Sealing Your Success
e-Seminar Series

Paul Smith

AMERICAN BILTRITE
PERFORMANCE SHEET RUBBER
Where commitments still matter.

Reformulating Rubber Manufacturing Under Highly Competitive and Uncertain Times

ISD INTERNATIONAL SEALING DISTRIBUTION ASSOCIATION
THE ASSOCIATION OF FLUID SEALING PROFESSIONALS

Paul Smith – American Biltrite

AMERICAN BILTRITE
Servicing the Market since 1908

1. Founded in 1908 – Head Office Boston
2. Established in Canada since 1913
3. Manufacturer of Footwear Components, Performance Sheet Rubber, Uncured Rubber, Truck Flaps and Rubber, Vinyl and Non-PVC Flooring
4. 250 employees

AMERICAN BILTRITE
Introduction

1. Manufactures and imports one of the widest selections of performance sheet rubber in the industry
2. Outstanding range of polymers
3. On-site mixing
4. State of the art curing
5. Fully equipped testing

OUR FACILITIES
The Manufacture

Located in Sherbrooke, Quebec, Canada
300,000 square feet

AMERICAN BILTRITE
Our Product Lines

AMERICAN BILTRITE
Our Product Lines

SHEET RUBBER PRODUCTS:

Industrial and Commercial	Imports	Specialty Products
Neoprene	Neoprene	DuraShield
Natural	Red Sheet	Transeal
Nitrile	Skirtboard	Military Specs
SBR	CI Sheet **	AASHTO
EPDM		
Butyl		
Hypalon		
CI Sheet Packing		
Diaphragm		

**coming soon

AGENDA

1. Common Elastomers
2. Compound Ingredients
3. Fillers
4. Processing Aids and Reinforcement
5. Physical Properties


ELGIN
Eagle

COMMON ELASTOMERS
Natural Rubber (ASTM: NR)

- **Other name:** Polyisoprene
- **Advantages:** outstanding resistance, high tensile strength, superior resistance to tear and abrasion, excellent rebound elasticity (snap), good flexibility at low temperatures, excellent adhesion to fabric and metal
- **Limitations:** poor resistance to heat, ozone and sunlight; very little resistance to oil, gasoline and hydrocarbon solvents.
- **Temperature:** -55 C to +55 C (-67 F to 122 F)
- **Applications** - where abrasion resistance and rebound are critical:
  - Cement sleeves, chute linings
  - Low temperature belting
  - Hose
  - Tank lining
  - Cyclones
  - Concentrators


McNeilus

COMMON ELASTOMERS
SBR-Styrene-Butadiene (ASTM: SBR)

- **Other name:** GRS, Buna-S
- **Advantages:** excellent impact strength, very good resilience, tensile strength, abrasion resistance and flexibility at low temperatures.
- **Limitations:** poor resistance to ozone and sunlight; very little resistance to oil, gasoline and hydrocarbon solvents.
- **Temperature:** -55 C to +70 C (-67 F to 158 F)
- **Applications** - bulk and non-critical applications:
  - Basic gaskets and washers
  - Hose
  - Skirtboards, scrapers
  - Grade II industrial belting

COMMON ELASTOMERS
Neoprene-Polychloroprene (ASTM: CR)

- **Advantages:** good inherent flame resistance, moderate resistance to oil and gasoline, excellent adhesion to fabrics and metals, very good resistance to weather, ozone and natural aging, good resistance to abrasion and flex cracking, very good resistance to alkalis and acids.
- **Limitations:** poor to fair resistance to aromatic and oxygenated solvents; limited ability at low temperatures.
- **Temperature:** -40 C to +135 C (-40 F to 275 F)
- **Applications** - where mild oil resistance and weathering properties are both required:
  - Gaskets and washers
  - Seals for doors and windows
  - Hose for steam, garden or radiator
  - Wire and cable

Bucket With Durashield

COMMON ELASTOMERS
Nitrile – Acrylonitrile-Butadiene (ASTM: NBR)

- **Other Name**: Buna-N
- **Advantages**: very good resistance to oil and gasoline; superior resistance to petroleum-based hydraulic fluids; wide range of service temperatures; good resistance to hydrocarbon solvents; very good resistance to alkalis and acids.
- **Limitations**: inferior resistance to ozone, sunlight and natural aging; poor resistance to oxygenated solvents.
- **Temperature**: -65 C to 150 C (-65 to +300 F)
- **Applications** - where oil resistance in the main concern:
  - Machinery gaskets, around oil and gas handling equipment
  - White food grade
  - Heat and oil resistant belting
  - Hose cover
  - Wire and cable

COMMON ELASTOMERS
Butyl – Isobutylene-Isoprene (ASTM: IIR)

- **Advantages**: outstanding impermeability to gases and vapour; very good resistance to heat, oxygen, ozone and sunlight; high energy absorption (damping); excellent resistance to alkalis and oxygenated solvents; good hot tear strength; superior resistance to water and steam.
- **Limitations**: high compression set; poor resistance to oil, gasoline and hydrocarelasticity (snap); fair processability; poor resilience.
- **Temperatures**: -55 C to 120 C (-67 to +248 F).
- **Applications**:
  - Gaskets and seals
  - Tire inner tubes
  - Sport ball bladder
  - Hose

