

## 2.15 30915 TECHNOLOGY OF ELASTOMERS

### UNIT-1

Principles of compounding Rubber compounding – definition and objectives formulation of recipe and its significance, role of recipe in rubber product manufacturing. Method of representing the relative proportions of ingredients in a recipe, PHR, importance of compounding. Compounding Ingredients and their classification Different class of compounding ingredients, base polymer, and curing system, vulcanizing agents, accelerators, activators and their function in a compound.

The role of other ingredients like filler, plasticizers, softener and other special additives in a recipe, selection procedure of ingredients. Compatibility and solubility parameter concept Theory of Vulcanization – changes in elastomers due to vulcanization. Sulphur vulcanization – theory of Sulphur vulcanization. Different types of cross links formed and their effect on vulcanite properties. Classification of vulcanization system low Sulphur vulcanization system – C.V, E.V and S.E.V. system – comparison Non-Sulphur vulcanization system – Sulphur chloride – organic peroxide – metal oxides – resin – dioxime – isocyanates etc. with example. Curing system for olefin and non-olefin rubbers

### UNIT-2

Preparation, Properties & Application of compounding ingredients Fillers – definition and objectives – classification of fillers – non-black fillers preparation, properties and application of non-black fillers such as silica, silicates, clays, whiting, lithopone, barites, talc, zinc oxide, MgO, TiO<sub>2</sub>. Fibrous fillers – asbestos, cellulose fiber, flocks, wood flour Organic fillers – cork, glue, cyclized NR, hevea -plus, HSR, phenolic resin Carbon black – different grades and method of manufacture – furnace process – thermal process channel process – lamp black process Different grades – SAF, ISAF, HAF, FEF, GPF, SRF, MT, conducting black – etc.

ASTM D 1765, colour coding and international reference black. Properties of carbon black – particle size, structure physical nature of particle size, chemical nature of particle size, particle porosity. Determination of particle size and structure – application of carbon black Antioxidants and Antiozonents – functions, types staining and non-staining. Mechanism of degradation external and internal factors affecting degradation. Retarders - functions Plastizers – softeners and extenders Plasticizer function – classification of plasticizers, special purpose ingredients – blowing agents, flame retardants, abrasives, antistatic agents, integral bonding additives, stiffening agents coupling agents, deodorants etc.

### UNIT-3

Cure characteristics & Measurements Define cure time – cure index, vulcanization time, scorch and scorch time, heat history of compounds, optimum cure, and state of cure methods to avoid scorch Define – reversion cure, marching cure and plateau. Define over cure and under cure, illustrate with cure graph. Discuss the various cure graphs by changing the compounding ingredients such as accelerator, vulcanizing agents Mooney viscometer – viscosity, plasticity and elasticity – determination of viscosity using Mooney viscometer Rheometers – MDR, ODR – determination of cure characteristics using Rheometers Assessment of state of vulcanization

Define rate of cure – cross-link density – determination of cross-link density – swelling of rubber vulcanisate by liquids. Practical assessment of state of cure. Calculation of cure in thick articles

#### **UNIT-4**

Compounding for Vulcanizate Properties General principles of compounding vulcanization properties. Comparison of raw elastomeric properties factors to be considered for designing a rubber compound with examples. Effect of particle size and structure of fillers on processing and vulcanisate properties. Compounding to meet processing requirement viscosity control, control of nerve, and adhesion to mill rolls, tack, scorch, calendaring and extrusion – continuous vulcanization.

Calculation of specific gravity and volume costs with worked out examples compounding for vulcanisate properties such as hardness and modulus with worked out examples. Tensile properties, T.S, elasticity etc. Resistance to abrasion and tear Resistance to cyclic stressing, flex cracking cut growth and fatigue Resistance to degradative agents such as heat, flame, liquids, light ozone, atmospheric exposure compounding for low temp flexibility, electrical properties – resistance to gas permeation. Contact with food stuffs, drugs etc. Compounding for bonding to non-rubber substrates such as metals, textile materials

#### **UNIT-5**

Vulcanization methods Brief introduction of processing methods for product manufacture - flow chart Moulding – compression – transfer – and injection molding. Blank preparation – blank heating – water bath and ovens – high frequency and microwave heating – heat transfer – methods of heat transfer Heating medium for presses comparison of electrical heating and steam heating Vulcanization methods other than molding Radiation vulcanization method.

Batch vulcanization methods – autoclave - hot air oven – gas curing – peachy process – advantages and disadvantages. Continuous vulcanization method High-pressure steam – hot air tunnel molten salt bath – fluidized bed – continuous drum cure microwave curing. Examples of products vulcanized by each method Finishing of Rubber components Flash and spew removal – hand trimming machine trimming. Buffing – low temperature tumbling – punching – grinding – shot blasting pointing and lacquering– chemical surface treatment. Safety in rubber industries

#### **Reference Books:**

1. Rubber technology and manufacture – C.M. Blow
2. Rubber technology – Morton
3. Vander built rubber hand book – Vander built Rubber Company
4. Advance in rubber technology – Tata McGraw hill