The Science of Tire Aging

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By Sean Phillips

“The auto-oxidation of rubber has been known for a long time, and for a long time, too, it has been known that it plays an important part in spontaneous deterioration or aging, and it has been the object of numerous studies of much interest.” - Journal article from 1931

There's been quite a bit of controversy over the issue of tire aging lately. Many people would like to see manufacturers and dealers either put expiration dates on their tires or otherwise clearly mark the age of each tire for consumers at the time of purchase.

The issue came to a head earlier this year when Maryland debated a bill to require Maryland tire dealers to give consumers a printed statement on the dangers of tire aging whenever they sell a tire that is more than three years past its manufacture date.

There are multiple and complex issues at stake here:

- Should tires have more evident dating?
- When is a tire too old to be safe?
- Should a tire be taken out of service because of age even if it has tread life remaining?
- If a new tire is stored for a long time should it be sold with a warning label or not sold at all?

The Science of Aging

"Tires are primarily degrading from the inside-out, due [to] permeation and reaction of the pressurized oxygen within the tire structure, with rates proportional to temperature." - Summary of NHTSA Tire Aging Test Development Research

Tire aging is an issue of oxidation. As rubber is exposed to oxygen, it dries out and becomes stiffer, leading to cracking. The issue is primarily about how the inner, "wedge" layers of rubber oxidize.

The stiffening and cracking of aged rubber can lead to the inner layers of the tire delaminating from the steel belts rather than flexing with the steel as the tire rolls underweight.

There are essentially four major factors that determine how fast a tire will age:

- **The Inner Liner:** The inner liner of any tire is a specialized butyl rubber compound that is designed to be impermeable to air to keep the air inside the tire where it belongs. No inner liner is entirely waterproof, so some air will always leak slowly through the liner due to osmosis. The quality of the inner liner determines just how much air leaks through, and therefore how fast the inner structure of the tire is exposed to oxygen.
- **Oxygen Concentration:** It's pretty easy to see that oxidation rates will increase when the oxygen concentration is higher. What this means is that a tire that is mounted and filled with compressed air will age much faster than a tire that is just being stored, because the air pressure is orders of magnitude higher in a filled tire, and more oxygen will permeate through the liner.
- **Heat:** Oxidation of rubber occurs much faster under high heat than low heat. In essence, heat increases both the permeability and reactivity of oxygen, making it both easier for oxygen to get through the inner liner and easier for it to react with the rubber inside the tire.
- **Usage:** When a tire is driven, the pressure and flexing motion circulate the internal oils through the rubber. These oils lubricate the internal rubber and keep it from drying and stiffening. So tires that are used less are often more vulnerable to aging effects.

The History of the Science

- In 1989, ADAC, Germany's consumer advocacy group concluded: "Even tires that are just six years old – though they appear to be brand new – can present a safety risk. Tire experts even say that if they are not used, indeed, tires age more quickly."
- In 1990, vehicle manufacturers including BMW, Audi, Volkswagen, Toyota, Mercedes-Benz, Nissan, and GM Europe, among others, included in the owner's manual warnings that tires older than six years should only be used in an emergency and replaced as soon as possible.
- The British Rubber Manufacturer's Association noted: "BRMA members strongly recommend that unused tires should not be put into service if they are over 6 years old and that all tires should be replaced 10 years from the date of their manufacture."
- In 2005, Ford, DaimlerChrysler, and Bridgestone/Firestone added warnings that tires should be inspected at 5 years and replaced after 10. Michelin and Continental issued similar bulletins in 2006. Hankook did so in 2009.

NHTSA Research Provides Evidence

In 2007, NHTSA's Research Report to Congress on Tire Aging presented clear evidence of both tire aging failures and the outsized effect of sustained heat on the aging mechanism.

> *"This trend was observed in NHTSA's analysis of data provided by a large insurance company… It reported that 27 percent of its policyholders are from Texas, California, Louisiana, Florida, and Arizona, but 77 percent of the tire claims came from these states and 84 percent of these were for tires over 6 years old. While tire insurance claims are not necessarily an absolute measure of the failures due to aging, [they are] an indication that a large number of tire failures are likely occurring because of the effect of sustained high temperature on tires."* - NHTSA Research Report to Congress on Tire Aging

When NHTSA conducted further testing in Arizona, they found not only that tires did show an increasing failure rate with age, especially at around 6 years, they also found that the rate of aging was only slightly less for spare tires.

- *"DOE analysis confirms that mileage was a relatively unimportant factor in [failures due to] aging compared to time. Thus time, not mileage, is the correct metric for tire aging… Besides variations from manufacturer to manufacturer, tire size, or more specifically, tire aspect ratio seems to effect the tire aging rate. Tires with higher aspect ratios age faster than tires with lower aspect ratios."* - Rubber Oxidation And Tire Aging - A Review.

- *"...the results support the hypothesis that spare tires could degrade while stored on the vehicle. This is a particular concern when coupled with the inflation pressures of full-size spare tires at retrieval. Over 30% of the passenger and light truck tires at the spare tire location had inflation pressures below the T&RA Load Table minimums. A recent study by the agency projected that more than 50% of passenger vehicles will still be on the road in the U.S. After 13 years of service, and more than 10% will still be on the road after 19 years. For light tucks, those figures go to 14 and 27 years respectively. Since few consumers replace their full-size spare tires when replacing on-road sets of tires, full-size spare tires have the potential for very long service lives. This elicits the logical concern that older full-size spare tires with possible degradations in capability may see emergency use while significantly under-inflated."* - NHTSA Tire Aging Test Development Project: Phase 1

Higher speed rated tires degraded less – even on spare tires.

> *"Results indicated a strong correlation to the speed rating of the tire, with the higher speed rated tires losing the least capability with increasing age and mileage."* - NHTSA Tire Aging Test Development Project: Phase 1

Conclusions

If you've had tires on the car for five years, you should be checking them for cracking along the sidewall or inside the tread grooves, which would indicate aging problems. If you've had tires on the car for six years, they should be replaced.

If you live in Phoenix, you should be checking both your tires and your sanity at four years max. Spare tires should be checked and replaced on the same schedule. You should also check before you use one. Because spares are not used often, if at all, the oils in the tire do not circulate under pressure and because trunks can get very hot, spare tires can be particularly vulnerable to aging effects.

Tires may age somewhat in storage, but they don't start to age until they are mounted and filled with air. Even if you were to buy a new tire that's already three years old, I would conservatively count those years as half years and say the tire has 4.5 years left. It would have to be up to you whether you think that you'll get that many years out of the tread. However, storage under sweltering conditions may somewhat negate this effect.

Right now, to find out when the tire was made, you'll have to decode the Tire Identification Number or TIN. Many are in favor of a readable date of manufacture being put on both sidewalls.

Lower aspect ratios and higher speed ratings tend to correlate with longer life. This is probably due to less surface area in the air chamber and better construction, especially better inner liners.