Regulatory Updates on Copper Antifouling and the Science Behind

- September 11, 2025
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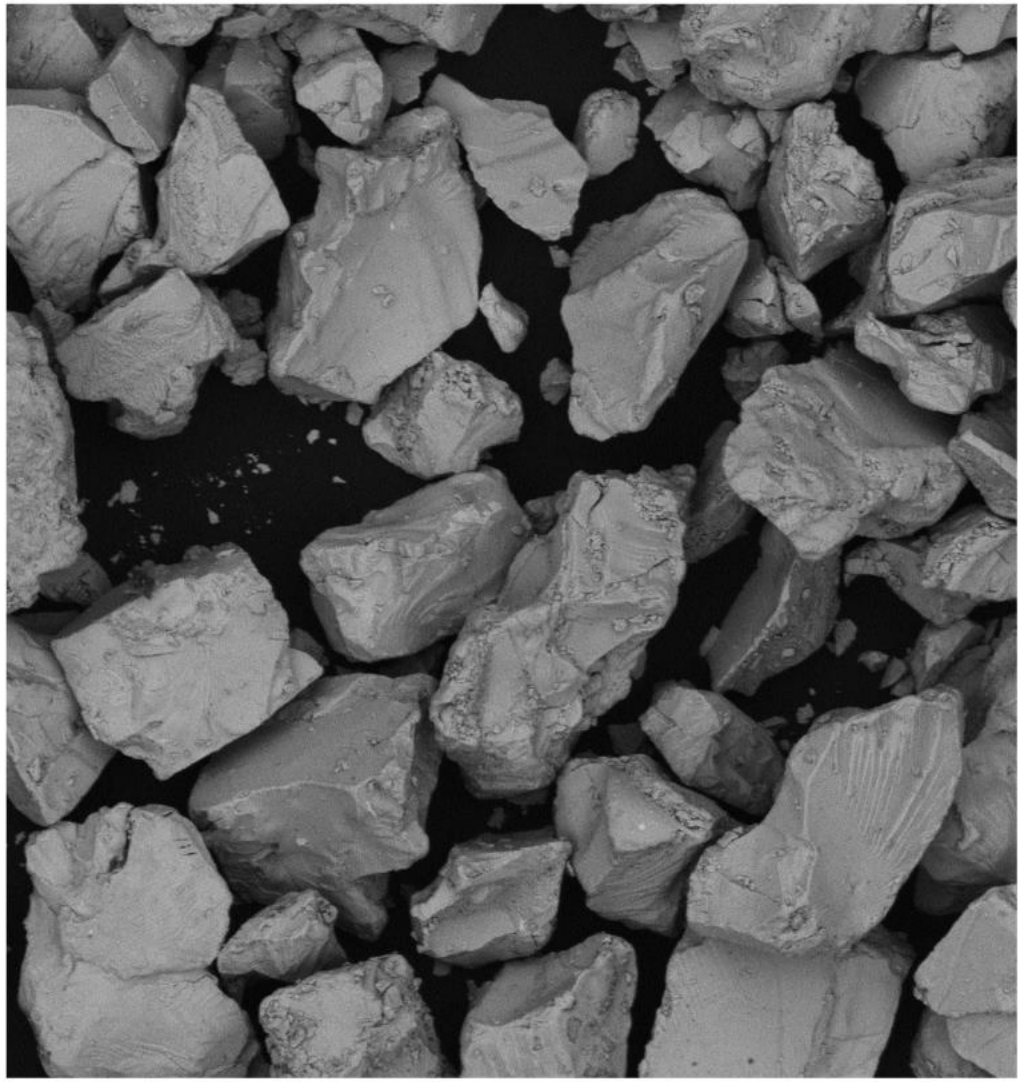
AMERICAN chemet CORPORATION



Agenda

I. **Copper in Antifouling Regulatory Updates**
   - USA
   - EU
   - Korea

II. **The Copper Solution**

III. **How We Move Forward Together**

Regulatory Updates

USA – WASHINGTON STATE

- Background
  - 2011 – Phase out of Copper Based AF Paints
  - 2017 & 2019 – Study on availability and impact of alternatives
  - 2020 – DoE directed to study again
  - 2024 – Published report

