

INTRODUCTION TO POLYMERS

Objectives

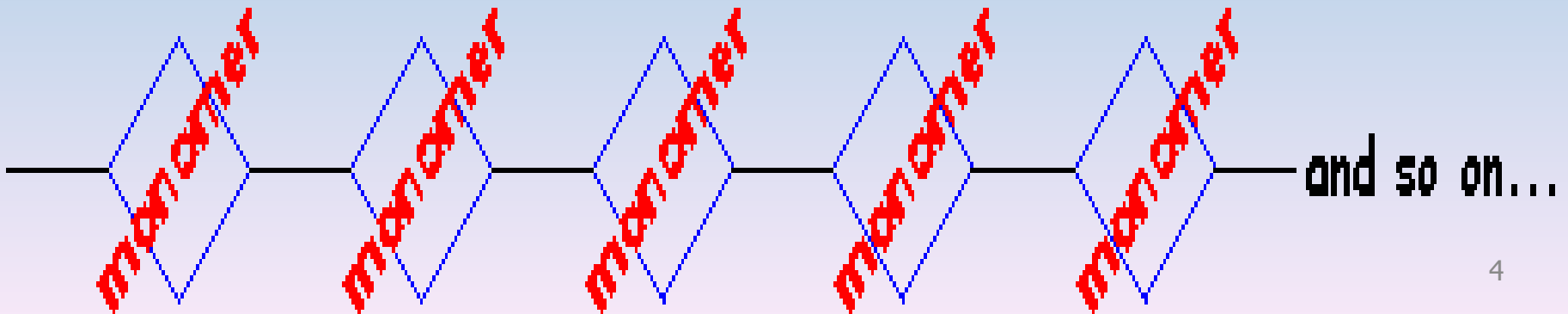
- Introduction about polymers.
- Different types of polymers
- Ideas about polymer chains
- Amorphous & Crystallinity properties
- Polymerization technique .
- Some typical examples related to Railways.

POLYMERS:

- Polymer (Greek, poly-many, mers-unit or part)
- Polymer have influenced our life style in such away that it would not be wrong to say that we are in polymer age. For example, house-hold utensils, clothes, furniture, automobile,space aircraft etc.
- These are so frequently use by people that a common man calls them by names like plastics, fibres, rubbers resins etc.

