GUJARAT TECHNOLOGICAL UNIVERSITY

RUBBER TECHNOLOGY (26)
VULCANISATION
SUBJECT CODE: 2152601
B.E. 5th SEMESTER

Type of course: B. E. Rubber Technology

Prerequisite: NA

Rationale: NA

Teaching and Examination Scheme:

Teaching Scheme			Credits	Examination Marks						Total Marks
				Theory Marks			Practical Marks			
L	T	P	C	ESE (E)	PA (M)		ESE (V)		PA (I)	
					PA	ALA	ESE	OEP		
3	0	3	6	70	20	10	20	10	20	150

Content:

Sr. No	Topics	Teaching Hrs.	Module Weightage
1.	Introduction: Drawbacks of Raw Rubber, Definition of Vulcanization, Properties of Unvulcanized Compound, Difference between Vulcanized Rubber and Unvulcanized Rubber, Structural Changes observed in Rubber After Vulcanization, Structure of Rubber Vulcanizate.	6	10
2.	Sulphur Vulcanization :- Practical systems for Natural & Synthetic Olefin Rubber-Theory of Sulphur vulcanization.	6	10
3.	Non-sulphur vulcanizing systems for olefin & Non-olefin Rubbers: Metallic oxides, Polyfunctional amines, peroxides for polyacrylates, Silicone Rubbers, Fluorocarbon Rubbers,	6	10
4.	Types of Vulcanizing agents & their effects: 1. Sulphur 2. Sulphur donors 3. Accelerated sulphur vulcanization 4. Peroxides : Introduction, Classification of Peroxides and their Structures, Examples of Peroxides, Efficiency of Peroxides, Chemistry of peroxide cure, Compounding Aspects of peroxide Cure, Advantages of Peroxides cure over sulphur vulcanization, Disadvantages, Reaction mechanism, Peroxide cure of saturated and unsaturated elastomers 5. Metal oxides: Introduction, Reaction mechanism, Suitable examples 6. Phenolic curatives: Introduction, Reaction mechanism, Suitable examples, Vulcanisation by benzoquinone derivatives, bis-maliemides, Vulcanization by triazine accelerators, Urethane cross -linking.	6	10
5.	Relations between Structure and Properties of Vulcanizates: Modulus and Strength, Hardness, Resilience and Heat Buildup, Fatigue Properties, Heat Stability, Swelling, Low Temperature Properties, Abrasion, Compression Set, Aging, Dynamic Properties and Rolling Friction.	6	10

6.	Different Vulcanisation System: Conventional, EV and Semi EV system in rubber, Accelerator system selection & adjustment, Vulcanization of rubber blends and filled systems.	6	10
7.	Modern Vulcanisation System: Moisture curing, Dynamic Vulcanisation, Shrinkage and Post Vulcanisation reaction.	6	10
8.	Vulcanisation techniques: Introduction, Classification of Vulcanization Techniques. Batch Vulcanization Techniques: Moulding, Autoclave, Hot Air Oven Curing, Lead Curing, Moisture Curing, Free Heating: General Comments About Free heating, Difference between hot air and steam vulcanization, Vulcanization Phases During Free Heating, Comparison of Saturated Steam Vulcanization and Super heated Steam, Vulcanization in Air/Steam Mixture, Vulcanization in Water, Cold Vulcanization. Continuous vulcanization : Liquid Curing Method, Fluidized Bed Vulcanization, Continuous Vulcanization in Stem Pipes, Rotocure, Hot Air Tunnel, Comparison of Performance of CV lines. Microwave curing process and equipment, Ultrasonic vulcanization, Electron beam vulcanization, emerging methods of rubber vulcanization.	6	15
9.	The assessment of state of vulcanization.: Theoretical study of degree of cross linking. -Practical assessment of state of cure. Determination of state of cure: Methods and techniques: 1. Chemical method, 2. Physical test method, 3. Continuous method, Discussion of methods of measuring cure, Calculation of cure in thick articles, The relation between curing system type & properties (Sulphur - poly olefins Rubbers), Vulcanization process by rheometer curve, Prediction of State of Cure, Cure Simulation Instruments, Prediction of State of Cure by Arrhenius equation.	6	15

Suggested Specification table with Marks (Theory):

Distribution of Theory Marks					
R Level	U Level	A Level	N Level	E Level	C Level
14	**14**	**14**	**14**	**14**	**-**

Reference Books:

1. Rubber Technology & Manufacture by Blow & Hepburn.
2. Rubber Processing & Production Organization by Philip K. Freakley
3. Rubber Product Manufacture Technology by Anil K. Bhowmick

Course Outcome:

After learning the course the students should be able to

1. Able to learn about theory of Sulphur vulcanization..
2. Compare the different types of vulcanizing agents.
3. Know about the Vulcanising agents for olefin & non olefin rubbers.
4. Understand the importance of unique vulcanization system.
5. Understand the different curing techniques.
6. Learn about the different vulcanization system.
7. Able to learn about Practical assessment of state of cure.
8. Compare the Relation between structure and properties of Vulcanizates.
9. Able to understand the importance of different methods of measuring cure.

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List of Experiments:

Tutorials/Presentation/Practicals based on above topics

Design based Problems (DP)/Open Ended Problem:

1. Conventional and Efficient Cross-linking of Natural Rubber.
2. Studies on new binary accelerator systems in rubber vulcanisation.
3. Safe Vulcanisation System for Heat Resistant Natural Rubber Products for Engineering Applications

Major Equipments:

Vulcaniser, Semi Hydraulic Press, Rheometer, Mooney Viscometer, Hardness tester etc.

List of Open Source Software/learning website:

- http://digital.csic.es/bitstream
- https://www.tut.fi/ms/muo/tyreschool/
- http://dyuthi.cusat.ac.in/
- http://www.ajer.org/papers/rase-2-2013/Volume-3/BV120130813.pdf

ACTIVE LEARNING ASSIGNMENTS: Preparation of power-point slides, which include videos, animations, pictures, graphics for better understanding theory and practical work – The faculty will allocate chapters/ parts of chapters to groups of students so that the entire syllabus to be covered. The power-point slides should be put up on the web-site of the College/ Institute, along with the names of the students of the group, the name of the faculty, Department and College on the first slide. The best three works should submit to GTU.