Summary of NHTSA Tire Aging Test Development Research

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Safety Issue

+NHTSA estimates that about 400 fatalities per year (~1% of total motor vehicle fatalities) may be attributed to tire failures of all types*

- Many contributing factors involved

“Tire Aging” Definition

- Fatalities, injuries, and crashes resulting from tire failures where thermo-oxidative degradation of the tire components is a cause or a factor

  - Mechanism: Tires are primarily degrading from the inside-out, due permeation and reaction of the pressurized oxygen within the tire structure, with rates proportional to temperature

*Based on analysis of NASS-CDS data, from 1994 through 2004
Tire Aging Project Background

Overall Research Approach

- Study tires retrieved from on-vehicle service in a southwestern US state
  - Higher temperatures = higher rates of degradation
- Develop an accelerated laboratory aging process for new tires followed by a roadwheel durability test that:
  - Simulates several years of use in states with high ambient temperatures
  - Evaluates a tire’s ability to retain safety-critical durability properties after simulated aging
Tire Aging Project Phase 1

Phoenix, Arizona Tire Study
Phoenix, AZ Tire Collection

Tires collected during March to April 2003

- Tires had to be in production from 1998 to 2003 with no ‘significant’ design changes in that period
- Separated out 20% of tires full-size spare and tires that did not experience full-time service in AZ
- Tested 250 tires of six different models
Phase 1 Results

When tires of the six models collected from on-vehicle service in Phoenix, AZ were compared to new tires of each model:

- There was a marked decrease in time-to-failure in endurance and high-speed laboratory roadwheel tests with increased tire age & mileage
- Tire component material/structural properties exhibited increased degradation with increased tire age & mileage
Stepped-Up Load Roadwheel Test Results - New vs. Phoenix Tires

Tires become less resistant to overloading or underinflation with age...
Tire Aging Project Phase 2

Evaluation of Laboratory Tire Aging Methods
Laboratory Tire Aging Methods

New versions of each of the six tire models collected from Phoenix were subjected to three accelerated aging methods:

- Continental General – “P-END” Roadwheel Test
  - 104 valid tests
- Michelin – “LTDE” Roadwheel Test
  - 134 valid tests
- Ford – Oven Aging Protocols
  - 91 valid tests
Phase 2 Results

Oven aging was the only method of the three examined that could replicate the material properties of the six Phoenix-retrieved tire models.

Valid test conditions:
- 3 weeks < Oven Time < 12 weeks
- 55-70 degrees C
- 50/50 N2/O2 inflation gas
  - Weekly pressure maintenance required
- Pre-oven roadwheel break-in necessary
Phase 3

Oven Aging Test Development
Oven Aging Test Development

18 Additional (i.e., non-Phase 1 & 2) Tire Models

- Multiple test conditions evaluated:
  - 7-10 weeks, 60°C, weekly inflation gas replacement
  - 5-8 weeks, 65°C, weekly inflation gas replacement
  - Pre-test 23-hr roadwheel break-in @ 50 mph, 5-8 weeks, 65°C, weekly inflation gas replacement
Phase 3 Conclusions

- Both 60 deg C and 65 deg C oven aging elicited the desired material properties in the regions studied
  - Use of 65 deg C results in a shorter oven test
- Weekly venting and refilling with fresh 50/50 N2/O2 shortened test
  - Prevents oxygen depletion during oven aging
- Pre-oven roadwheel break-in is required
  - Produces a better match to “in-service” tire rubber properties
Phase 4 Results

Oven Aging Test Validation Phase
Phase 4 – Oven Aging Test Validation

Evaluation of final oven test procedure

- 20 additional (i.e., non-Phase 1-3) tire models
- Pre-test roadwheel break-in
  - 2-hour, 50 mph FMVSS No. 139 High Speed test break-in
- 65 degrees C
  - 3-5 weeks with weekly vent & refill of inflation gas
- Post-oven durability test
  - FMVSS No. 139 Endurance and Low-Pressure test sequence
Phase 4 Results

As the oven test severity was increased (i.e., longer durations of oven aging), more tires failed the FMVSS No. 139 Endurance & Low Pressure roadwheel test sequence.

- An independent analysis of tire model material properties and constructions suggest that tires that passed the roadwheel test after oven aging contained features making them more resistant to heat aging.
Next Steps

Research Report to Congress on Tire Aging, DOT HS 810 799, August 2007, Docket NHTSA-2005-21276-0042

"NHTSA is currently evaluating the feasibility of a regulation related to tire aging by analyzing:

- The safety problem (tire aging as a significant causal factor in crashes)
- Potential benefits and costs of a requirement for minimum performance based on an aging method.”
Documents

http://www.regulations.gov

- NHTSA Tire Aging Docket
  - NHTSA-2005-21276
- Historical FMVSS No. 139 Dockets
  - NHTSA-2000-8011
  - NHTSA-2003-15400