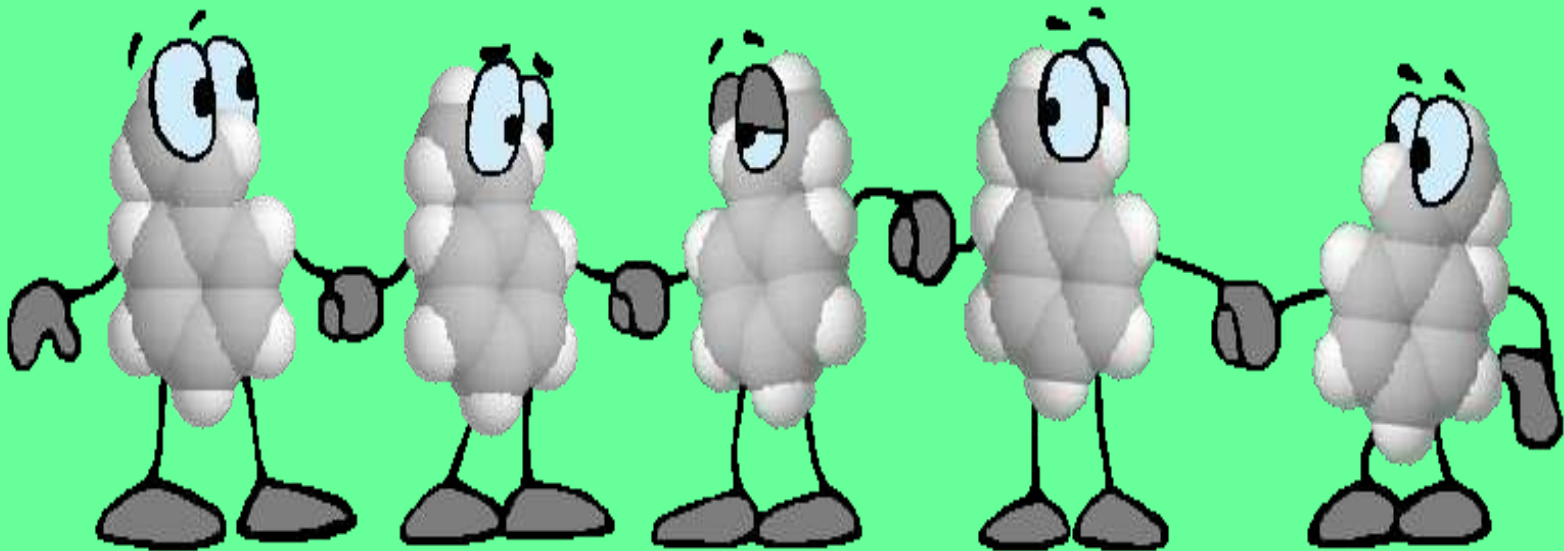
Polymers

- ❖ Polymers are large bunch of monomer units, normally in the range of few thousand to 1,00000 units.
- ❖ The properties of polymers are very different with that of monomers.
- ❖ Polymers are of many types, but our area of interest is in the rubber type or plastic type polymers.



❖ Rubbers are more important for engineering applications due to their load bearing capacity, vibration reduction, impact reduction, energy absorption, electrical sheath insulation and sealing properties.

❖ Sometimes polymers are called "macromolecules". "Macro" means "large" and that polymers must be *very* large molecules!



INTRODUCTION.

Polythene is a Polymer formed by the linking together of large no of of ethane (C_2H_4) molecules.

- Polymers are macro molecules built up by the linkage of small molecules (monomers) by chemical bond into a long chain.
- POLYMER MEANS A SUBSTANCE WITH MANY PARTS.

“POLYMER IS A UNION OF MONOMERS.”

“ POLYMERS ARE COMPOUNDS FORMED BY A MORE OR LESS REGULAR REPETATION OF LARGE NUMBER OF THE SAME AND DIFFERET ATOMIC GROUPINGS THAT ARE JOINED BY A CHEMICAL BONDS INTO A LONG CHAIN. ”

INTRODUCTION.

- **MATERIALS USED AS PLASTICS, RUBBERS, FIBRES, ADHESIVES AND SURFACE COATING MATERIALS ARE ALL POLYMERS.**
- **COMMONLY USED POLYMERS ARE- PE,PP,PVC,PS,NYLONS,SBR,BR,BAKELITE etc.**
- **TODAY IT IS VERY DIFFECULT TO CONSIDER A WORLD WITHOUT POLYMERS.**

INTRODUCTION.

POLYETHYLENE :- UNION OF ETHYLENE MOLECULES

PVC :- UNION OF VINYL CHLORIDE.

TEFLON :- UNION OF TFE. ETC.

PMMA(Polymethylmethacrylate) :- TRANSPARENCY, PLEXIGLASS.

PAN(Polyacrylonitrile):- Acrylon fibres, orlon.etc.

PROPERTIES OF POLYMERS.

- LIGHT IN WEIGHT.
- HIGHER STRENGTH TO WEIGHT RATIO.
- WIDER & DESIGN FREEDOM.
- EASY PROCESSABILITY.
- LOW ENERGY REQUIRED FOR MANUFACTURE.
- MINIMUM POSTS FINISHING.
- CORROSION RESISTANT.
- LOW CREEP.
- BETTER AESTHETIC LOOK.

PROPERTIES OF POLYMERS

- WIDE COLOUR RANGE.
- EASY REPLACEABLE.
- RESISTANT TO CHEMICALS.
- RESISTANT TO WATER.
- LOW MAIRENANCE COST.
- ADHESIVE OF PLASTIC RESIN ARE VERY STRONG, DURABLE & PRODUCE VERY THI FILM.

CLASSIFICATION.

1. ORIGIN.

- NATURAL.(RUBBER, SILK,STARCH,PROTEINS etc.)
- **SEMISYTHETIC** (CHEMICALLY MODIFIED N.POLYMERS)
- **SYNTHETIC.** (MAN MADE POLYMERS)

2. MODE OF FORMATION.

- ADDITION.(PE,PP,PS etc)
- CONDENSATION.(NYLON,POLYESTER etc)

CLASSIFICATION.