- Not able to determine “that safer and effective alternatives to copper based antifouling paints are feasible, reasonable, and readily available.”
- Follow-up in 2029

USA – WASHINGTON STATE : THE WHAT

- Paints Reviewed:
  - Biocidal Active Ingredients:
    - Cuprous Oxide
    - Tralopyril
    - Zinc pyrithione
    - DCOIT
  - Non-biocidal
    - Foul Release
- Safer, Feasible, Readily Available, and Effective
- Reasonable Alternatives

From “Antifouling Paints in Washington State: Third Report to the Legislature” https://apps.ecology.wa.gov/publications/documents/2404034.pdf

USA – WASHINGTON STATE : THE WHY BEHIND THE DECISION

Safer

- GreenScreen ® Benchmark – 2

- Foul Release
  - Environmental Impact Unknown
    - Limited information
    - Fluorinated chemicals
    - Silicone oils

Key: vL = very low; L = low; M = moderate; H = high; vH = very high; DG = data gap; *italics = lower confidence*; **bold = higher confidences**

CAS #	Name	GreenScreen® Benchmark	Carcinogenicity (causes cancer)	Mutagenicity (mutates DNA)	Reproductive Toxicity	Developmental Toxicity	Endocrine Activity	Acute Toxicity	Systemic Toxicity	Systemic Toxicity, Repeated dose*	Neurotoxicity (toxic to nervous system)	Neurotoxicity, Repeated dose*	Skin Sensitization*	Respiratory Sensitization*	Skin Irritation	Eye Irritation	Acute Aquatic Toxicity	Chronic Aquatic Toxicity	Persistence (does not break down easily)	Bioaccumulation (builds up in tissue)	Reactivity (reacts easily with other chemicals)	Flammability (ignites easily)
1317-39-1	cuprous oxide	1	*L*	**L**	**L**	*M*	DG	**M**	*H*	**M**	DG	DG	**L**	*L*	**L**	*H*	**vH**	**vH**	*vH*	*L*	*L*	*L*
122454-29-9	Tralopyril	1	*M*	**L**	*L*	*H*	DG	**vH**	DG	**H**	*vH*	**H**	*L*	*L*	*M*	*M*	**vH**	**vH**	*vH*	**vL**	**L**	**L**
13463-41-7	zinc pyrithione	1	**L**	**L**	**L**	**H**	*M*	**vH**	*vH*	**H**	**M**	**H**	*L*	*L*	**L**	**vH**	**vH**	**vH**	*H*	**vL**	**L**	*L*
64359-81-5	DCOIT	2	**L**	**L**	**L**	**L**	*M*	**vH**	*vH*	**L**	DG	**L**	**H**	DG	**vH**	**vH**	**vH**	**vH**	***L***	*vL*	*L*	**L**

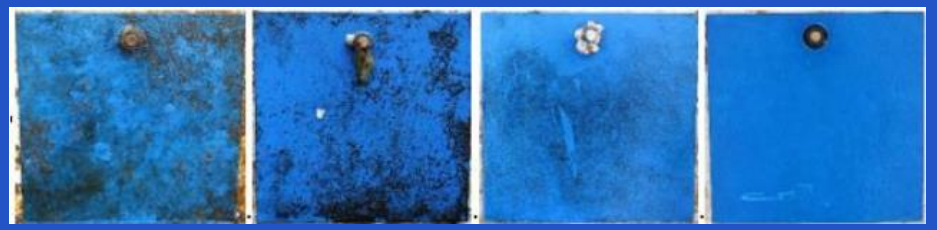
Chart taken from “Antifouling Paints in Washington State: Third Report to the Legislature” https://apps.ecology.wa.gov/publications/documents/2404034.pdf

USA – WASHINGTON STATE : THE WHY BEHIND THE DECISION

- Effective
  - Panel Testing
    - 19 paints
    - 12 months
    - 4 Locations

Ecology noted drawback of Foul-Release is idle period and poor mechanical strength.

