Antioxidants and Antiozonants role in manufacturing safe tires

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Speakers

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USTMA Members - https://sustainability.ustires.org/
What we will cover

- Overview of 6PPD and 6PPD-Quinone – two distinct materials
- Relevant data gaps raised by Tian et al.
- USTMA’s response to the Tian et al.
- Overview of the function of a tire, tire manufacturing and tire materials
- Overview of the functions 6PPD provides in manufacturing safe tires
- USTMA member commitment to supporting an alternatives analysis under the Safe Consumer Products Regulations
6PPD and 6PPD-Quinone – two distinct materials

6PPD

- Antioxidant and antiozonant - protects tires during both static and dynamic conditions
- Minimizes thermal degradation

6PPD-Quinone

- Transformation material of 6PPD, identified for the first time by Tian et al. in December 2020
6PPD-Quinone Relevant Data Gaps

Toxicity
- Mechanism of toxicity to coho salmon?
- Toxicity to other aquatic species, terrestrial species, humans?

Environmental Fate and Distribution
- Basic physical and chemical properties
- Mechanism of formation under environmental conditions (How does 6PPD-Quinone form? And where does it form?)
- Influence stormwater and receiving water parameters such as salinity, pH, temperature
- Mass balance throughout tire life cycle

Alternatives
- Do other alternatives to 6PPD impact aquatic species?
- Do other PPDs form quinone and cause toxicity?

Coho salmon in Puget Sound as compared to other coho
- Coho in the Great Lakes are successfully spawning and not suffering the same mortality events. What is different about coho in Puget Sound as compared to the Great Lakes?
- Are there additional factors impacting the coho in Puget Sound?
### Tire manufacturing industry response to Tian et al. 2020

1. **Continued engagement with researchers and regulators**
   - For example - University of Washington, Washington Stormwater Center, Department of Ecology, DTSC, Alaska DEC, EPA, NOAA, NIST, SFEI

2. **Identification of relevant data gaps**
   - World Business Council for Sustainable Development (WBCSD), Tire Industry Project (TIP) is engaged to fill relevant data gaps

3. **Alternatives analysis**
   - Proactive outreach to DTSC to review 6PPD in tires under the CA Safer Consumer Products Regulations (SCPR)
   - Member company research to evaluate alternatives
   - Coordination with chemical suppliers
WHAT MUST TIRES DO?
The functions of the tire

- Support weight of the vehicle
- Provide precise/effortless everyday steering
- Provide stable & effective emergency steering
- Grip to accelerate
- Grip to brake
- Perform in wet conditions
- Perform in winter conditions
- Provide a quiet ride
- Absorb vibrations and impacts
- Provide long wear life
- Resist heat, overload, speed, low inflation
- Improve vehicle fuel economy (low rolling resistance tires)
- Comply with NHTSA Federal Motor Vehicle Safety Standards
Tires are Highly Engineered Products

*In General:*
- **10-15 Rubber compounds**
  - Each formulated for a unique function
    - Air Retention, tread wear, wire adhesion, etc…
- **45-60 Unique materials per tire**
Safety is our Priority

Tires are highly regulated products to ensure consumer safety.


Changes in tire materials may change a tire’s ability to meet NHTSA safety standards.
Raw Materials Used in Tires

- Synthetic Elastomers
- Natural Rubber
- Processing Aids
- Fillers
- Protection
- Textiles
- Steel
- Curing systems
### Example of a Tread Rubber Compound

<table>
<thead>
<tr>
<th>Material</th>
<th>Function</th>
<th>~ Percentage (%)</th>
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<tbody>
<tr>
<td>SBR, BR, Natural Rubber</td>
<td>Elastomer</td>
<td>50</td>
</tr>
<tr>
<td>Carbon Black / Silica</td>
<td>Filler</td>
<td>22</td>
</tr>
<tr>
<td>Naphthenic Oil</td>
<td>Processing Aid</td>
<td>21</td>
</tr>
<tr>
<td>Stearic Acid</td>
<td>Component of Curing System</td>
<td>0.7</td>
</tr>
<tr>
<td>Zinc</td>
<td>Component of Curing System</td>
<td>0.7</td>
</tr>
<tr>
<td>6PPD</td>
<td>Protection Material</td>
<td>1</td>
</tr>
<tr>
<td>Wax</td>
<td>Protection Material</td>
<td>0.7</td>
</tr>
<tr>
<td>Silane</td>
<td>Coupling Agent</td>
<td>1.8</td>
</tr>
<tr>
<td>Sulfur</td>
<td>Component of Curing System</td>
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<tr>
<td>DPG</td>
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<tr>
<td>CBS</td>
<td>Component of Curing System</td>
<td>0.6</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>~ 100</td>
</tr>
</tbody>
</table>
ROLE OF 6PPD IN MANUFACTURING
SAFE AND DURABLE TIRES
Protection Materials

- Antioxidants and antiozonants prevent degradation and cracking of the rubber compounds caused by exposure to oxygen, ozone, and temperature fluctuation during both dynamic and static conditions.
  - **Antioxidants** help to keep rubber from breaking down due to the effect of temperature and oxygen exposure.
  - **Antiozonants** are used to impede the effects of exposure to ozone on the surface of the tire.
Protection Materials

• 6PPD is used by USTMA Members because it is the **most effective** antioxidant and antiozonant, that protects the rubber compound during dynamic and static conditions, to prevent degradation and cracking.

• Without the use of high-performing protection materials like 6PPD, tires will crack and can degrade rapidly, leading to possible catastrophic failure.
Qualities/functions required of Dynamic Protection Materials

- Continuously present at the surface
  - Good solubility and diffusivity in rubber compounds
- Reactive with ozone but not too reactive to prevent premature depletion
- No adverse effects on the rubber processing
- Available in rubber compound over its entire life cycle to ensure protection of the rubber
- Low toxicity of the material and its transformation products
Reaction Transformation Products

• The 6PPD reaction with ozone and oxygen forms transformation products
  o Mechanism of formation of 6PPD-quinone still to be clarified

• The rubber and tire industry have investigated the reaction mechanisms over time to understand by product formation

• Prior to Tian et al., 2020, 6PPD quinone was unknown
Our commitment to supporting the alternatives analysis process

Is there a safer alternative that can be used in place of 6PPD to manufacture tires?

USTMA response – proactive outreach to DTSC to review 6PPD in tires under the Safer Consumer Products Regulations (SCPR)

USTMA is committed to working with DTSC to complete the alternatives analysis for 6PPD in tires under the SCPR
THANK YOU

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