3. BASED ON STRUCTURE/SHAPE.

- LINEAR. (HDPE PVC,PS etc.)
- BRANCHED.(LDPE)
- CROSSLINKED.(BAKELITE)

4. THERMAL RESPONSE.

➤ **THERMOPLASTICS**

➤ **THERMOSETTING.**

CLASSIFICATION.

5. MECHANICAL PROPERTIES & BEHAVIOUR.

➤ RUBBER.

➤ PLASTICS.

➤ FIBRES

6. TYPES OF MESOMERS INVOLVED I THE POLYMERS.

➤ HOMOPOLYMERS.

➤ HETRO POLYMERS

➤ A RANDOM COPOLYMER

A-A-B-B-A-B-A-B-

CLASSIFICATION.

* AN ALTERNATIVE COPOLYMERS.



* A BLOCK COPOLYMER HAS DIFFERENT MESOMERS IN BLOCK OF INDIVIDUAL SPECIAL.



* A GRAFT COPOLYMER



B

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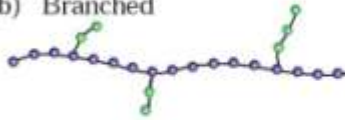
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Polymer Chains

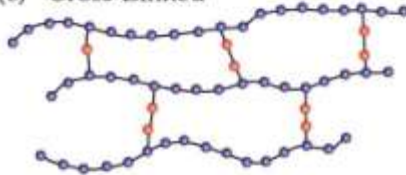
(a) Linear



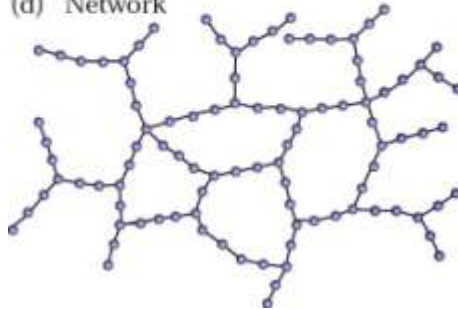
(b) Branched



(c) Cross-Linked



(d) Network



Schematic illustration of polymer chains.

(a) Linear structure--thermoplastics such as acrylics, nylons, polyethylene, and polyvinyl chloride have linear structures.

(b) Branched structure, such as in polyethylene.

(c) Cross-linked structure--many rubbers or elastomers have this structure, and the vulcanization of rubber produces this structure.

(d) Network structure, which is basically highly cross-linked--examples are thermosetting plastics, such as epoxies and phenolics.

Thermofforming plastics

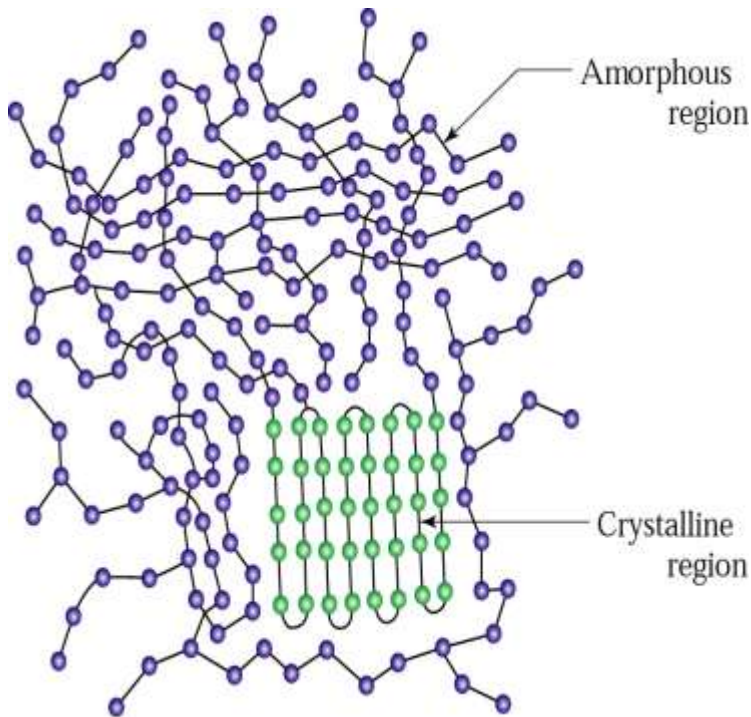
Amorphous Resins

- ❑ Clear & Transparent
- ❑ Examples - Acrylic, Polycarbonate and Polystyrene

Crystalline Resins

- ❑ Opaque and usually quite tough
- ❑ Examples - Nylon, Polypropylene and Acetal