Schauenburg Pipe End With Seals

COMMON ELASTOMERS
Ethylene – Propylene-Diene (ASTM: EPDM)

- **Other name**: EPT, EPR
- **Advantages**: excellent resistance to heat, ozone and sunlight; very good flexibility at low temperatures; good resistance to alkalis, acids and oxygenated solvents; superior resistance to water and steam; excellent colour stability.
- **Limitations**: poor resistance to oil, gasoline and hydrocarbon solvents; adhesion to fabrics and metals is poor.
- **Temperature**: -55 C to 135 C (-67 to +275 F).
- **Applications**:
  - Weatherstripping for doors and windows
  - Automotive weatherstripping
  - Gaskets and washers around electrical equipment
  - Conveyor belting
  - Hose for steam, garden, radiator
  - Caulking material

COMMON ELASTOMERS
Hypalon-Chlorosulfonated Polyethylene (ASTM: CSM)

- **Advantages**: good flame retardance; good abrasion resistance; superior resistance to weather, ozone, sunlight and oxidation; excellent resistance to alkalis and acids; very good colour stability; moderate resistance to oil and gasoline.
- **Limitations**: poor to fair resistance to aromatic solvents; limited flexibility at low temperatures; fair resilience and compression set.
- **Temperatures**: -40 C to 160 C (-40 to +320 F).
- **Applications**:
  - Very specialized gaskets and seals
  - Hot conveyor belting
  - Automotive hoses
  - Air conditioning hose
  - Tank lining
  - Wire and cable jacket

COMMON ELASTOMERS
Silicone – Polysoloxane (ASTM: VMQ)

- **Advantages**: flexible at extreme temperatures; low compression set; very good electrical insulation; excellent ultra-violet, ozone and weather resistance; silicone is inert, being odourless tasteless and complete lack of toxicity makes it unique for many food and medical applications.
- **Limitations**: poor abrasion and tear resistance; poor resistance to solvents, alkalies and acids; difficult to mold to tight tolerances and to bond.
- **Temperatures**: -65 C to 250 C (-65 to +480 F).
- **Applications**:
  - Extruded and molded gaskets
  - O-rings
  - Valve gaskets
  - Ignition cable cover
  - Seals in transmission
  - Coolant/ heater hose
  - Conveyor belting

COMMON ELASTOMERS
Other Elastomers

- Butadiene-Polybutadiene (ASTM: BR)- blended with other polymers to improve wear and cold temperature properties.
- Urethane-Polyurethane Di-Isocyanate (ASTM: AU, EU)-abrasion and wear resistant.
- Viton-Fluorinated Hydrocarbon (ASTM: FPM)- oil resistant at high temperatures. Other name: Fluorocarbon.
- Hydrin-Epichlorohydrin (ASTM: ECO)- impermeable to hydrocarbon liquids and gases.
- Chlorinated Polyethylene (ASTM: CPE)- excellent chemical resistance.
- Crosslinked Polyethylene (ASTM: XLPE)- excellent chemical resistance.
- Hydrogenated Nitrile (ASTM: HNBR)- high heat, oil resistant and good physical properties, H2SO sour gas resistant.

RUBBER COMPOUNDING
Definition

Compounding is the art or science of selecting the proper materials for a particular rubber compound which will then be mixed, processed and vulcanized into a useful product with specific physical properties suitable for its end use.

COMPOUND INGREDIENTS
Rubber Classes

- The rubber compounder must first decide what particular use the end product will be subjected to before choosing the proper rubber. Rubbers are generally classified into three major classes:
  - **General purpose** - for services where specific resistance to the action of petroleum-base fluids is not required.
  - **Solvent resistant** - for services where specific resistance to the action of petroleum-base fluids is required
  - **Heat resistant** - for services where specific resistance to the effects of prolonged exposure to abnormal temperatures or compounded petroleum oils, or both, is required.

COMPOUND INGREDIENTS
Compounds

- **Elastomer/Polymer** - natural, one of synthetic or blend of two or more bales, chips, pellets, powder
- **Vulcanizing agents** - materials necessary for vulcanization, since without chemical crosslinking reactions involving these agents, nor improvement in the physical properties of rubber mixes can occur. Sulphur, peroxide, metallic oxides.
- **Accelerators** - speed up the curing process and set it in motion at the prescribed part of the curing cycle for optimum physical properties.
- **Activators** - ingredients used to activate the accelerator and improve its effectiveness.

COMPOUND INGREDIENTS
Compounds

- **Antidegradants-** used to improve the basic polymer's resistance to oxygen, ozone, heat, ultra violet, etc. or slow down the deterioration of rubber products.

- **Processing aids-** plasticizers, softeners and tackifiers are added to aid mixing, modify viscosity, produce tack, provide flexibility at low temperatures or replace a portion of the base elastomer without substantial loss in physical properties. Aid during extrusion, calendering or molding operations. Oil waxes, stearic acid.

- **Fillers**-added to reinforce or modify physical properties and reduce cost; the most common are carbon black, clay and fibre.

