R-40759
Physical Properties							
Nature	Reactive	Reactive	Reactive	Reactive	Reactive	Reactive	Reactive
Melting Point, °C	60-70	60-74	77-100	60-70	60-68		49-52%
Softening Point,°C	-	-	-	-	-	85-98	
Methylol Content, %	8-11	12-17	10-15	10-14	9-11	13-16	
Gardner Color	3	6	8	6	13	3	12
Compatibility							
PCP	•	•	•	•	•		
PU/SBS/SIS	•	•	•	•	•		
NBR/NR/IIR	•	•	•	•	•		•
Solubility							
Aromatic	•	•	•	•	•		•
Aliphatic	•	•	•	•	•		
Ketones	•	•	•	•	•		
Technical Properties							
Heat resistance	-	-	-	-	-	-	★★★★
Open Time	-	-	-	-	-	-	-
Cross-linking	★★★	★★★	★★★	★★★	★★★	★★★	-

SI Group Resins for Adhesives

	SP 553	*SP 558*	*SP 560*	*SP 1068*	*HRJ 2765*	*ST 5115*	*HRJ-11112*
Physical Properties							
Nature	Novolac	Novolac	Novolac	Novolac	Novolac	Novolac	Novolac
Softening Point, °C	110-120	92-100	140-155	85-95	90-100	111-119	39-45%
Gardner Color	10	10	10	-	-	4	
Compatibility							
PCP	•	•	•	•	•	•	•
PU/SBS/SIS	•	•	•	•	•	•	•
NBR/NR/IIR	•	•	•	•	•	•	•
Solubility							
Aromatic	•	•	•	•	•	•	
Aliphatic	•	•	•	-	-	•	
Ketones	•	•	•	•	•	•	
Technical Properties							
Tack (adhesives)	★★★★	★★★★	★★★★	-	-	★★★	★★★★
Tack (rubber articles)	-	-	-	★★★	★★★	-	
Cohesion (reactive adhesives)							

Hot Melt Chemistry



- POLYMERS add strength and toughness
- TACKIFIER RESINS increase tackiness and speed of set
- WAXES & OILS control melt viscosity and reduce costs
- ANTIOXIDANTS prevent discoloration, gel formation

The Role of our products in HMA/HMPSA

- The participation of SI Group to the HMA market is marginal with phenolic resins but important with antioxidants.

- The role of **SI Group resins**:
  - Thermoplastic resins (tackifiers – e.g. novolacs, hydrocarbon resins, terpene resins) are added to boost the adhesion properties of the formulated product.
  - They contribute to the "wetting" of the adhesive and exhibit better compatibility with the surfaces to bond.
  - SI Group offer Terpene Phenolic Resins for such purpose
  - Main chemistry used as tackifiers is Rosin Resins & Hydrocarbon Resins

- The role of **SI Group antioxidants**:
  - The presence of antioxidant is essential in all adhesive formulations for adequate protection against oxidative breakdown and acid tendering of substrates.
  - Primary antioxidants react rapidly with alkoxy radicals and are, therefore, called "Radical Scavengers".
  - The majority of primary antioxidants for polymers are sterically hindered phenols.

Adhesives – Hot Melts

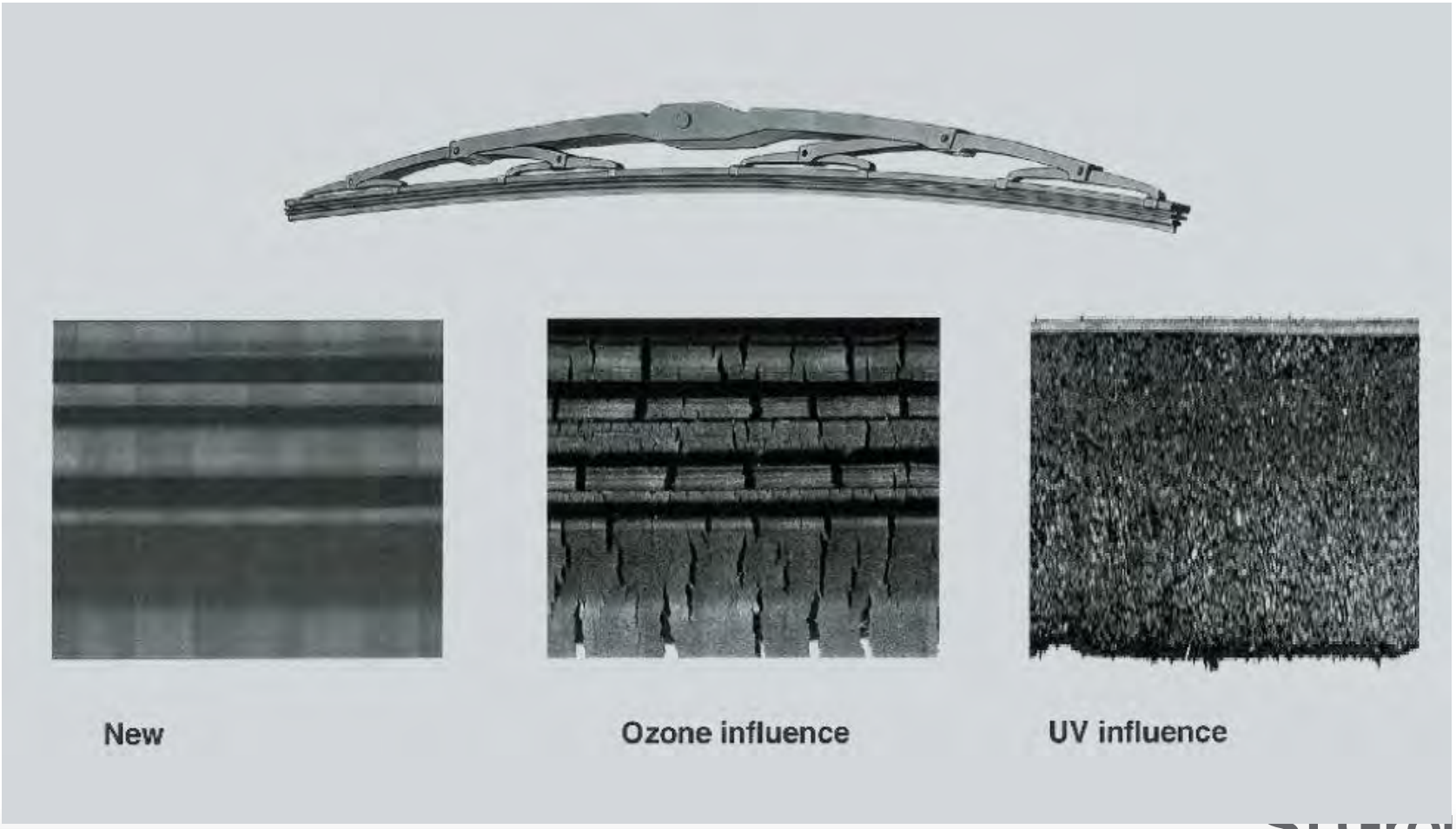
Tackifiers

- Improves specific adhesion
- Reduces melt viscosity
- Imparts or increases tack
- Influences peel strength
- Affects shear strength
- Improves compatibility