Crystallinity



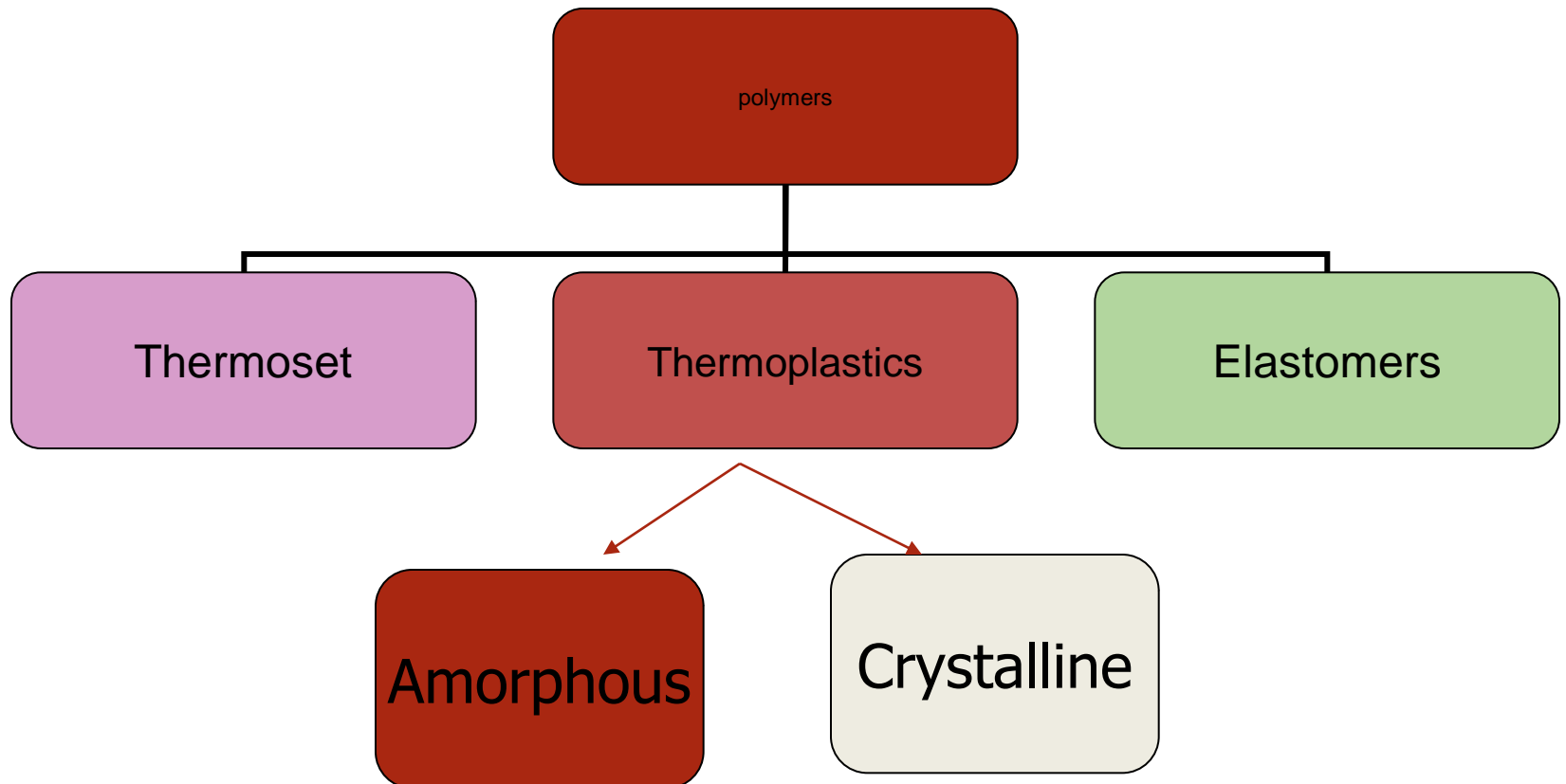
Amorphous and crystalline regions in a polymer.

