List of Symbols and Abbreviations

ASTM	-	American Society for Testing and Materials
BR	-	Polybutadiene rubber
CBS	-	N-cyclohexyl-2-benzothiazolesulfenamide
CRI	-	Cure rate index
CR	-	Polychloroprene rubber
CV	-	Conventional vulcanization
D	-	Diffusivity
DBBS	-	N, N-dibenzyl-2-benzothiazolesulfenamide
DCBS	-	N, N-dicyclohexyl-2-benzothiazolesulfenamide
DEG	-	Diethylene glycol
DMA	-	Dynamic mechanical analysis
DTDC	-	Dithiodicaprolactam
DTG	-	Derivative thermogravimetry
E	-	Extension ratio
E_a	-	Activation energy
ENR	-	Epoxidised natural rubber
EV	-	Efficient vulcanization
FDA	-	Food and drug administration
FEF	-	Fast extrusion furnace
GPF	-	General purpose furnace black
HAF or N330	-	High abrasion furnace
Hexa	-	Hexamethylene tetramine
HPG	-	High Pure Grade TQ
IARC	-	International Agency for Research on Cancer
IR	-	Polyisoprene rubber

ISAF	-	Intermediate super abrasion furnace
ISO	-	International organization for standardization
k	-	Cure reaction rate constant
M_{100}	-	Modulus at 100 % elongation
MBS	-	N-oxydiethylene 2-benzothiazolesulfenamide
MPa	-	Mega pascal
MTP	-	Microtiter plate
MTT	-	Methylthiazolyl tetrazolium
M_w	-	Weight average molecular weight
NBR	-	Nitrile rubber
NR	-	Natural rubber
P	-	Permeation coefficient
PEG	-	Polyethylene glycol
6PPD	-	N-(1, 3-dimethyl buty1)-N'-pheny1-p-phenylenediamine
Q_t	-	Mole percent solvent uptake
R	-	Universal gas constant
RPA	-	Rubber process analyzer
s	-	Sorption coefficient
SAF	-	Super abrasion furnace
SBR	-	Styrene butadiene rubber
SEM	-	Scanning electron microscope
SEV	-	Semi efficient vulcanization
T	-	Absolute temperature
tan δ	-	Loss tangent
TBBS	-	Tertiarybutyl benzothiazolesulfenamide
TBzTD	-	Tetrabenzyl thiuramdisulfide
TEA	-	Triethanolamine

TESPT or Si69	-	Bis (triethoxysilylpropyl)tetrasulfide
TGA	-	Thermogravimetric analysis
T_i	-	Onset of degradation temperature
TMTD	-	Tetramethyl thiuramdisulfide
TQ	-	Polymerized 1,2-dihydro-2,2,4–trimethyl quinoline
ZBEC	-	Zincdibenzyl dithiocarbamate
ZnO	-	Zinc oxide
cc/hr	-	Cubic centimeter per hour
cSt	-	Centistokes
°C	-	Degree celsius
°C/min	-	Degree Celsius per minute
dNm	-	Deci newton meter
f_s	-	Shape factor of filler
g/cc	-	Gram per cubic centimeter
G'	-	Storage modulus
G''	-	Loss modulus
G*	-	Complex modulus
G_0	-	Shear modulus of pure elastomer
G_f	-	Shear modulus of filled compound
ΔG	-	Elastic Gibbs free energy change
Hz	-	Hertz
ΔH	-	Change in enthalpy
J/mol K	-	Joule per mole Kelvin
kg/m^3	-	Kilogram per cubic meter
KJ/mol	-	Kilo joule per mole
KN	-	Kilo newton
M_H	-	Maximum torque

M_L	-	Minimum torque
ml	-	Milli litre
nm	-	Nanometer
phr	-	Parts per hundred rubber
ΔS	-	Entropy change
t_{10}	-	Scorch time
t_{90}	-	Optimum cure time
V_r	-	Volume fraction of rubber
V_s	-	Molar volume of the solvent
Xc^{aged}	-	Crosslink density after ageing
Xc^{ini}	-	Crosslink density before ageing
ΔXc	-	Crosslink density change
α_f	-	Filler specific constant
µm	-	Micrometer
φ	-	Volume fraction of filler
χ	-	Interaction parameter

Publications

List of Publications in International Journals

[1] Studies on non-regulated safe binary accelerator system for efficient vulcanisation of natural rubber, **Abhitha K.**, Philip Kurian, Thomas Kurian and L. Jayabalan, ***Progress in Rubber, Plastics and Recycling Technology***, **29**(2), (2013), 99-108.

[2] Safe vulcanisation system for heat resistant natural rubber products for engineering applications, **Abhitha K.** and Thomas Kurian, ***American Journal of Engineering Research (AJER),*** **3,**(2013), 8-13.

[3] Evaluation of TBBS and TBzTD based binary accelerator systems in natural rubber compounds, **Abhitha K.**, Thomas Kurian and Jayabalan L., ***Rubber Science***, **29**(2), (2016), 199-206.