SI Group products:

- Terpene phenolics: SP-558, SP-553, SP-560 - improve heat stability
- Alkylphenol tackifiers: SP-1068, HRJ-2765
- Antioxidants

SI Group Antioxidants & Antiozonants



When does a Rubber Compound need an AO?

Elastomer	Temp Limit, Deg C	AO?
Natural Rubber (NR)	100	Yes
Styrene Butadiene (SBR)	100	Yes
Polyburadiene (BR)	100	Yes
Acrylonitrile Butadiene (NBR)	125	Yes
Polychloroprene (CR)	125	Yes
Polyacrylates (ACM)	190	Maybe
Chlorinated Polyethylene (CM)	150	Maybe
Epichlorohydrin (ECH)	125	Yes
Flouroelastomers (FKM)	225	No
Silicone Elastomers (VMQ)	200	No
Polyisiprene (IR)	100	Yes
Ethylene Propylene (EPDM)	150	Maybe
Butyl (IIR)	140	Maybe
Ethyelene Acrylic (AEM)	175	Yes

A Wide Range of Rubber Chemicals

Accelerators/ Retarders	Antioxidants	Antiozonants	Waxes	Additives/ Others
BIK™ OT	AMINOX™	DURAZONE™ 37	SUNPROOF™ EXTRA	BONDING AGENT™ P-1
HEPTEEN™ BASE	BLE™	FLEXZONE™ 3C	SUNPROOF™ IMPROVED	OPEX™ 80
TRIMENE™ BASE	FLEXAMINE™	FLEXZONE™ 4L	SUNPROOF™ JUNIOR FT	THIOSTOP™ N
ROYALAC™ 150	LOWINOX™ 22M46		SUNPROOF™ SUPER	
RETARDER™ ESEN	LOWINOX™ CPL			
	NAUGARD™ 445			
	NAUGARD™ Q			
	NAUGARD™ SP			
	NAUGARD™ TNPP			
	NAUGARD™ XL-1			
	NAUGAWHITE™			
	NOVANOX™			
	OCTAMINE™			
	Genox™ EP			
	ROYALTUF™			
	ALKANOX™			
	*NOVAZONE™ AS			
	*NAUGARD™ RM51			

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Stabilizers Usage

Stabilizers for Polymers

- *Stabilizers for polymers* are used directly or by combination to prevent the various effects such as,
  - Oxidation,
  - Chain scission,
  - Uncontrolled recombination and,
  - Cross-linking reactions that are caused by photo-oxidation of polymer.

- Polymers are considered to get weathered due to direct or indirect exposure to,
  - Heat and ultraviolet light.

