Car Tires
Climatic Influences and Aging Behaviour

Introduction

Testing car tires is an integral part of car inspection, as the tires make the only contact with the road. The tires together with brakes and steering mechanisms are crucial for safety. Different degradation can be detected on a tire. Besides mechanical degradation, it is important to look at climatic influences which effect the aging and service life of the tire.

This case study provides confirmation about the influence of the environment on aging behaviour of tires. Although the testing periods are relatively short (for practical reasons) related to life cycle of this highly stabilized material, results provide initial and interesting tendencies about possible failures of relevant mechanical properties.

Task

Aging affects the entire tire, but in doing so, different parts of the tire receive varying amounts of sunlight. Therefore, it was important to take samples of the running surface and inner and outer sidewalls. For the test, two different tires were chosen and samples were taken from new and used tires of each.

Sample Identification / Design / Evaluation

Two different brands (new – used)

The samples were visually and mechanically analyzed according to grey scale ISO 105-A02 (grey scale color change). After that the samples were mechanically tested according to ASTM D2240 (shore hardness) and DIN 53504 (tensile test).

Climate Simulation Tests

The tires were exposed to the following tests to measure climatic influence:

- **accelerated weathering testing** with Xenon light (SUNTEST® XXL+ from Atlas®, ISO 4892-2, 2003)
- **ozone testing** (Argentox 3MR, DIN 5350-1)
- **climatical testing** (CTS climatic chamber C-40/200)

Aging Evaluation

The most important aging characteristic of car tires is the hardening of the outside surface caused by oxidation of the polymers under influence of sunlight. As result of the hardening of the outer surface, the tire loses its dynamic flexibility and the wear behaviour of the tire changes. This leads to a safety hazard.

Weathering Test

(Experimental) setup in a SUNTEST® XXL+

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Test Time and Conditions

To simulate one year average Central European climate, cycle 1 method A of ISO 4892-2 2003 was chosen. Based on average total radiation the test duration has been defined as 1000 hours.

Test Results

After exposure to a weathering test:

1. Test samples showed increased hardness (Shore A Hardness acc. DIN 53505:2000).

Material / Sample	Hardness change in percent (rounded)			
running surface used	**Brand 1**	9 %	**Brand 2**	9 %
inner sidewall used		20 %		12 %
outer sidewall used		20 %		12 %
running surface new		14 %		9 %
sidewall new		20 %		18 %

2. The tensile strength / elongation properties changed. The maximum elongation and tensile strength decreased by about 30 % as an average value for all samples (DIN 53504:1994) as shown in CHART 1.

3. The visual inspection showed the following distinctive features:

- The cord fibres of the side wall samples discoloured from dark grey to bright white (Grey Scale 1)
- The samples showed deformation after the test
- Existing cracks on the running surface of the used Brand 2 tires increased in size and depth

Conclusion

The environmental tests (weathering, climatic, ozone) have been selected in order to simulate one year of service life in Europe. CHART 2 represents a rough estimation about possible long term behaviour of new and used tires. New tires will suffer considerable changes during the first service year. Used tires (3–4 years old) starting with lower initial values might lose up to 50% of mechanical properties during 10 years. Over time, the differences in properties between new and used tires decrease.

Outdoor weathering tests (Horb, Germany) using the same material have been started at the end of 2006 in order to confirm the correlation with the accelerated tests described in this case study.

Weathering tests based on solar radiation are difficult to find in literature studies. This relates to the fact that most aging tests are based on ozone not on sunlight and to the very long exposure periods for this extremely long lasting product.

This study proved the damaging effect of simulated sunlight on tires. Safety regulations should encourage the industry to continue this approach considering the variety of brands and environments / service conditions around the world. Authorities should encourage the industry to continue this approach considering the significant changes in material properties and the impact this might have on safety.

General information

This case study represents a short summary of a thesis performed at the Academy in Horb, Germany (University of Cooperative Education) using a SUNTEST XXL+ under the requirements of TÜV SÜD Auto Service GmbH, Filderstadt, Germany. The author of this thesis is Mr. Marcus Zipperle.

CHART 1

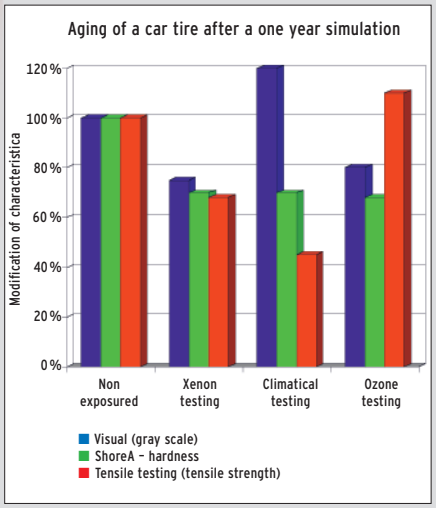
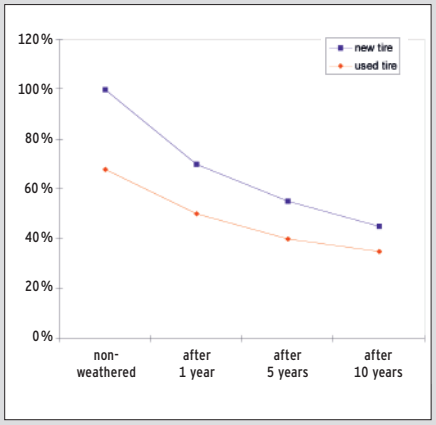


CHART 2



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