- Other-added for unique properties, these include colour, perfume, abrasives, blowing agents (foam).

ELASTOMERS / POLIMERS
Categories

- Most important is the type of elastomer selected. This choice is based on the environment in which the final product will be used. For this purpose elastomers are classified into three major categories:
  - **General purpose**
  - **Solvent resistant**
  - **High or low temperature resistance**
- Many times, the price of the compound is important so the compounder is restricted to the selection of elastomers.

Silos for Powder & Bulk Solid Fillers and Extenders

FILLERS
Facts

- Fillers have been used since the discovery of rubber vulcanization to:
  - Colour
  - Reinforce
  - Extend
  - Reduce the cost of the compound
- Two general classes are used:
  - Carbon Blacks
  - Non-Black fillers

FILLERS
Non-Black Fillers

The major non-black fillers are not classified as well as the blacks. They include:

Clays	Semi-reinforcing	Hard and soft clays
Calcium carbonate	Extending filler	Reduce cost or dilute
Precipitated silica	Reinforcing	Replace carbon black in coloured compound
Titanium dioxide	Pigmenting filler	

FILLERS
Non-Black Fillers (cont.)

- **Hard**- tend to produce:
  - High modulus values
  - High tensile strength
  - Good abrasion
- Particle size: 0.3 micron
- **Soft-** tend to produce:
  - Lower modulus values
  - Lower tensile strength
  - Less abrasion resistance
  - Low unvulcanized viscosity
- Particle size: 1.3 micron

FILLERS
Non-Black Fillers (cont.)

- The selection of a particular filler for a compound will depend on:
  - Processing characteristics
  - Physical properties
  - Cost
  - Final performance of the product

CARBON-BLACK REINFORCEMENT
Rubbers

- The reinforcement of rubbers by carbon black improves the rubber properties due to a combination of physical and chemical interactions between carbon black and rubber.
- Reinforcement is strongly influenced by the type and amount of carbon black and its dispersion in rubber.
- The degree to which carbon black disperses in rubber is related to:
  - Type of rubber
  - Mixing conditions
  - Carbon black pellet properties

CARBON-BLACK REINFORCEMENT (CONT.)
Rubbers

- The three carbon black properties usually considered to have the greatest influence on reinforcement are:
  - **Structure**
  - **Surface area**
  - **Particle size**
- It is important that all of these characteristics of carbon blacks be considered in each case in order to control processing, vulcanization and final physical properties.

EFFECTS OF « PARTICLE » SIZE AND STRUCTURE
Properties

Distinctive properties of carbon black that influence the basic processing vulcanizate properties of elastomeric compounds; their effects are basically additive

Property	Decreasing particle size (constant structure)	Increasing structure (constant particle size)
Hardness	Increases	Increases
Tensile	Increases	Decreases
Modulus	Not a major factor	Increases
Elongation	Decreases	Decreases
Resilience	Decreases	Not a major factor
Viscosity	Increases	Increases
Dispersibility	Decreases	Increases
Dimensional Stability (green)	Not a major factor	Increases

Oil aging in oven – samples being removed

OIL SOFTENERS-PHYSICAL PLASTICIZERS
Types

These materials are used to improve processing (2-10 phr).

- Extenders include:
  - Naphtenic Oils (non-staining)
  - Aromatic Oils (staining)
  - Paraffinic Oils
- Many other materials act to modify elastomer vulcanizates by giving high elongations, lower modulus and softer vulcanizates (lower hardness). They include:
  - Fatty acids,
  - Vegetable oils
  - Petroleum products
  - Coal tar and pine tree products
  - Esters (for nitrile rubber)
- Selection of the amount and type used will depend on the compatibility of the oil in the elastomer used and how it will affect the physical characteristics of the product.

PROCESSING AIDS
Definition

- These materials react chemically for easier processing or increase building tack after mixing (ex. Struktol WB 16-improve flow properties)

- Peptizer react with the free radicals formed when the rubber is mixed to shorten the chain length of the polymer and help reduce the time required for breakdown and improve the dispersion of the ingredients added.

PROTECTIVE AGENTS
Antioxidants / Antiozonants

- The two major classes are Antioxidants and Antiozonants.
- **Antioxidants**:
  - Protect uncured polymer against heat and oxygen degradation.
  - Oxygen can cut the polymer chain and reduce the physical properties
  - Heat accelerates oxidation
- **Antiozonants**:
  - Inhibit static atmospheric cracking and frosting induced by ozone
  - Flexzone+sunproof provides high level of resistance to ozone cracking.
- Wax that migrates to the surface of the rubber product acts as a physical protective agent.

ACCELERATORS - ACTIVATORS
Definition

- Materials which increase the effectiveness of the cure system. These added ingredients are believed to form activated complexes with accelerators which permit the activation of the sulfur in the compound, producing more rapid and uniform cures.
- Inorganic compounds:
  - Zinc Oxide (ZnO)
  - Magnezium Oxide
- High molecular organic acids
  - Stearic acid
- ZnO in combination with stearic acid involves the formation of a rubber-soluble zinc soap in the compound which would be more reactive than either compound separately.
- Alkaline substances will increase the cure rate.
- Acid substances will retard the cure rate.