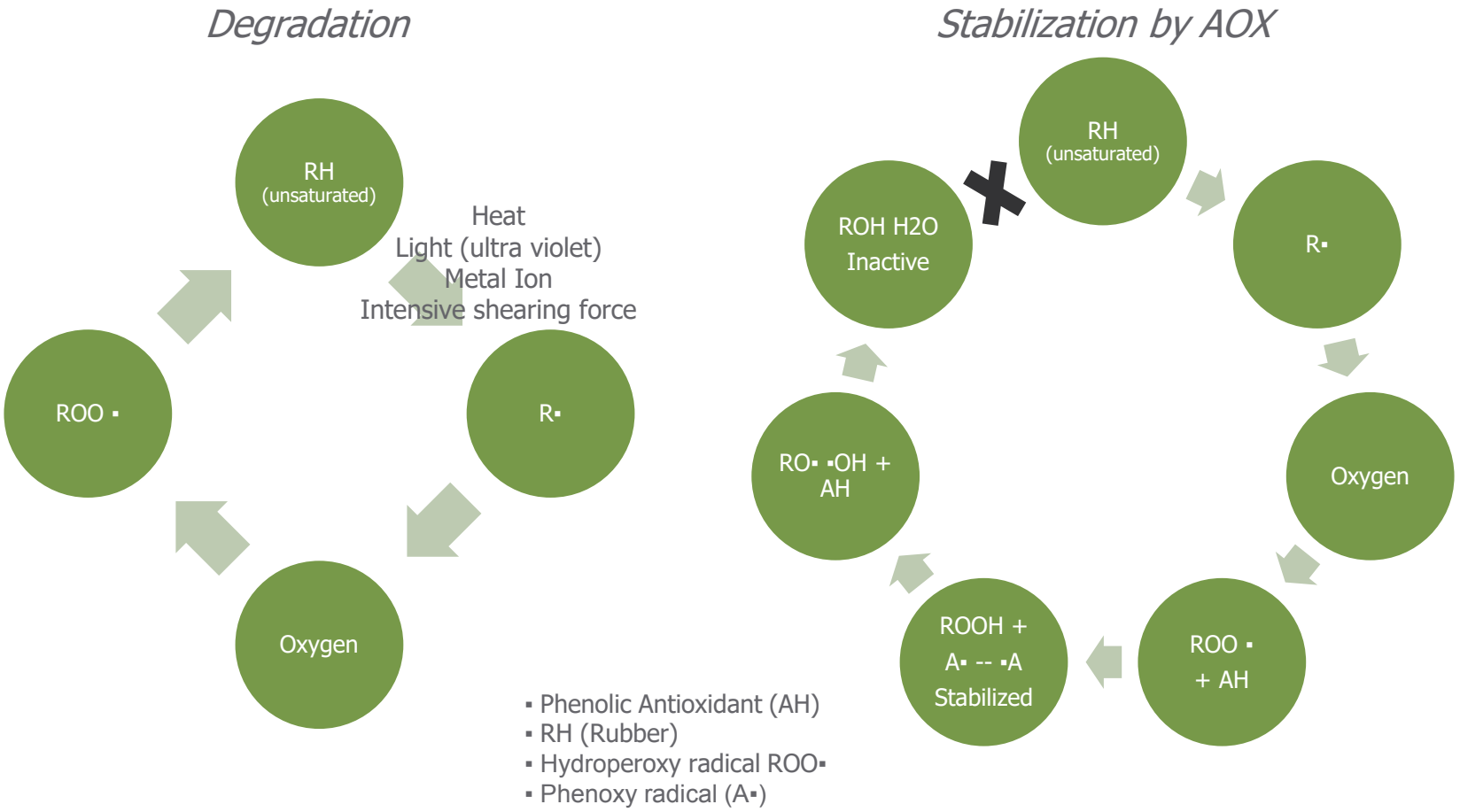
Stabilizers Usage

Stabilizers for Polymers

- The *effectiveness* of the stabilizers against weathering depends on,
  - Solubility,
  - Ability to stabilize in different polymers matrix,
  - The distribution in matrix,
  - Evaporation loss during processing and use.

- The *effect on viscosity* is also important concern for processing.

SI Group Chemistry / Antioxidant / How does it work ?



AO Segmentation

Antioxidants Types

- Amine / quinoline
- Phenolic
- Phosphite

Antiozonants Types

- p-Phenylene diamines (PPD's)
- Specialty chemicals
- Paraffin waxes (forms a surface barrier)

Antioxidants

Amine / Quinoline Types:

- Used as primary antioxidants and general antiozonants
- Can cause discoloring and/or staining
- Aid in anti-flex
- Little to no effect on cure rates
- Non-blooming before and after cure

Antioxidants

Phenolic Types:

- Used in non-black compounds
- Discoloration is much less than amine type
- Excellent for long term heat degradation
- Disrupts the degradation before the radicals can be formed

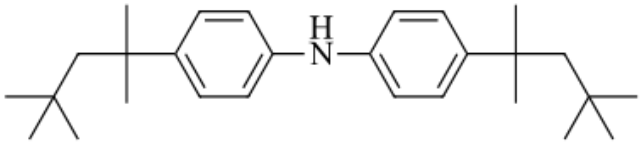
Antioxidants

Phosphite Types:

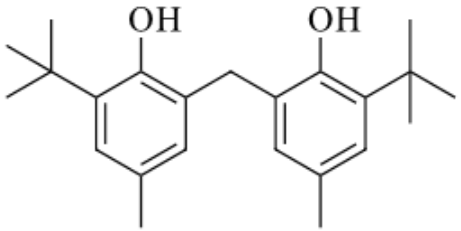
- Used as secondary antioxidants
- Consumed during the vulcanization process.
- Used mainly in tank inner liners, and
- Protection for raw polymer during manufacturing (polymerization) and storage (shelf-life)

SI Group Chemistry / Antioxydant

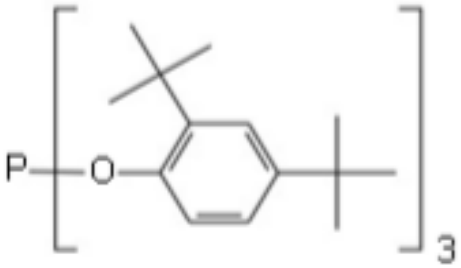
Aminic



Phenolic

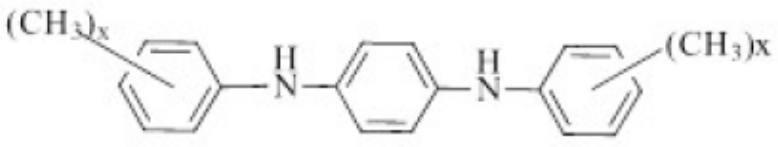


Phosphite

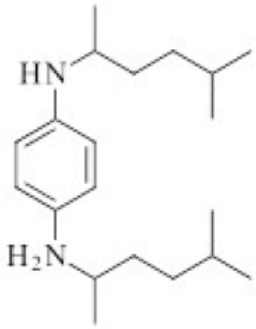


SI Group Chemistry / Antiozonant

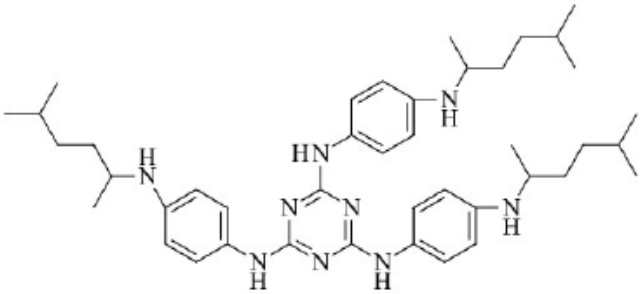
Novazone AS



Flexzone



Durazone



HMA & HMPSA Formulas

In both cases, the formulation is based on:

- A polymer (EVA, acrylic, SBC, etc.), a tackifier (Hydrocarbon/rosin ester/terpene phenolic resin)
- a viscosity controlling substance (wax, oil) and Additives (e.g. antioxidants).

Component		Pressure Sensitive Adhesives LABEL RECIPE (%)
Polymer	SBS/ SIS	**33**
Tackifier	Rosin ester/ Mod. C 5	**50**
Oil	Naphthenic	16
AO	Stabilizer	1
	Total	**100**

Component		EVA HMA Carton sealing RECIPE (%)
Polymer	EVA	**40**
Tackifier	Rosin ester	**40**
Wax	Fischer-Tropsch wax	19.5
AO	Stabilizer	0.5
	Total	**100**

Component		mPO HMA Packaging RECIPE (%)
Polymer	Metallocene PO	**34.5**
Tackifier	Hydrocarbon resin	**35**
Wax	Fischer-Tropsch wax	30
AO	Stabilizer	0.5
	Total	**100**