- Results (top three):
  - Zinc Pyrithione



  - Copper

  - Foul-Release

Photos taken from “Antifouling Paints in Washington State: Third Report to the Legislature” https://apps.ecology.wa.gov/publications/documents/2404034.pdf

USA – WASHINGTON STATE SUMMARY

- Safer
  - DCOIT was “safer”
    - Has toxicity concerns and not approved for non-professionals
- Effective
  - FR, ZnPT effective
  - DCOIT was NOT more effective

Final Recommendation: Not able to determine “that safer and effective alternatives to copper based antifouling paints are feasible, reasonable, and readily available”

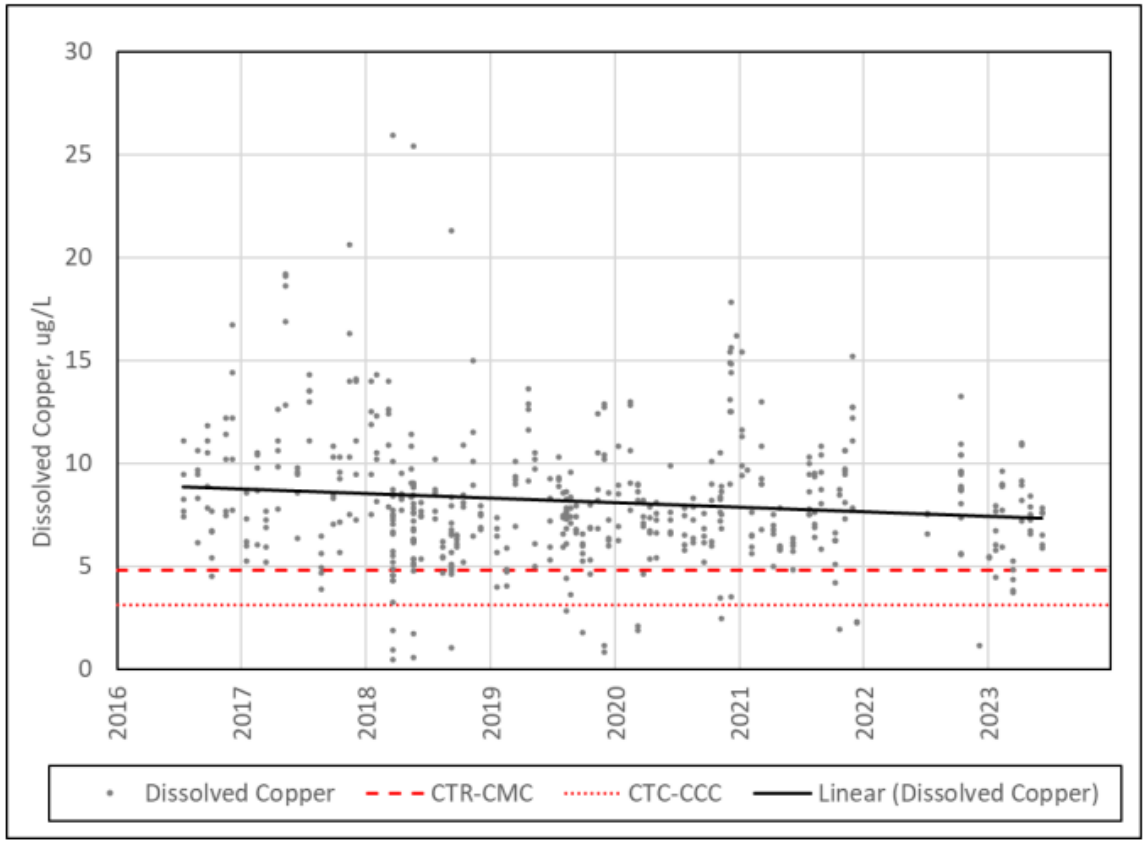
From “Antifouling Paints in Washington State: Third Report to the Legislature” https://apps.ecology.wa.gov/publications/documents/2404034.pdf

USA – CALIFORNIA

Marina Del Rey

- TMDL in 2006; 85% reduction
- Leach rate limit of 9.5 µg/cm^2/day
- Alternative Testing
- Reconsideration of the TMDL
- WER Study
- WER = 1.32
  - Acute: 4.8 µg/L → 6.3 µg/L
  - Chronic: 3.1 µg/L → 4.1 µg/L
- TMDL in 2024; 57% reduction