VULCANIZATION AGENTS
Definition

- Material involved in forming the actual crosslinks, give vulcanized elastomers their characteristics physical properties.
- Sulphur is the most common chemical used for this purpose. Metal oxides are used for vulcanizing Neoprene (Zn, litharge, magnezia).
- The saturated elastomers which do not have reactive groups of carbon to carbon double bonds in the main chain must be vulcanized with organic peroxides.

ACCELERATORS
Definition

- Accelerators are used to control the rate of vulcanization. This is done by selecting one type or a combination of two or more accelerators.
- If a single accelerator is used, it is called a primary accelerator.
- Combinations that involve primary and secondary accelerator will give a faster cure rate than with a single accelerator system.
- The selection of an accelerator system for a compound will depend on:
  - Processing safety
  - Vulcanization characteristics
  - Physical properties desired

CHEMICAL CLASSIFICATION OF ACCELERATORS
Chart

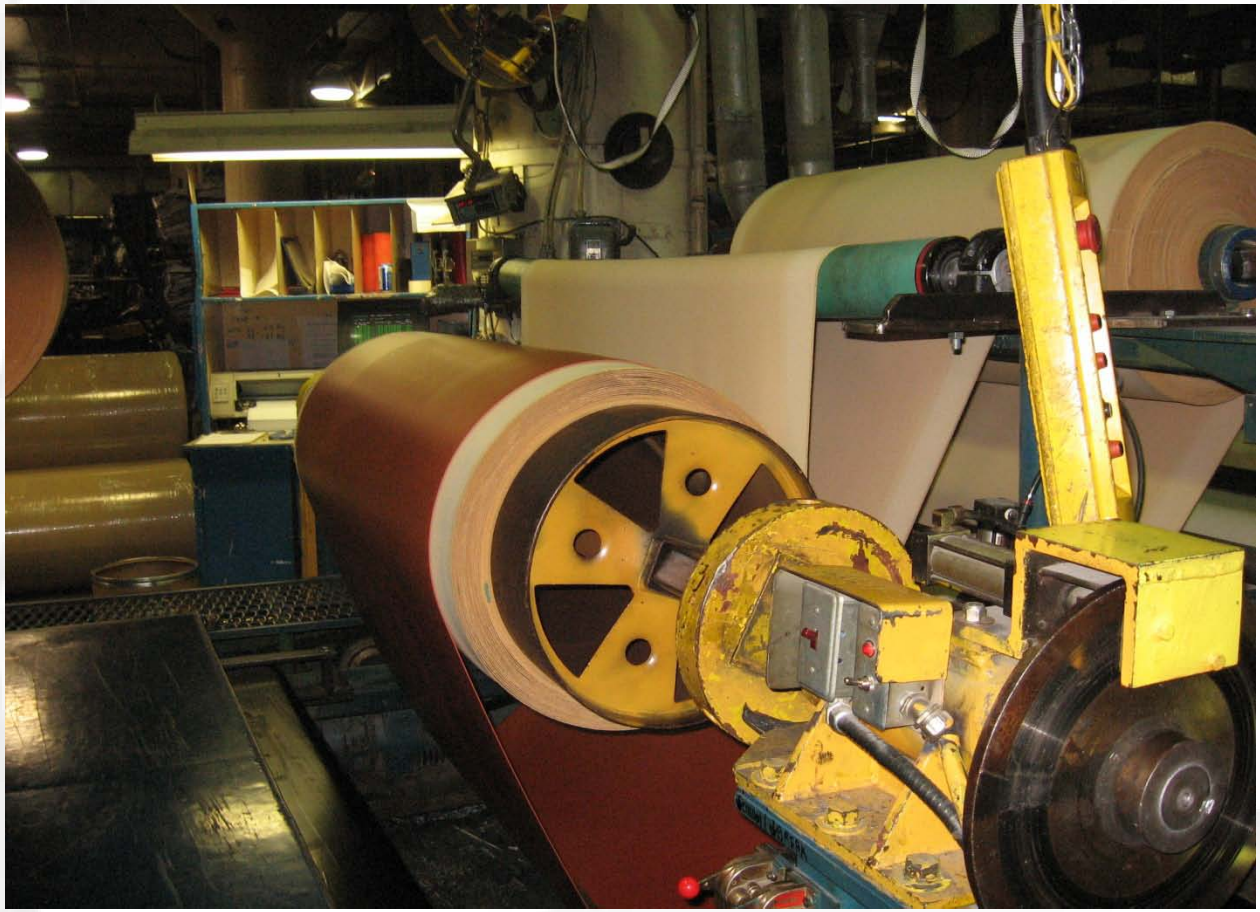
TYPE	USE
Aldehyde-amines	Adhesives
Amines	Delayed action in NR
Guanidines-Moderately Fast	Secondary accelerator usage
Thioureas	Fast cures with CR
Thiazoles-Fast	General purpose use
Thiurams-Ultra accelerator	Fast curing, safe
Sulfenamides	Delayed action
Dithiocarbamates-Ultra-accelerator	Low temperature use
Xanthates-Ultra-accelerator	Low temperature cures, mainly for latex systems

TYPICAL COMPOUND FORMULATION
Sample

A practical compound formulation usually consists of 10 or more ingredients. Each ingredient has a specific function.