HMA recipes used

Polyolefin Elastomers

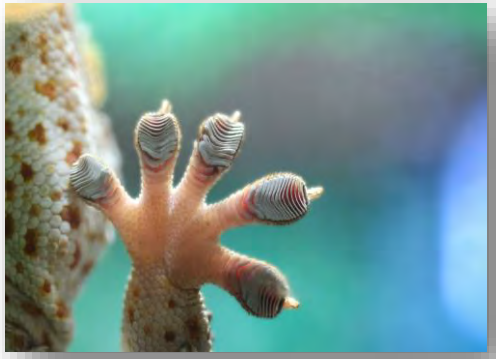
- Polyolefin Elastomer (POE): 34.5%
- Hydrogenated hydrocarbon tackifier resin: 35%
- Fischer-Tropsch wax: 30%
- Antioxidant: 0.5%

Antioxidants Used

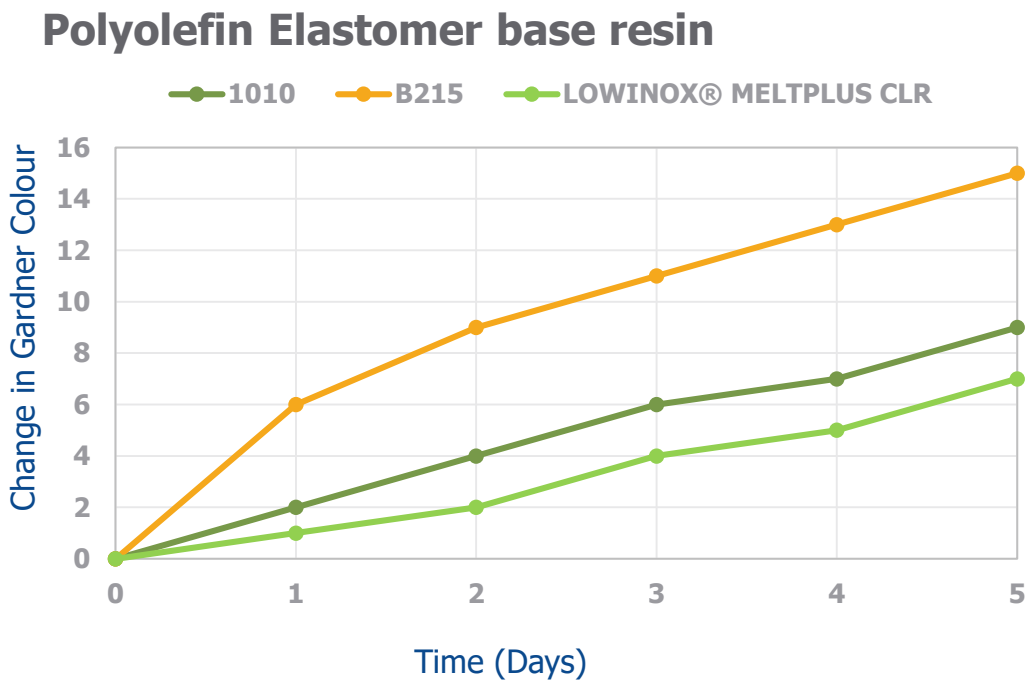
A20 type
A20+A240 type
LOWINOX™ MELTPLUS CLR

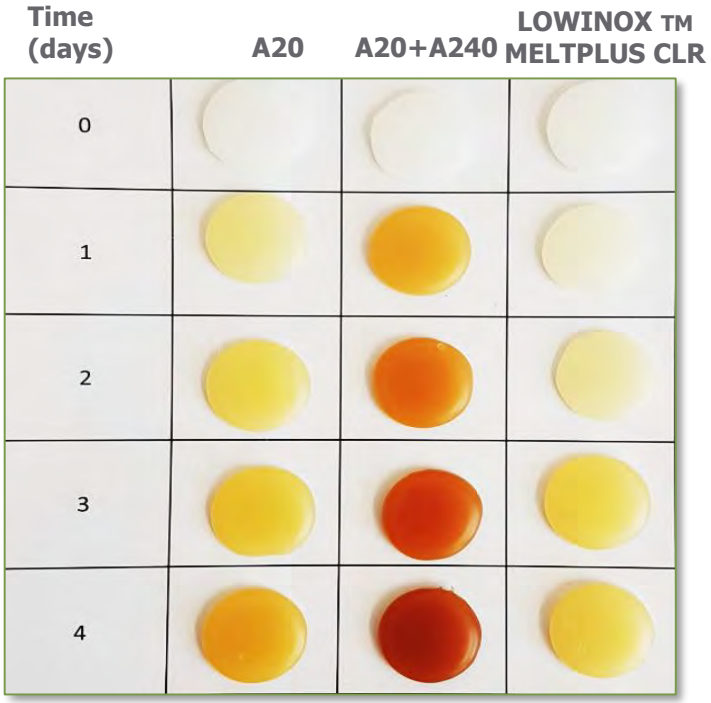
EVA

- Ethyl Vinyl Acetate Copolymer resin *(vinyl acetate content 28%)* : 39.5%
- Aromatic modified aliphatic hydrocarbon resin: 40%
- White process oil: 10%
- Fischer-Tropsch wax: 10%
- Antioxidant: 0.5%