[4] Non-regulated Accelerator (DCBS/DBBS) Incorporated Natural Rubber Formulations - Cure Characteristics and Mechanical Properties, **Abhitha K.** and Thomas Kurian, ***International Journal of Research and Scientific Innovation (IJRSI)***. **(In Press)**

[5] Non-carcinogenic Accelerators for Natural Rubber Vulcanization, **Abhitha K.** and Thomas Kurian, ***Progress in Rubber, Plastics and Recycling Technology*****. (Communicated)**

[6] Effect of carbon black on safe binary accelerator incorporated natural rubber vulcanizates, **Abhitha K.** and Thomas Kurian, ***Rubber Chemistry and Technology***. **(Communicated)**

[7] Epoxidised natural rubber - a substitute for silane coupling agent in safe silica-filled natural rubber formulations, **Abhitha K.** and Thomas Kurian, ***Polymers for Advanced Technologies.*** **(Communicated)**

List of Papers Presented at Conferences

[1] Non – carcinogenic cure system for natural rubber, **Abhitha K.**, Philip Kurian, Thomas Kurian and L. Jayabalan, ***National conference on 'Recent Trends in Material Science and Technology (NCMST 2013)*** organized by Department of Chemistry, Indian Institute of Space Science and Technology, Thiruvananthapuram, Kerala, India, July 10 – 12, 2013.

[2] Efficient vulcanisation of natural rubber using safe (non - carcinogenic) accelerator system, **Abhitha K.**, Philip Kurian, Thomas Kurian and L. Jayabalan, ***Third International Conference on 'Materials for the Future' Innovative Materials, Processes, Products & Applications (ICMF 2013)*** organized by GEC, Thrissur, Kerala, India, Nov 6-8, 2013.

[3] Non - carcinogenic binary accelerator based vulcanization system for natural rubber, **Abhitha K.**, Philip Kurian, Thomas Kurian and L. Jayabalan, ***12th Prof. K.V.Thomas Endowment National Seminar Novel Concepts in Computational and Supramolecular Chemistry*** organized by Department of Chemistry, Sacred Heart College, Kochi, Kerala, India, Dec 11-12, 2013.

[4] Safe vulcanisation system for heat resistant natural rubber products for engineering applications, **Abhitha K.**, Philip Kurian, Thomas Kurian and L. Jayabalan, ***CUSAT National Conference on Recent Advances in Structural Engineering RASE 2013***, Kochi, Kerala, India, Dec 13-15, 2013.

[5] Effect of safe non – regulated accelerators in gum and carbon black filled NR vulcanisates, **Abhitha K.**, Philip Kurian, Thomas Kurian and L. Jayabalan, ***National Seminar on Recent Advances in Polymer Technology (RAPT – 2K15)*** organized by Department of Polymer Engineering, School of Technology and Applied Sciences, Mahatma Gandhi University, Kottayam, Kerala, India, March 12-13, 2015.

[6] Influence of non-carcinogenic thiuram and sulphenamide accelerators on the properties of NR vulcanisates, **Abhitha K.**, Thomas Kurian and L. Jayabalan, ***National Seminar Chemistry in Cancer Research (CCR 2015)***, organized by St. Alberts College, Ernakulam, Kerala, India, Oct 8-9, 2015.

[7] Benzoylpyrrolidinylthiourea:A new binary accelerator for the vulcanisation of natural rubber, Molice Thomas, K.Kurien Thomas, Thomas Kurian and **Abhitha K.**, ***52nd Annual convention of Chemists and International conference on Recent Advances in Chemical Sciences, JECRC University, Jaipur, Rajasthan,*** Dec 28-30, 2015.

[8] Rheological and mechanical properties of nitrosamine safe carbon black filled natural rubber vulcanisates, **Abhitha K.**, Thomas Kurian and L. Jayabalan, ***International conference on Advances in applied Mathematics,Materials science and Nano technology for Engineering and Industrial Applications (IC-AMMN-2K16)*** organized by Federal Institute of Science and Technology, Angamaly, Kerala, India, Jan 7-9, 2016.

[9] Effect of carbon black and silica on the cure characteristics and mechanical properties of nitrosamine - safe natural rubber vulcanisates, **Abhitha K.** and Thomas Kurian, ***International conference on Science and Technology: Future Challenges and Solutions (STFCS- 2016)***, organized by University of Mysore, Karnataka, India, August 8-9, 2016.

[10] Effect of Terephthalic Acid Hydrazone synthesized from PET Bottle Wastes on the Thermo-oxidative Aging of Natural Rubber, Neena George, **Abhitha K.** and Thomas Kurian, ***International conference on Science and Technology: Future Challenges and Solutions (STFCS- 2016)***, organized by University of Mysore, Karnataka, India, August 8-9, 2016.

[11] Influence of Silane Coupling agent on Cure characteristics and Mechanical properties of Silica-filled Nitrosamine-safe Natural Rubber Vulcanizates, **Abhitha K.** and Thomas Kurian, ***Prof. K.V. Thomas Endowment International Symposium- New Trends in Applied Chemistry (NTAC-2017)***, organized by Sacred Heart College, Kochi, Kerala, India, February 9-11, 2017.

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