The crystalline region (crystallite) has an orderly arrangement of molecules. The higher the crystallinity, the harder, stiffer, and less ductile the polymer.

Commodity Plastics

- ❑ Plastics that are used for consumable items
- ❑ Low Mechanical or Physical properties
- ❑ Examples: Polyethylene, Polystyrene and Polypropylene and others
- ❑ Products: Plastic forks and knives, Plastic cups and plates, Polyethylene containers and trash bags etc.


Classification of polymers



Engineering Plastics

- ❑ Plastics having very well defined mechanical properties
- ❑ Usually very tough and high strength
- ❑ Examples : Acetal, Polycarbonate, Nylon and Polyesters and others.

CLASSIFICATION

Commodity Plastics PE,PP,PS,PVC	Low Performance  High Performance
Intermediate Plastics Polymethyl Methacrylate (PMMA) Acrylonitrile Butadine Styrene (ABS)	
Engineering Plastics PC, Nylons, Polyphenylene Sulphide (PPS)	
Advanced / High Performance Plastics Liquid Crystal Polymer (LCP), Polyetheretherketone(PEEK), Polyethersulphone (PES)	

POLYMERISATION:-

The process by which small molecules (monomer) join together in large molecules is called POLYMERISATION.

TWO TYPES OF POLYMERISATION:

*** Addition Polymerization.**

*** Condensation polymerization.**

Addition Polymerization:

There is simple addition of monomer molecules to each other without loss of any atoms from the original monomer molecules.

Condensation polymerization:

In this process bond is established between the molecules, & some of the atoms in the monomer are lost as a by product compound.

ADDITION & CONDENSATION POLYMERISATION.

- Involves unsaturated monomers (double bonds) like ethylene, Vinyl chloride, Styrene etc.
- Fast reaction, (Formation of polymer takes 10^{-2} to 10^{-4} second)
- At any instant, only monomer and polymers are present
- Involves substances with at least two functional groups like ethylene glycol (2-OH groups), adipic acid (2-COOH groups).
- Step-wise slow addition. (The reaction usually takes hours and days.)
- * No monomer. Mixtures of dimmers, trimers, tetrameres etc.

ADDITION & CONDENSATION POLYMERISATION.

- No by product.
- Homo-chain polymer, generally a Thermoplastic is obtained.
- The growth of the chain is at one active center.
- Always yields a by-product along with a polymer.
- Hetero-chain polymer either Thermoplastic or Thermoset can be obtained.
- The growth of the chain occurs at minimum of two active centers.

TYPES OF POLYMERS:

* **Homopolymer.**

* **Copolymer.**

Homopolymer- A polymer consists of identical monomer is called Homopolymer.

Copolymer- A Polymer consists of monomer of different chemical structure is called copolymer.



Homopolymer



Copolymer

ARRANGEMENT OF MONOMERIC UNITS:

1. Linear.
2. Branched.
3. Cross –Linked (Three dimensional structure)

THERMOPLASTICS.

- Thermoplastics consists of linear or branched macromolecules.
- Held together by intermolecular forces.
- NOT Deform permanently.Do not recover.
- Thermally recoverable.
- Can dissolve in solvents and can be recovered after solvent evaporates.

THERMOSET:-

- On heating undergo chemical change.
- Heating causes similar effect as vulcanizing.
- Change due to heating causes formation of more tightly cross linked molecules than rubber. Hence rigid and hard.
- Can not be reprocessed.

