# Service Life Prediction for Tires

## About ARDL's Methodology

ARDL is working on establishing service life prediction of tire components to generate theoretically and experimentally derived oxidative profiles that match with field samples. Our studies show that the thermo-oxidative degradation of the tire components is influenced by a diffusion-limited-oxidative effect. Preliminary studies demonstrate good agreement between the theoretically derived oxidation profiles and the experimentally obtained properties using tensile testing (modulus on microdumbbell).

ARDL's seven-level methodology is shown on the back of this page. The first step is to define the characteristic(s) of each tire component non-destructively. Based on the function, a failure criterion is established from an unacceptable change which causes a particular damage. Changes may be in sulfidic crosslink densities, stiffness/modulus (static, impact and dynamic), peel adhesion, tear resistance, etc. The underlying mechanism involved in this change is identified and characterized. The rate of change is then determined by an accelerated laboratory test at different levels of severity and at different time intervals. It is important to keep the accelerated test condition similar to the service condition and perform the test at multiple temperatures higher than the average service temperature.

## Predictive Testing For:

- Tire Service Life
- Tire Performance
- Tire Failure

## Using The Combined Techniques Of:

- "Ahagon" Type Aging Studies (Type I, II and III Aging)
- Arrhenius Techniques and Weibull Studies (Based on Accelerated Aging)
- Statistical Life Prediction Approach (Sigma Plot)
- Finite Element Analysis (ABAQUS)
- Dynamic & Vibration Study (Electrodynamic Shaker)
- Field & Laboratory Data Correlation (Drum Testing)
- Fracture Mechanics (Micro DeMattia, Planar Shear and Torsional Test)
- Sulfidic Crosslink Densities (Sp, Sd, Sm) (DSC, FTIR, NMR, GC-MS & DMA)
- Antidegradant Depletion Rate
- Peel Adhesion Strength Testing

# Seven-Level Methodology

## Level 1: Preliminary Non-Destructive Evaluation

- Shore Hardness of Tire
- Tire Footprint Profile
- Tire Inspection
- Tire Shearography
- Tire X-Ray & Uniformity
- Ultrasonic Evaluation
- Whole Tire Air Permeation
- Whole Tire Stiffness

## Level 2: Basic Component Testing

- Dynamic Mechanical Testing (DMA)
- Peel Test
- Tensile Test on Wedge & Skim
- Tire Modulus Profile
- Total Crosslink Density Test
- Total Oxygen Content Test

## Level 3: Complete Tire Analysis

- 2-Ply Laminate Test
- C13 & Proton NMR
- Dynamic Mechanical Testing (DMA)
- Finite Element Analysis (FEA)
- Hopkinson Bar High Strain Rate Impact Test
- Interlaminar Shear Test
- Mini DeMattia
- Oxygen Consumption Modeling
- Peel Test High Speed & High Temperature
- Innerliner Permeation Test
- Skim Crack Growth Properties
- Tensile Test on Wedge & Skim
- Tire Modulus Profile Static & Dynamic
- Total Crosslink Density & Distribution Test
- Total Oxygen Content Test

## Level 4: Tire Aging - Static & Dynamic

## Level 5: Tire Road Wheel / Customized Fleet Testing

## Level 6: Tire Compound / Material Development

## Level 7: Tire Defect Failure Analysis & Reporting

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