IMPROVED COLOUR STABILITY

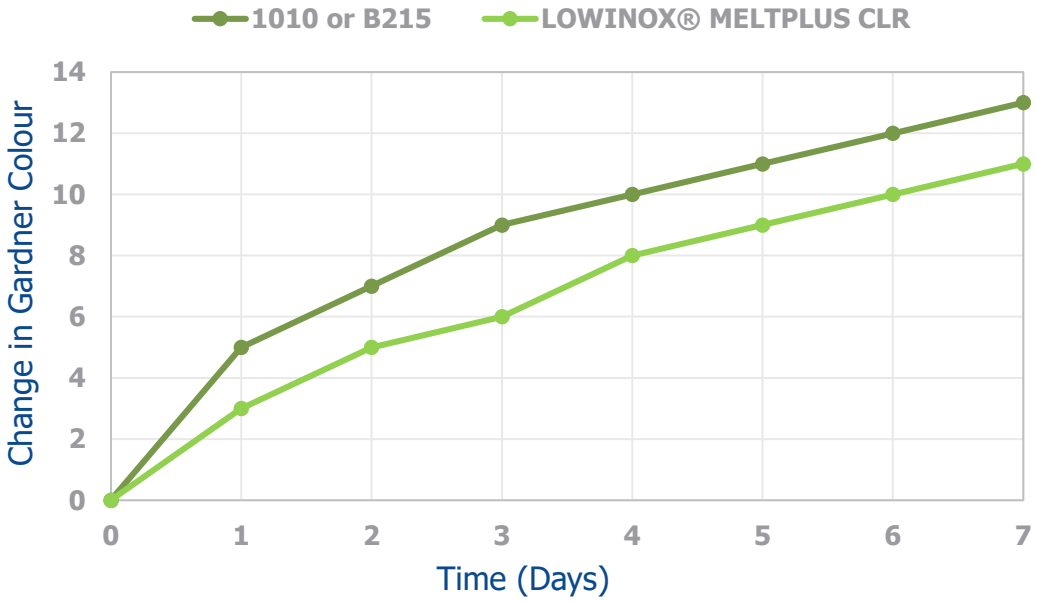


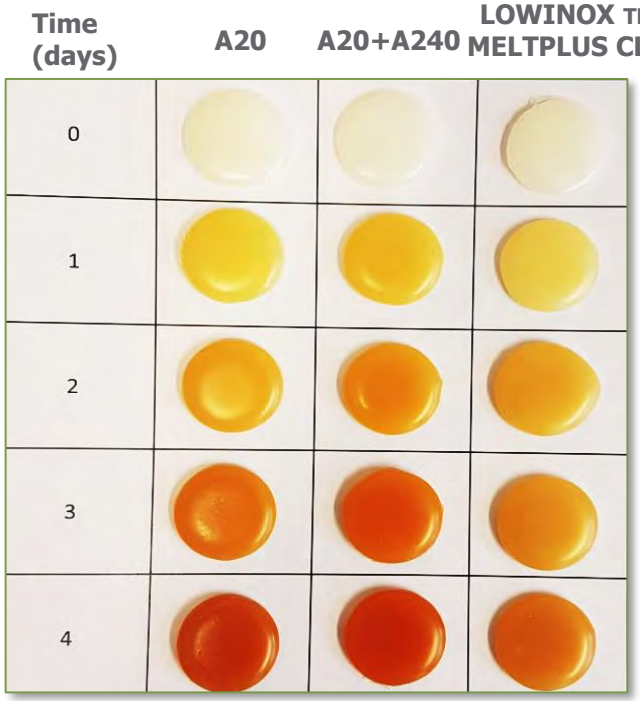


- LOWINOX™ MELTPLUS CLR offers significantly better colour stability than competitive systems on oven aging at 175ºC
  - ✓ **4 day better colour stability vs binary blend (8 Gardner colour units less at 175°C)**
  - ✓ **24hrs better colour stability vs A20 (2 Gardner colour units less at 175°C)**
- Improved colour stability constant from beginning to day 5. Significant colour improvement achieved at 175°C

IMPROVED COLOUR STABILITY

EVA base resin

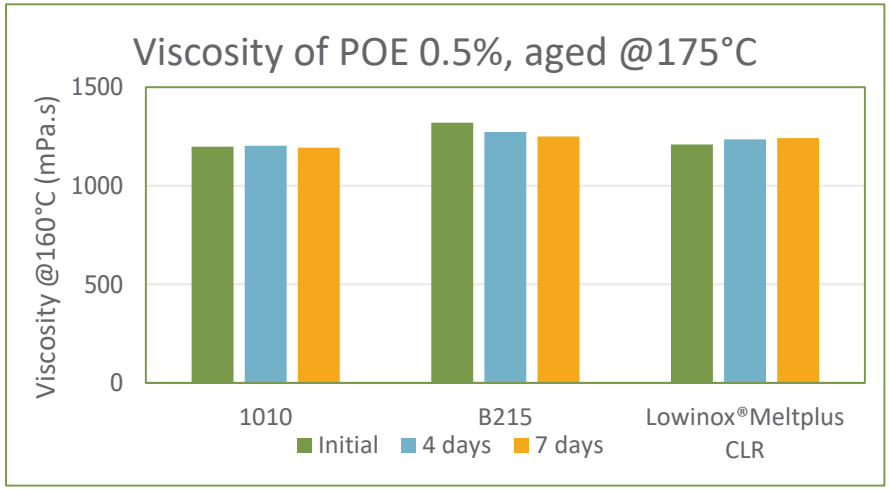




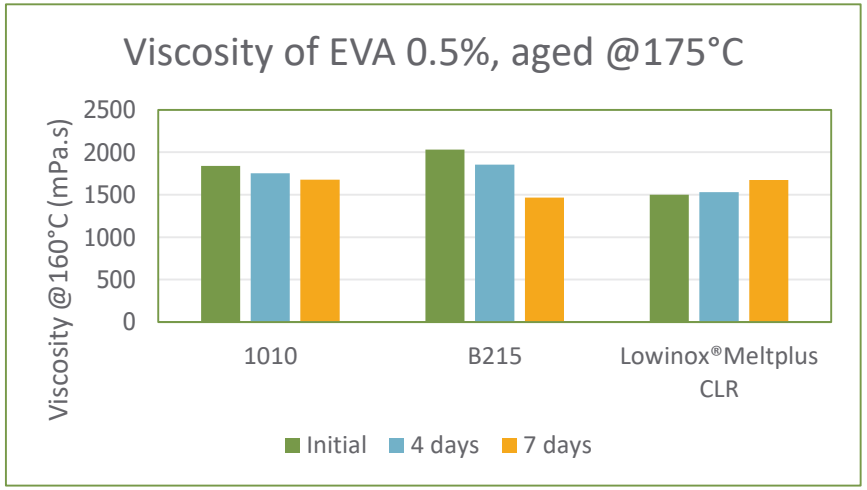
- LOWINOX™ MELTPLUS CLR offers significantly better colour stability than competitive systems on oven aging at 175ºC
  - ✓ **2 day better colour stability vs binary blend / A20 (2 Gardner colour units less at 175°C)**
- Improved colour stability constant from beginning to day 7. Significant colour improvement achieved at 175°C

EQUIVALENT VISCOSITY PROTECTION

Polyolefin Elastomer base resin



EVA base resin



- In both base resin systems, all three stabilisation systems provide equivalent viscosity protection
- LOWINOXTM MELTPLUS CLR provides excellent viscosity protection

Benefits of excellent viscosity stability include:

- **Precise control of bead size and placement lowering costs / reducing rejects**
- **Good and consistent adhesive bonding level increasing adhesive reliability**

SI Group Solutions for HMA Formulas

Type	Applications	Our Solutions	Performances
EVA	Carton sealing Book binding Furniture Assembly	Anox™20 Lowinox™Meltplus CLR	Better colour stability at 175°C Higher thermal stability leading to lower char formation
SBS/SIS	Labels Tapes	Anox™20	Improved colour stability Better viscosity retention
mPO	Packaging Hygiene	Anox™20 LowinoxTMMeltplus CLR	Better colour stability at 175°C Higher thermal stability leading to lower char formation

WESTON™ 705T

NEXT-GEN **GLOBALLY AVAILABLE** ANTIOXIDANT FOR **ELASTOMERS**

What is WESTON™ 705T?