INGREDIENT	TYPE OF INGREDIENT	AMOUNT IN PHR
#1 – RSS (Natural Rubber)	Elastomer	100.00
Soft Clay	Filler	100.00
Calcium Carbonate	Filler	50.00
Naphtenic Oil	Plasticizer	5.00
Activated Dithio-Bis-Benzanilide (Pepton 44)	Processing Aid (Peptizer)	0.25
Stearic Acid	Activator	2.00
Zinc Oxide	Activator	5.00
Red Iron Oxide	Colour Pigment	15.00

Reinforcements



REINFORCEMENTS
Types

- Cotton-Organic Fibre
  - Advantages- heat resistance, little stretch, high adhesion, does not loose strength in water.
  - Limitations- susceptible to bacteria, bulky, low tensile.
- Rayon-Cellulose Fibre
  - Advantages- low stretch, higher tensile than cotton.
  - Limitations- susceptible to bacteria and moisture.
- Nylon-Synthesized from crude oil
  - Advantages- high tensile strength and elongation, good flexibility and fatigue resistance.
  - Limitations- high stretch, not resistant to acid.

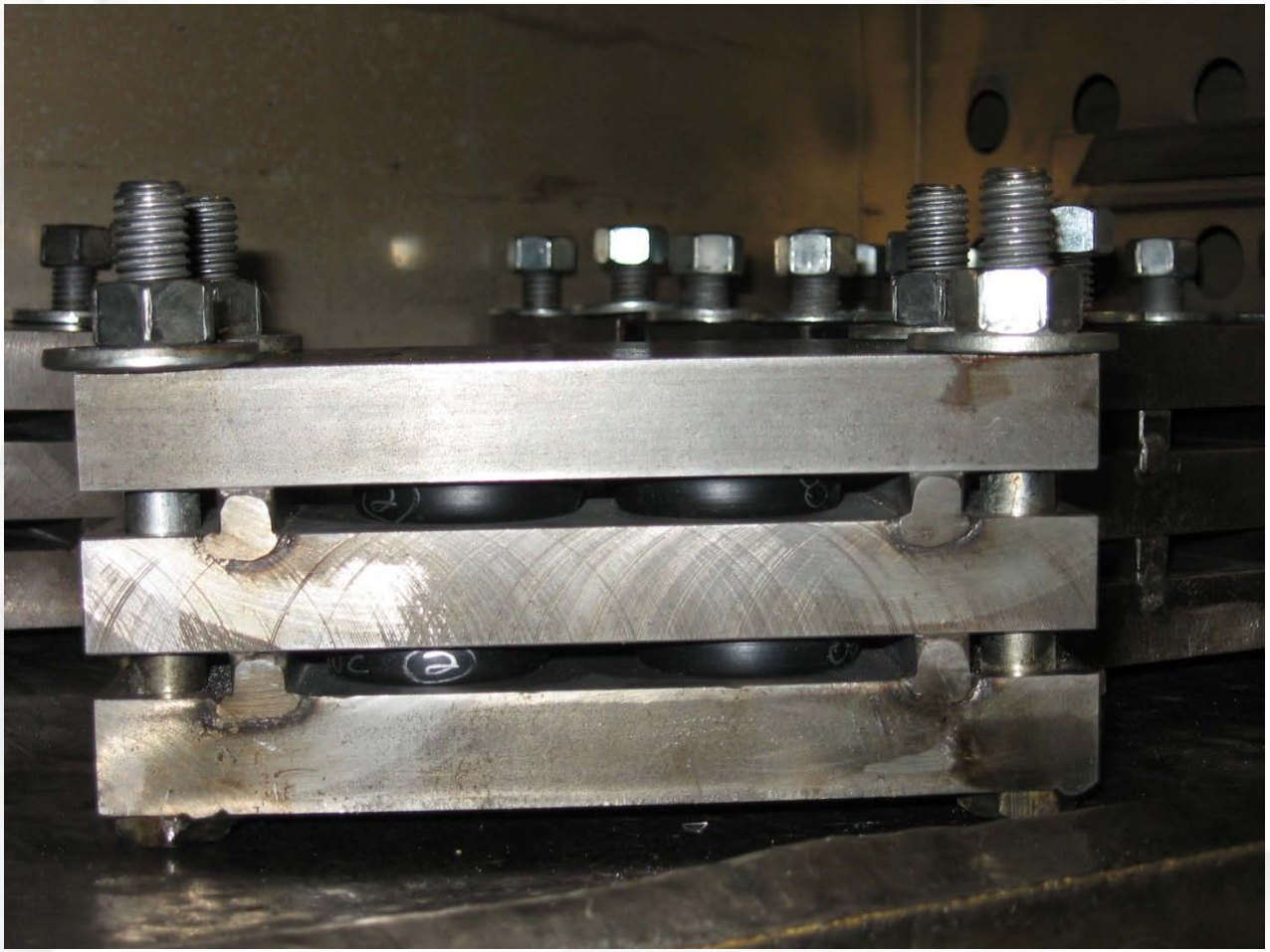
REINFORCEMENTS (CONT.)
Types

- Polyester-Synthesized from crude oil
  - Advantages - high tensile strength, low elongation, good flexibility, 1/10 water absorption of of nylon, acid resistant.
  - Limitations - slightly lower tensile than nylon (pound for pound).
- Fibreglass-Silica fibre
  - Advantages - high strength, no stretch, heat and chemical resistant.
  - Limitations - poor flexibility, difficult to bond.
- Aramid- Aromatic Polyamide
  - Advantages - excellent tensile strength and heat resistance.
  - Limitations - poor fatigue.