Figure 4-4. Dissolved copper concentrations in Marina del Rey Harbor water column samples from 2016 through 2023 and the copper trendline.



$$\text{WER} = \frac{\text{EC50 Site Water}}{\text{EC50 Reference Water}}$$

USA – CALIFORNIA

Shelter Island Yacht Basin

- TMDL in 2005; 76% reduction
- 2011 Study – 1 of 62 samples showed somewhat toxicity
- 2022 – Achieved 46% reduction in copper loading
- Non-copper concerns
- Forward Thinking Regional Board
    - Holistic view of marina health

USA – CALIFORNIA

Newport Bay

- August 2025 approved TMDL
- 12 years to decrease 60%
- Orange County Public Works opposed
- State Board encouraged collaboration and development of site-specific criteria

EU

- Undergoing BPR renewal
- Marina Monitoring
- Field Studies of Leach Rate for Pleasure Crafts

KOREA

- Cuprous Oxide classified as toxic substance in K-CCA >1%
  - Handling permits, labeling requirements, etc.

- August 2025, K-CCA changed from regulatory classification-based to hazard-based approach
  - Will be impact to the 1% threshold
  - Based on GHS Rules linked to concentration and hazards

The Copper Solution

Copper is a Biocide

HOWEVER…

It is also:

- A micronutrient
- Naturally occurring
- Present in streams and rivers

AND…

Copper-based coatings are the most prominent coating being used today…

Copper Coatings are Essential

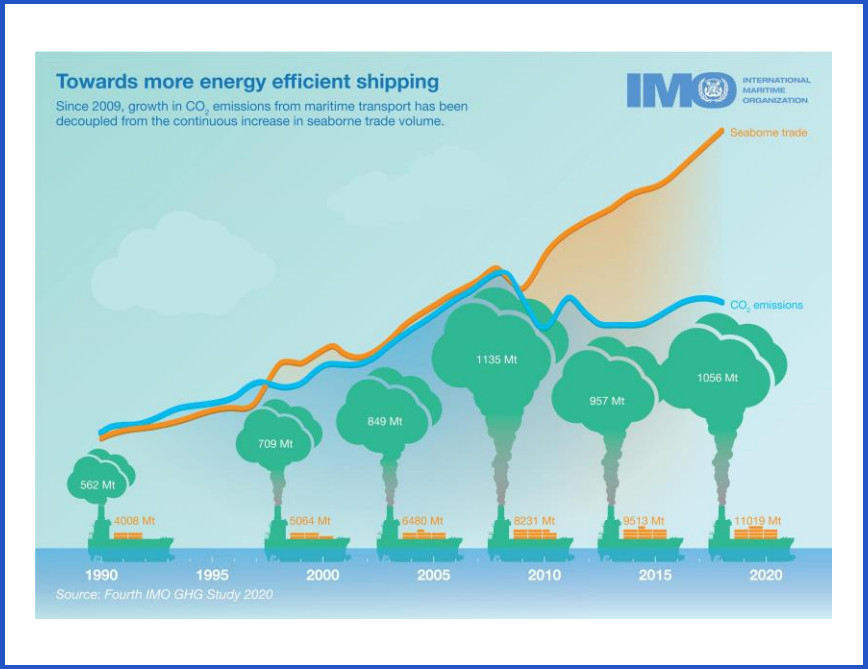
- Copper Coatings are the most prominent because they work
  - Broad spectrum of biofouling control, especially hard fouling
  - Low solubility in seawater
  - Natural sources
  - Effective even if damaged
  - Cost-effective

- Copper is the best we have so far

How We Move Forward Together

Diversity of Approaches

- Supporting Environmental, Social, and Economic needs of the world
- We all need all anti-fouling solutions
- Diversity of Approaches
  - Holistic perspective
  - No “one size fits all”
  - Allows for solutions for different situations
  - Co-biocides aid effectiveness
  - Potential unknown risk



Summary

- Copper coatings are widely approved for use
- Shift from water quality to biological health supports the use of copper
- Copper coatings are essential for meeting GHG emissions targets and goals
- Continue to offer a diversity of solutions to combat biofouling

Lloyd's Register Anit-Fouling Coating Type Approvals, June 2025