It is a modern liquid highly effective antioxidant that has been primarily developed as a next generation replacement of TNPP (a product that is being regulated out of the market), but it also represents an **attractive alternative** to solid phosphites such as ALKANOX™ 240 (AO-168 analogs).

WESTON™ 705T is also **fully approved for food contact applications in synthetic elastomers** and other polymeric materials. Additionally, the product has an accomplished safety profile based on the latest regulatory standards including the complete NIAS assessment.

How does WESTON™ 705T work?

WESTON™ 705T is a highly-reactive secondary antioxidant that is intended to be combined with phenolic primary antioxidants such as ANOX™ PP18 or ANOX™ 20 to provide much improved antioxidant efficiency and economics through its excellent synergistic effect.

WESTON™ 705T

NEXT-GEN **GLOBALLY AVAILABLE** ANTIOXIDANT FOR **ELASTOMERS**

How robust is the current supply base of WESTON™ 705T?

SI Group has currently three independent production assets available to source WESTON™ 705T from - two located in the US (both in Morgantown, WV) and one in China (ChangHe). The combined nameplate capacity of these assets is designed for future growth and therefore **it safely exceeds the current demand for WESTON™ 705T**.

Is SI Group also backward-integrated with key raw materials necessary for production of WESTON™ 705T?

Yes. SI Group produces the key intermediates for WESTON™ 705T in-house at multiple production sites is in the US and in Europe.

WESTON™ 705T

NEXT-GEN **GLOBALLY AVAILABLE** ANTIOXIDANT FOR **ELASTOMERS**

Are there any potential performance drawbacks in using WESTON™ 705T vs. ALKANOX™ 240 / AO-168?

No – actually, rather the opposite. WESTON™ 705T can be used at lower loadings compared to ALKANOX™ 240 to achieve the same or better antioxidant protection. Your customers – elastomer compounders and converters – may pleasantly observe more consistent elastomer color and experience improved stability of Mooney viscosity. Overall, no negative performance aspects whatsoever should be anticipated compared to the incumbent.

Is there any manufacturing-process-related difference in WESTON™ 705T compared to ALKANOX™ 240 / AO-168?

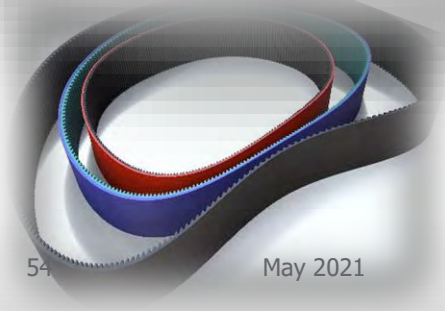
WESTON™ 705T is a liquid product that can be easily mixed with other liquid components in both solution or emulsion polymerization process, hence, it may bring process simplification and thus new cost efficiencies over solid antioxidants such as ALKANOX™ 240/AO-168.

SI Group also offers fully formulated liquid antioxidant solutions based on WESTON™ 705T.

WESTON™ 705T

KEY **BENEFITS** OVER INCUMBENT ANTIOXIDANTS **FOR ELASTOMERS**

EXCELLENT WHITENESS AND VISCOSITY RETENTION

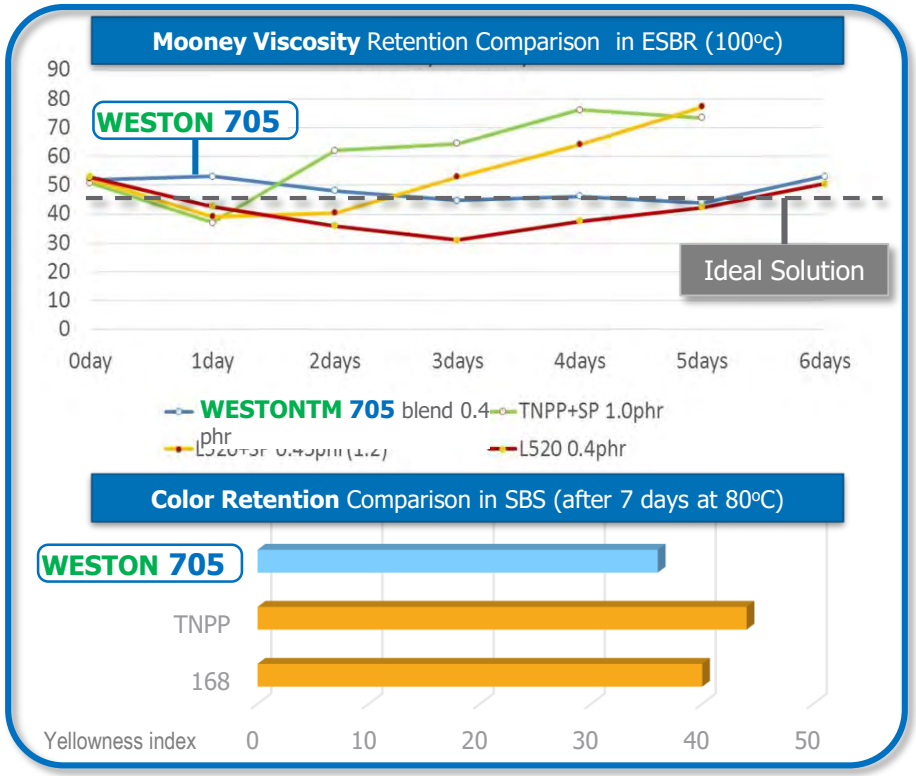


- **EXCELLENT MOONEY VISCOSITY RETENTION** IN COMBINATION WITH COMMON PHENOLIC ANTIOXIDANTS
- **SIGNIFICANTLY BETTER COLOR PROTECTION** THAN COMMON LIQUID ANTIOXIDANTS USED IN ELASTOMERS
- **NO ODOR, NEITHER STAINING**
- **THE ONLY DROP-IN INDUSTRIAL-PROVEN AND SAFE ALTERNATIVE TO TNPP ON MARKET**. 100% NONYLPHENOL-FREE.
- **GLOBAL REGISTRATION AND FOOD CONTACT COMPLIANCE** IN ELASTOMERS

