



THE TIRE INDUSTRY'S QUEST
for More Sustainable
Antidegradants

FLEXSYS 



Rubber tires are everywhere—on cars, trucks, buses, farm equipment and even airplanes. Their deceptively simple exteriors hide a complex, multi-material composite construction designed to deliver long-term performance and passenger safety across diverse conditions.



To meet these requirements, tires rely on chemical additives, including a critical class of materials called Antidegradants.

The most effective Antidegradant in rubber, 6PPD*, has been widely used in all tire applications for decades. A recent study, however, uncovered potential concerns around 6PPD-quinone, a transformation product that may form from 6PPD.

*6PPD is N-(1,3-dimethylbutyl)-N'-phenyl-p-phenylenediamine

As the leader in tire Antidegradants, Flexsys has positioned itself at the forefront of a collaborative ecosystem uniting a wide-range of industry stakeholders to pioneer a global solution.



UNDERSTANDING THE VITAL ROLE OF 6PPD

Rubber's unique physical properties make it ideal for tires, offering toughness, wear resistance, pliability across a wide temperature range, and the ability to absorb energy for quick stops. However, rubber molecules are highly susceptible to attack by atmospheric ozone and oxygen. When unchecked, these environmental factors will lead to rapid degradation and cracking, and the rubber's critical properties will be lost.

In the late 1950s, engineers discovered 6PPD as providing remarkably effective protection against ozone, oxygen and other forms of degradation. By the 1980s, 6PPD had become the standard Antidegradant, contributing significantly to increased tire longevity, safety and reduced waste.



THE DISCOVERY OF 6PPD-QUINONE

In December 2020, a study uncovered a new compound, 6PPD-quinone (6PPD-q), formed when 6PPD reacts with ozone. The authors raised concerns about its potential toxicity to Pacific Northwest coho salmon, suggesting that 6PPD-q might enter the environment through tire wear particles—small crumbs of rubber that are shed from the tire during normal use.

Although the full lifecycle of 6PPD-q is not yet completely understood, Flexsys is not hesitating and is already investing heavily in the search for an alternative.



THE COMPLEX JOURNEY TOWARD A SOLUTION

Developing a 6PPD alternative that maintains tire performance while meeting stringent environmental and safety standards is a formidable task. The replacement must shield rubber compounds against ozone and oxygen attack over extended periods, integrate seamlessly with modern tire formulations, be effective at low doses, and contribute to industry decarbonization and sustainability goals, among other technical and commercial requirements.

Failure to meet any of these objectives could lead to new issues, jeopardizing passenger safety or increasing waste. Rigorous testing is crucial, spanning diverse conditions and applications. Rushing the implementation of an alternative poses risk, emphasizing the need for a measured approach that achieves both tire performance and passenger safety while protecting fish populations and the communities that rely on them.

Attempting to validate a variety of unproven technologies will not be feasible due to the comprehensive, long-term testing required. The solution in this case is most likely to come from a reputable firm with a history in the industry of conceiving, commercializing and licensing new materials.



FLEXSYS LEADS THE WAY

To be successful in the pursuit of a more sustainable Antidegradant, several distinctive attributes are required. Flexsys is notably positioned as a leader in this undertaking, characterized by a combination of specialized expertise, enduring commitment and a proven track record.

- ▶ **Profound expertise and innovation:** Flexsys is recognized for its exceptional subject-matter expertise and a dedication to innovation within the tire chemical sector. This is reflected in its consistent efforts to redefine industry norms and push the boundaries of tire chemical innovation.
- ▶ **Longevity and dedication:** The complexity of this endeavor necessitates steadfast leadership. With a history rooted in inventive solutions, safety protocols and resource efficiency, Flexsys is prepared for the long-term commitment required to see the project through from inception to completion.
- ▶ **Resources, skills, and scalability:** The magnitude of the challenge requires substantial resources, advanced skills and the ability to scale. Flexsys has a global presence, expert capabilities and the resources to support comprehensive research. Its proven record of successfully developing products, as well as its ability to effectively scale-up and license technologies, ensures widespread accessibility to solutions.
- ▶ **Established collaborations and trust:** In the intricate landscape of developing an alternative Antidegradant, collaboration and trust are fundamental. Flexsys has a history of fostering robust relationships within the industry and with key stakeholders. This collaborative approach extends across diverse sectors, uniting tire manufacturers, government agencies, regulatory bodies, consumers and regional organizations including Native American tribes in the Pacific Northwest. Flexsys recognizes the collaborative nature of this solution and is adept at coordinating these multifaceted organizations to expedite progress.
- ▶ **Commitment to sustainability:** Flexsys' focus on innovation is grounded in a deep commitment to sustainability. Recognized with a Gold medal in the 2023 EcoVadis Sustainability Ratings, Flexsys aligns with the industry's environmental objectives of decarbonization and sustainable raw materials. Any alternative Antidegradant developed must also have a viable pathway to sustainability to enable the tire industry to meet its ambitious targets.
- ▶ **Collaborative engagement and research initiatives:** Flexsys' involvement extends beyond rhetoric to practical collaboration. Their partnership with the U.S. Department of Agriculture's Agricultural Research Service underscores their dedication to fundamental chemistry, bio-based materials and application testing. Flexsys complements its internal expertise with external professionals specializing in chemical synthesis, toxicology testing and process development, ensuring a holistic approach to innovation.