PHYSICAL PROPERTIES
Density (ASTM D297)

Also referred to as the **specific gravity**, is the amount of mass within a per unit volume. The usual unit of measure is grams per cubic centimeter (gr/cc). The specific gravity is in fact a ratio of density compared to water at 4 C.

Density



PHYSICAL PROPERTIES
Hardness (ASTM D2240)

Commonly referred to as the **Durometer** which is the standard instrument used in measuring the apparent hardness of cured rubber or resistance to indentation under specified conditions. The rubber industry uses the Shore “A” scale to measure soft rubber (hardness up to 90) and the Shore “D” scale (hardness greater than 90) will be seen on very hard ebonite type stocks.

Durometer / Hardness

PHYSICAL PROPERTIES
Tensile (ASTM D412)

The amount of force required to break a prescribed sample expressed as pounds per square inch (PSI).

Tensile Testing

PHYSICAL PROPERTIES
Elongation (ASTM D412)

Amount a prescribed sample will stretch in comparison to its original size before rupturing expressed as a percentage.

PHYSICAL PROPERTIES
Tear (ASTM D624)

The force required to tear a prescribed shaped sample of a compound expressed in pounds per inch. Total energy at rupture includes the energy necessary to propagate the tear and energy to stretch the tabs on the specimens.

PHYSICAL PROPERTIES
Modulus (ASTM D412)

- Is the force required to stretch the elastomer 100% or 300% of its original size, expressed in PSI.
- The specimen used is a dumbbell cut from a sharp die. The dumbbells are clamped in the grips of a Tensile Test machine. During the test the grips separate (rate 20 in/min.).

PHYSICAL PROPERTIES
Fluid Resistance (ASTM D471)

- Effects of prescribed fluids, e.g. oil, water, on the physical properties of an elastomer, expressed as a percentage change of the original physical properties, tensile, elongation, hardness, mass and volume under definite conditions of temperature and time.
- The resulting deterioration is determined by noting the changes in physical properties before and after immersion.
- Test shall be conducted in an oil base which has its aniline point nearest that of the service oil.

PHYSICAL PROPERTIES
Fluid resistance (ASTM D471) cont.

We determine the difference in:

- Duro-points
  - Elongation (%): value after-value before/value before X 100
  - Tension (%): value after-value before/value before X 100
  - Weight (%): value after-value before/value before X 100
  - Volume (%)
- Oil resistant rating based on volume swell in #3 oil:
  - Under 40%-Resistant
  - 40% to 120%- Moderate Resistant
  - Over 120%-Non-Resistant

PHYSICAL PROPERTIES
Cold Temperature (ASTM D746)

Temperature at which the compound is brittle and no longer exhibits elastic properties. The sample is cooled with Methanol+Carbon Dioxide. A single-impact is given on samples under specified impact and temperature conditions until the temperature is found at which no failure occurs.

PHYSICAL PROPERTIES
Ozone Resistance (ASTM D1171)

Compound's ability to resist deterioration when exposed to ozone. Testing is performed on a prescribed shape that is under tension for a set time and PPHM of ozone. Ozone present in low concentration, only several parts per hundred million (pphm) can cause stressed rubber to crack. The cracks occur at right angles to the direction of the applied stress.

- Test speciments:
  - 200% elongation
  - Loop
- Visual inspection:
  - No cracks
  - With cracks- fail the test

PHYSICAL PROPERTIES
Compression Set (ASTM D395)

The amount of permanent deformation expressed as percentage of the original gauge when a load is applied for a prescribed time and temperature, then removed.

PHYSICAL PROPERTIES
Compression Set (ASTM D395) cont.

