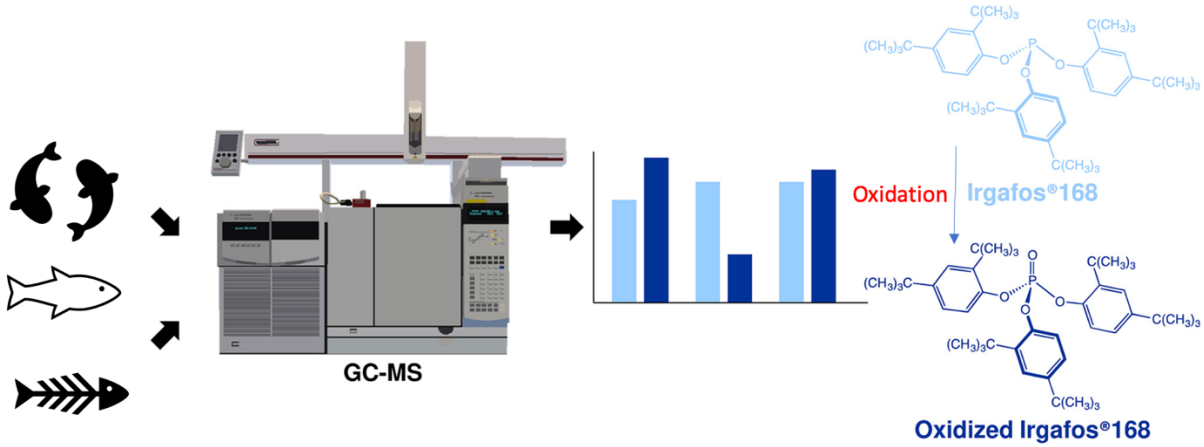
Serious Safety Issues Emerge Over Use of Common Additives in HDPE Pipes

by PPN Editor



Toxins Generated by Antioxidant Transformation Products in HDPE Pipes and Released into Fish Hatchery Containment Ponds

High-Density Polyethylene (HDPE) piping are extensively used in aquaculture, including fish hatchery ponds, due to their durability, impermeability, and resistance to chemicals. However, concerns have emerged regarding the potential leaching of toxic compounds from HDPE pipes, particularly those that contain common antioxidants and UV stabilizers. These additives, while essential for enhancing the durability and lifespan of HDPE pipes, can degrade over time, releasing harmful breakdown and conversion products into aquatic environments and leading to fish hatchling mortality.

<u>Potential Toxicants from HDPE Pipes:</u>

Breakdown Products of Antioxidants and Stabilizers

- HDPE pipes are commonly stabilized using phenolic antioxidants (e.g., Irganox 1010, Irganox 1076) and hindered amine light stabilizers (HALS) to prevent oxidative and UV-induced degradation.
- Over time, these additives degrade, releasing toxic by-products, including:
  - Phenolic conversion compounds and molecular fragments.

Tris(2,4-di-tert-butylphenyl) Phosphate (I-168O)

- A novel pollutant, **tris(2,4-di-tert-butylphenyl) phosphate (I-168O)**, a degradation product of Irgafos 168, has been identified in air and aquatic environments by Shi (2020).
- Studies in China detected I-168O in urban fine particulate matter (PM2.5) at concentrations as high as 851 ng/m³, suggesting widespread pollution.
- Heating, UV exposure, and water contact significantly accelerate the transformation of Irgafos 168 into I-168O, raising concerns about its potential toxicity.
- **Endocrine-Disrupting Potential:** Another degradation product of Irgafos 168, 2,4-di-tert-butylphenyl (24DP), has shown endocrine-disrupting effects *in vitro (*Shi (2020).

Breakdown Products of HALS in HDPE

- HALS stabilizers, commonly used in PE piping to prevent UV degradation, degrade into multiple toxic compounds, including:
  - Alkylated Piperidines (e.g., 4-Amino-2,2,6,6-tetramethylpiperidine)
  - Nitroxyl Radicals (e.g., 2,2,6,6-Tetramethylpiperidine-N-oxyl (TEMPO))
  - Amides and Carboxylated Derivatives (e.g., Carboxy-TMP)
- Some HALS degradation products exhibit high persistence and bioaccumulation potential in aquatic environments (Deng, 2024).

Potential Endocrine-Disrupting Effects of HALS By-products

Emerging research suggests that HALS by-products may act as endocrine disruptors, affecting fish and aquatic organisms by:

- Mimicking estrogenic hormones, disrupting reproductive processes.
- Interfering with steroid hormone production, leading to feminization or masculinization in fish populations.

A 2024 study published by Deng et al. in *Environmental Science & Technology* confirmed the widespread occurrence of HALS in dust and airborne particles, raising concerns about human and environmental health risks.

Recommendations for Aquaculture Applications

To mitigate the potential risks associated with phosphite stabilizers and HALS and their degradation products in aquaculture settings, the following steps should be considered:

1. **Select Safer Plastic Piping**
    - Use HDPE pipes specifically formulated for aquaculture, with alternative stabilizers such as tocopherols that pose lower risks.
2. **Pre-Use Conditioning**
    - Soak new HPDE pipes in clean water and test for leachates before deployment in fish hatchery ponds.
3. **Regular Water Monitoring**
    - Conduct periodic water quality assessments to detect and mitigate the presence of harmful compounds.
4. **Regulatory and Industry Oversight**
    - Encourage manufacturers to develop and adopt **safer additive formulations** such as tocopherols.
    - Promote **research on alternative stabilizers** that provide UV and oxidation resistance without environmental toxicity.

Conclusions

HDPE pipes remain a valuable tool for water transport in aquaculture, but the potential release of toxic additives and degradation by-products necessitates caution. Further research into alternative stabilizers and rigorous testing protocols will be critical in ensuring the safety and sustainability of aquaculture practices.

References and Further Reading

Shi, J., et.al. (2020) *Environ Sci. Technol. 54*, 10570 (2020). https://pubs.acs.org/doi/10.1021/acs.est.0c03709

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Common Antioxidant in Most Geosynthetics Found to Decompose by Multiple Pathways - ExcelPlas - Polymer Testing | Polymer Analysis | Geomembrane Testing | Plastics Analysis - ExcelPlas

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