"The top Antidegradant experts in the world are at Flexsys. They are collaborating with the world's best chemists, application engineers, toxicology scientists and tire manufacturers to find new molecular structures that will protect tires, passengers, communities and the environment."

Neil Smith

Flexsys' Chief Technology and Sustainability Officer

A CHALLENGE DEMANDING RESOLUTION

Finding an alternative is paramount, affecting the environment, tribal communities and passenger safety.

As the industry leader and the only U.S. headquartered 6PPD supplier, Flexsys is taking on the responsibility to spearhead development, testing and commercialization. The company is investing heavily in scientific research, education, innovation and participatory community outreach.

While Flexsys is committed, the support of tire manufacturers, clear regulatory guidelines, and new environmental impact measurement methods are essential. The Flexsys-led solution enables a coordinated, industry-wide approach to de-risk and accelerate the realization of a more sustainable alternative Antidegradant. The company has changed the landscape of the industry before and is working now to do it again.

Ensuring a Trusted Antidegradant Supplier

Developing and owning the solution requires responsible, reliable interests. Any disruption in Antidegradant supply could halt tire production.

Stakeholders in the Solution Include:

**Drivers or Passengers
in Vehicles with Tires**

Tire Manufacturers

**Local and National Regulatory
Bodies (in the U.S. and globally)**

Government Research Groups

Academia

Native Communities

Chemical Manufacturers



FORWARD-LOOKING STATEMENTS

This ebook contains forward-looking statements, within the meaning of applicable securities laws, which involve risks and uncertainties. Forward-looking statements provide current expectations of future events based on certain assumptions and include any statement that does not directly relate to a historical or current fact. The words “believe,” “expect,” “will,” “anticipate,” “plan,” “estimate,” “target,” “project” and similar expressions, among others, generally identify “forward-looking statements,” which speak only as of the date such statements were made. These forward-looking statements may address, among other things, the outcome or resolution of any pending or future environmental liabilities, the commencement, outcome or resolution of any regulatory inquiry, investigation or proceeding, the initiation, outcome or settlement of any litigation, changes in environmental regulations in the U.S. or other jurisdictions that affect demand for or adoption of our products, anticipated future operating and financial performance for our segments individually and our company as a whole, business plans, prospects, targets, goals and commitments, capital investments and projects and target capital expenditures, plans for dividends or share repurchases, sufficiency or longevity of intellectual property protection, cost reductions or savings targets, plans to increase profitability and growth, our ability to make acquisitions, integrate acquired businesses or assets into our operations, and achieve anticipated synergies or cost savings, all of which are subject to substantial risks and uncertainties that could cause actual results to differ materially from those expressed or implied by such statements. Forward-looking statements are based on certain assumptions and expectations of future events that may not be accurate or realized. These statements are not guarantees of future performance. Forward-looking statements also involve risks and uncertainties that are beyond Flexsys’ control. Matters outside our control have affected our business and operations and may or may continue to hinder our ability to provide goods and services to customers, cause disruptions in our supply chains, adversely affect our business partners, significantly reduce the demand for our products, adversely affect the health and welfare of our personnel or cause other unpredictable events. Flexsys assumes no obligation to revise or update any forward-looking statement for any reason, except as required by law. Readers are cautioned not to place undue reliance on forward-looking statements.