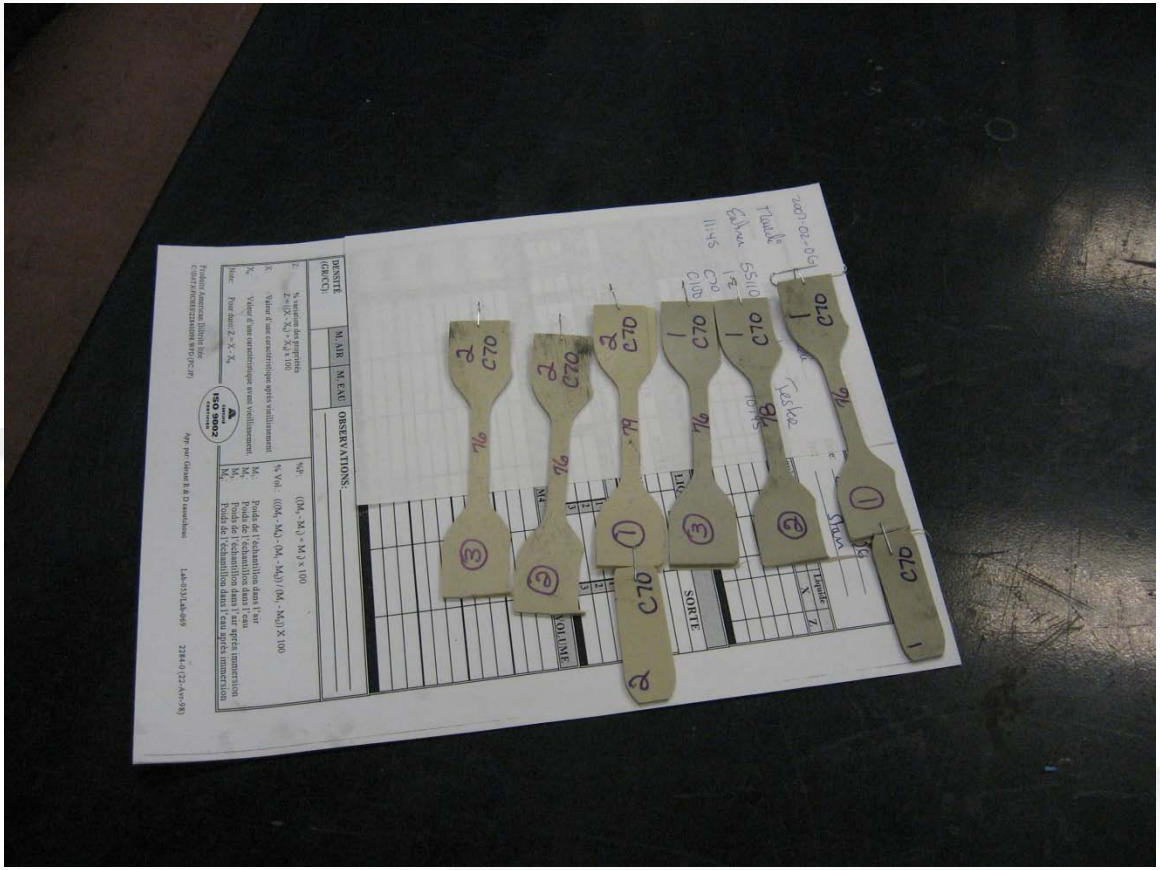
% Compression:

$$= \frac{\text{Initial Thickness- Final Thickness X 100}}{\text{Initial Thickness-Spacers Thickness (0.375”)}}$$

PHYSICAL PROPERTIES
Abrasion Resistance (ASTM D1630)

- The compound's resistance to abrasive wear expressed as a percentage to a standard stock used world-wide, referred to as the NBS test.
- A rubber test piece is pressed against a rotating cylinder that is covered with abrasive paper. The loss of material is then evaluated compared to a standard.

Heat Aged Samples



Heat Aged Samples in Oven

PHYSICAL PROPERTIES
Heat Resistance (ASTM D573)

- Represents the effect of high temperatures on the physical properties of a compound expressed as a percentage change of the original physical property's hardness, tensile, elongation, mass and volume, after performing an accelerated test.
- We measure:
  - Duro (points)
  - Tension (%)
  - Elongation (%)

PHYSICAL PROPERTIES
Heat Resistance (ASTM D573) cont.

$$\%= \frac{\text{Value after aging-Value before aging X 100}}{\text{Value before aging}}$$

PHYSICAL PROPERTIES
Oil Aging (ASTM S471)

- There are tests done with 3 different oils. Oil #3 is the most severe one.
  - A: Oil#1 for 70 hours at 100 C
  - B: Oil#2 for 70 hours at 100 C
  - C: Oil#3 for 70 hours at 100 C
  - D: Oil#3 for 70 hours at 25 C
  - E: Oil#1 for 70 hours at 125 C
  - F: Oil#1 for 70 hours at 150 C
  - G: Oil#3 for 70 hours at 125 C
  - H: Oil#2 for 70 hours at 25 C
  - I: Oil#3 for 70 hours at 70 C
  - J: Oil#1 for 70 hours at 70 C
  - K: Oil#1 for 25 C

PHYSICAL PROPERTIES
Adhesion (ASTM D429)

A measure of the stress needed to remove the rubber from a different surface, usually covered with a bonding agent. The objective is to get tearing in the rubber layer instead of in the rubber-metal interface. There are different types:

- To metal, directly; A-1: steel; A-2: brass coated; A-3: zinc coated
- To metal with chemlock
- To nylon with promoting agent
- To polyester with promoting agent
- To fiber glass
- To Kevlar with promoting agent

PHYSICAL PROPERTIES
ASTM “Line Call-Out”