WESTON™ 705T

PRODUCT PROFILE

- **Only drop-in industrial-proven** and safe alternative to TNPP on market
- 100% **nonylphenol-free**
- **23% lower loading** comparing to TNPP
- **No odor,** neither staining
- Significantly **better color protection** than other liquid AO
- **Excellent Mooney viscosity retention** in combination with phenolic antioxidants
- **Global registration** and **food contact compliance** in elastomers



SI Group operates multiple plants producing WESTON™ 705 to satisfy growing demand

SI Group

WESTON™ 705T

Global Food-Contact Approvals

PRODUCT PROFILE

Country	Polymer Approval	Loading Level / SML	Food Type
MERCOSUR	All Plastics	10mg/kg	All
US	LLDPE HDPE SIS, SEBS, SIBS	2000 ppm	All Incl. Infant Formula and Breast Milk
China	PE	2000 ppm	All
EU	All Plastics	10 mg/kg	All
India	PE & PP	2000 ppm	All
South Korea	All Polymers	N/A	All
Indonesia	All Polymers	2000 ppm	All
Philippines	All Polymers	2000 ppm	All
Ukraine	All Plastics	2000 ppm	All
Turkey	All Plastics	2000 ppm	All

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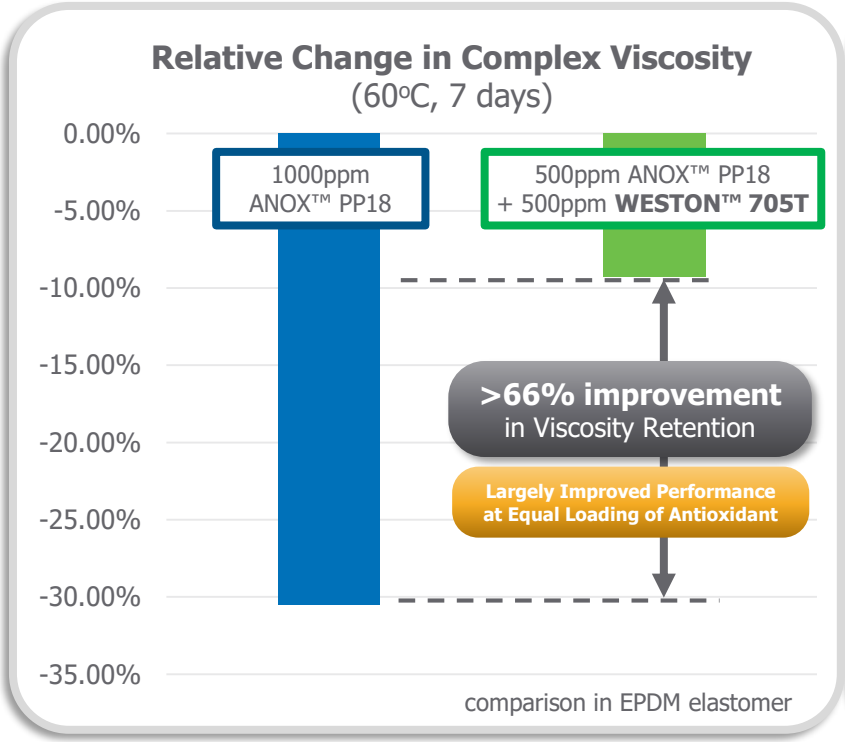
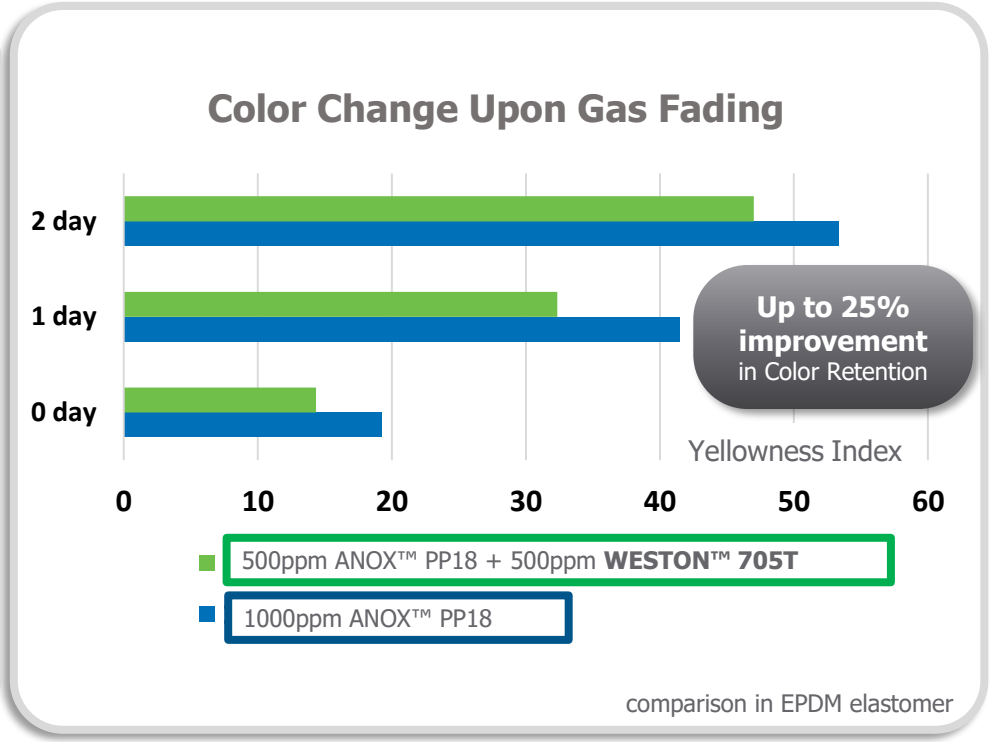
WESTON™ 705T