THERMOPLASTICS

Commodity Plastics

- **Poly Ethylene (LDPE, LLDPE, HDPE)**
- **Poly Propylene (PP)**
- **Poly Vinyl Chloride (PVC)**
- **Poly Styrene (GPPS, HIPS)**
- **Styrene Acrylonitrile (SAN)**
- **Poly Methyl Methacrylate (PMMA)**

THERMOPLASTICS

Engineering Plastics

- **Poly Amide (Nylon 6, 66)**
- **Acrylonitrile Butadiene Styrene (ABS)**
- **Poly Acetal**
- **Poly Carbonate (PC)**
- **Thermoplastic Polyesters (PET,PBT)**
- **Poly Phenylene Oxide (PPO)**
- **Thermo Plastics Poly Urethane (TPU)**

THERMOSETS

- **Phenol Formaldehyde (PF)**
- **Urea Formaldehyde (UF)**
- **Melamine Formaldehyde (MF)**
- **Epoxy**
- **Unsaturated Polyester**

Use of Polymer in Day to Day Life



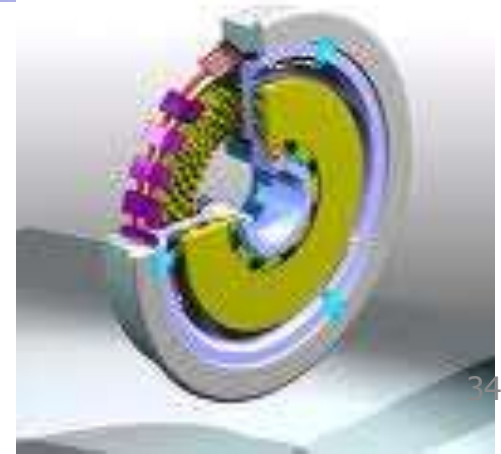
Use of Rubber In Day to Day Life



Use of Polymer in Medical Field



Use of Rubber in Railways



Some of the polymeric items used in Coaches.

1. Cushioning Material (Recron)
2. Rexine
3. Upper & lower Rubber Washer (Hytrel)
4. Brake Gear Bushes
5. PVC flooring
6. LP Sheet
7. Silent Block for Anchor Link
8. Some Rubber components

RUBBER COMPONENTS

RUBBER ITEMS

RUBBER PROFILE FOR FIXING SEALED WINDOW GLASS UNITS

IN AC COACHES

SPECIFICATION: ICF/M/D/SPEC/104

PROPERTIES TESTED: Polymer identification, Shore Hardness (before & after ageing),

Tensile strength & % elongation (before & after ageing), Specific

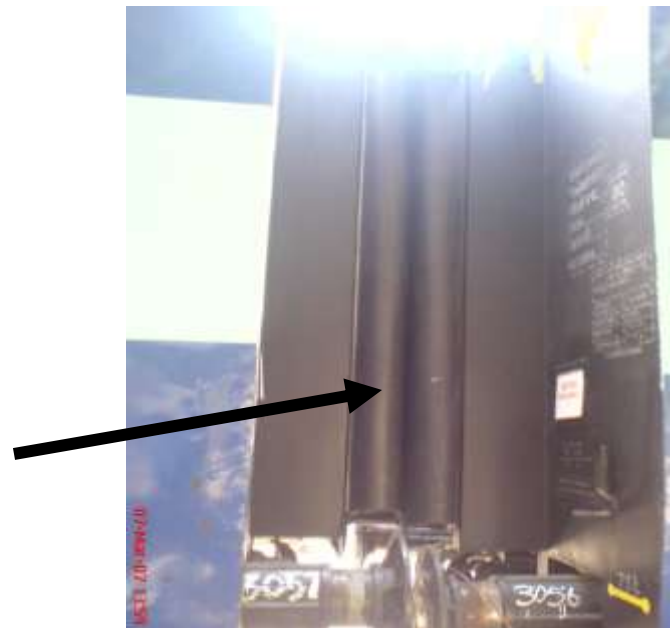
gravity, resista



ELASTOMER FLANGE CONNECTIONS FOR INTER COMMUNICATION BETWEEN PASSENGER COACHES (UIC VESTIBULE)

SPECIFICATION: RDSO C 8812

PROPERTIES TESTED: Shore hardness, tensile strength &% elongation (before and after ageing), tear strength, polymer identification, Flammability



MISCELLANEOUS RUBBER ITEMS

Fixing rubber, sealing rubber, rubber packing for carriage fan, packing rubber,

Rubber pad, rubber gasket, sealing rubber for roof mounted AC, Rubber buffer,

Rubber stopper etc.,

PROPERTIES TESTED: Shore hardness, polymer identification



Fixing Rubber (ICF/VNR 5-4-202)

(EPDM)

THANKS.