- Example: 2BC 625 A14 C12 F17 G21 Z
  - 2- Grade Number
  - B- Heat Resistant 100 C Chloroprene
  - C- 120% Maximum, Oil Volume Swell
  - 6- Hardness 60 Shore “A” Durometer + or –5
  - 25- 2500 PSI Minimum Tensile
  - A14- Heat Resistance Change:
    - Hardness +15
    - Tensile –15%
    - Elongation –40%
  - C12- Ozone Resistance (100 PPHM 100 Hours)
  - F17- Cold Temperature (-40 C)
  - G21- Tear Resistance (150 lbs)
  - Z- Special Requirements (for example: meets AASHTO Bearing Pad Spec)
- Metric version M2BC 617 A14 C12 F17 G21 Z

PHYSICAL PROPERTIES
ASTM Rubber Specifications

Basic requirements for establishing type by temperature

Type	Test Temperature (C)
A	70
B	100
C	125
D	150
E	175
F	200
G	225
H	250
J	275

PHYSICAL PROPERTIES
ASTM Rubber Specifications

Basic requirements for establishing class by volume swell

Class	Volume Swell (Max. %)
A	No Requirement
B	140
C	120
D	100
E	80
F	60
G	40
H	30
J	20
K	10

PHYSICAL PROPERTIES
ASTM Rubber Specifications – Meaning of Suffix Letters

SUFFIX LETTER	TEST REQUIRED
A	Heat Resistance
B	Compression Set
C	Ozone or Weather Resistance
D	Compression- Deflection Resistance
E	Fluid Resistance
F	Low Temperature Resistance
G	Tear Resistance
H	Flex Resistance
J	Abrasion Resistance
K	Adhesion
L	Aqueous Fluid Resistance
M	Flammability Resistance
N	Impact Resistance
P	Staining Resistance
R	Resilience
Z	Any Special Requirements, which shall be specified in detail

PHYSICAL PROPERTIES

Chart - COMPOUND AB-135; POLYMER NR (Tan); DENSITY 1.00 gr/cc

ASTM Method	Description	Typical Value	Units
D2240	Hardness	40	Shore A Durometer
D412	100% Modulus	185	PSI
D412	300% Modulus	470	PSI
D412	Tensile	2000	PSI
D412	Elongation	600	%
D412	Tear	146	Lbs/In.
D1630	NBS Abrasion	56	%
D746	Cold Temperature	-40	ºC
D573	Heat Age (70 hrs@ 70 C)		
	Change in Hardness	5	Points
	Change in Tensile	5	%
	Change in Elongation	-3	%

Storage

Storage

STORAGE OF RUBBER PRODUCTS
Facts

Can be adversely affected by: temperature, humidity, ozone, sunlight, oils, solvents, corrosive liquids and fumes, insects, rodents and radiation.

- Warehousing area: relatively cool, dark and free from dampness and mildew; no high or low humidity
- Should be used on a first-in, first-out basis
- Ideal storage temperature: 50 to 70ºF (10 to 21ºC); maximum limit of 100ºF (38 ºC). Do not store near sources of heat, such as radiators and base heaters.
- Avoid ozone and exposure to direct and reflected sunlight
- Store in original shipping containers when possible
- Protect against rodents and insects

TYPICAL RUBBER SHELF LIFE GUIDE
Type of Rubber VS Years

- UP TO 20 YEARS

	ABBREVIATIONS	
TYPE OF RUBBER	ASTM D-1418	ASTM D-2000
Silicone	Q	FE
Viton	FKM	HK

- 5-10 YEARS

	ABBREVIATIONS	
TYPE OF RUBBER	ASTM D-1418	ASTM D-2000
Nitrile	NBR	BF, BG, CH
Hypalon	CSM	CE
Butyl	HR	AA, BA
Neoprene	CR	BC, BE
Ethylene Propylene Diene Polymer	CR	BC, BE

PHYSICAL PROPERTIES
General Information

Polymer Type	Durometer Hardness Shore A	Tensile Strength (Min.)	Ultimate Elongation (Min.)	Abrasion Resistance	Ozone Resistance	Heat Aging	Resistance to diluted acids
Natural (NR)	30-42	2000+	600	Excellent	Poor	Fair	Fair To Good
Styrene Butadiene (SBR)	40-80	800+	300	Good To Excellent	Poor	Good	Fair To Good
Neoprene (CR)	40-80	800+	200	Very Good	Fair	Good	Good
Nitrile (NBR)	50-80	900+	200	Good	Poor	Very Good	Good
Butyl (IIR)	40-75	1000+	400	Good	Excellent	Very Good	Excellent

PHYSICAL PROPERTIES
General Information - continued

Polymer Type	Durometer Hardness Shore A	Tensile Strength (Min.)	Ultimate Elongation (Min.)	Abrasion Resistance	Ozone Resistance	Heat Aging	Resistance to diluted acids
Ethylene propylene diene (EPDM)	50-60	1000	400	Good to Excellent	Outstanding	Excellent	Excellent
Hypalon (CSM)	40-70	1000+	500	Very Good	Outstanding	Very Good	Excellent
Silicone (VMO)	40-80	600+	80	Poor	Excellent	Out-standing	Excellent
Viton (FKM)	70-80	1850+	200	Good	Outstanding	Out-standing	Good To Excellent

Banbury Mixing Station

Roller Head Extruder

Input End to Rotocure

Red Rubber Sheet Packing from the Mixer

Rubber Mill Mixing Black Product

Rubber Mill Mixing White Product

The perfect match