Performance Benefits from Synergy with Phenolic Antioxidants





- Combination of **WESTON™ 705T** with phenolic antioxidants (such as ANOX™ PP18, ANOX™ 20, AO-1520 etc.) results in synergistic boost in system`s performance
- **WESTON™ 705T** can provide much improved performance at comparable cost in use
- Alternatively, **WESTON™ 705T** can help reduce cost and maintain performance

SI Group

WESTON™ 705T

Application Guide for Elastomers

Elastomer Type	End Application	WESTON™ 705T / NAUGARD™ E-1 Solutions	Performance Benefits of WESTON™ 705T / NAUGARD™ E-1
SBC (SBS, SIS, SEBS)	Adhesive, impact modifier, shoe sole, asphalt	ANOX™ PP18/**WESTON™ 705T** (1:2 to 1:3) or **WESTON™ 802T** or **803T** at 5000-7000 ppm	Suppressed discoloration, improved physical properties retention and regulatory compliance
BR	Raw material for ABS and HIPS, shoe sole, technical products, tire	ANOX™ PP18/**WESTON™ 705T** (1:2 to 1:3) or **WESTON™ 802T** or **803T** at 3000-5000 ppm	Suppressed discoloration, improved physical properties retention and regulatory compliance
EP/EPDM	Automotive, seals, roofing, insulation layer of W&C, geomembranes	ANOX™ PP18/**WESTON™ 705T** (1:1) at 1000-2000 ppm	Suppressed discoloration, improved physical properties retention and regulatory compliance
sSBR	Tire, adhesives	ANOX™ PP18/**WESTON™ 705T** (1:1) at 4000-6000 ppm	Suppressed discoloration, improved physical properties retention and regulatory compliance
eSBR	Tire, adhesives, Footwear, adhesives	**NAUGARD™ E-1** Loading to be consulted with SI Group`s Technical Service representative	Suppressed discoloration, improved Mooney viscosity retention, better regulatory compliance
NBR	Automotive, conveyor belt, medical gloves, other technical products	**NAUGARD™ E-1** Loading to be consulted with SI Group`s Technical Service representative	Suppressed discoloration, improved Mooney viscosity retention, better regulatory compliance

WESTON™ 802T and NAUGARD™ E-1 are proprietary fully formulated liquid antioxidant solutions based on WESTON™ 705. Please, check availability and lead times for these products in your territory first.

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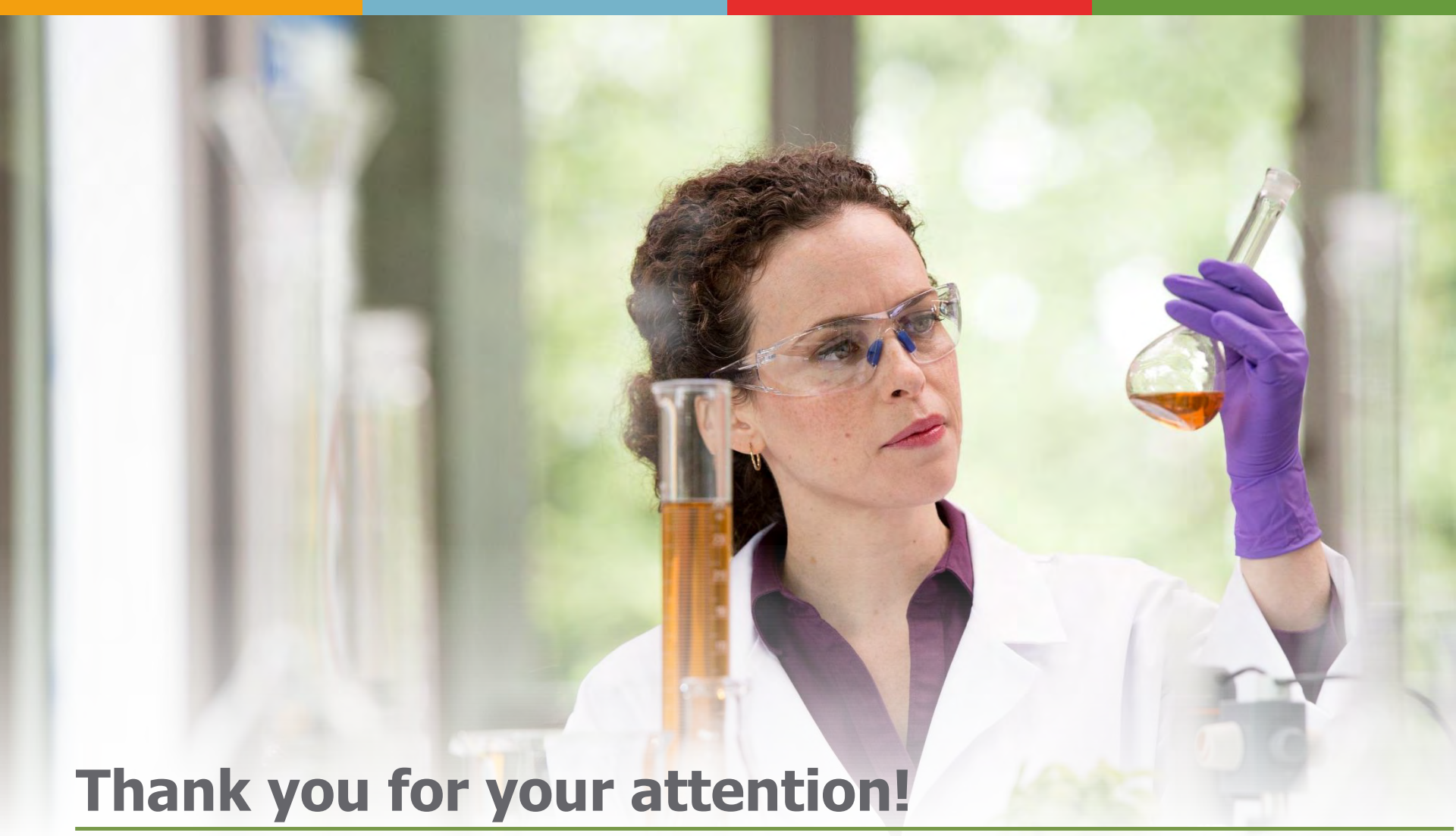
Our website : www.siigroup.com



Thank you for your attention!

SI Group®

The Substance Inside