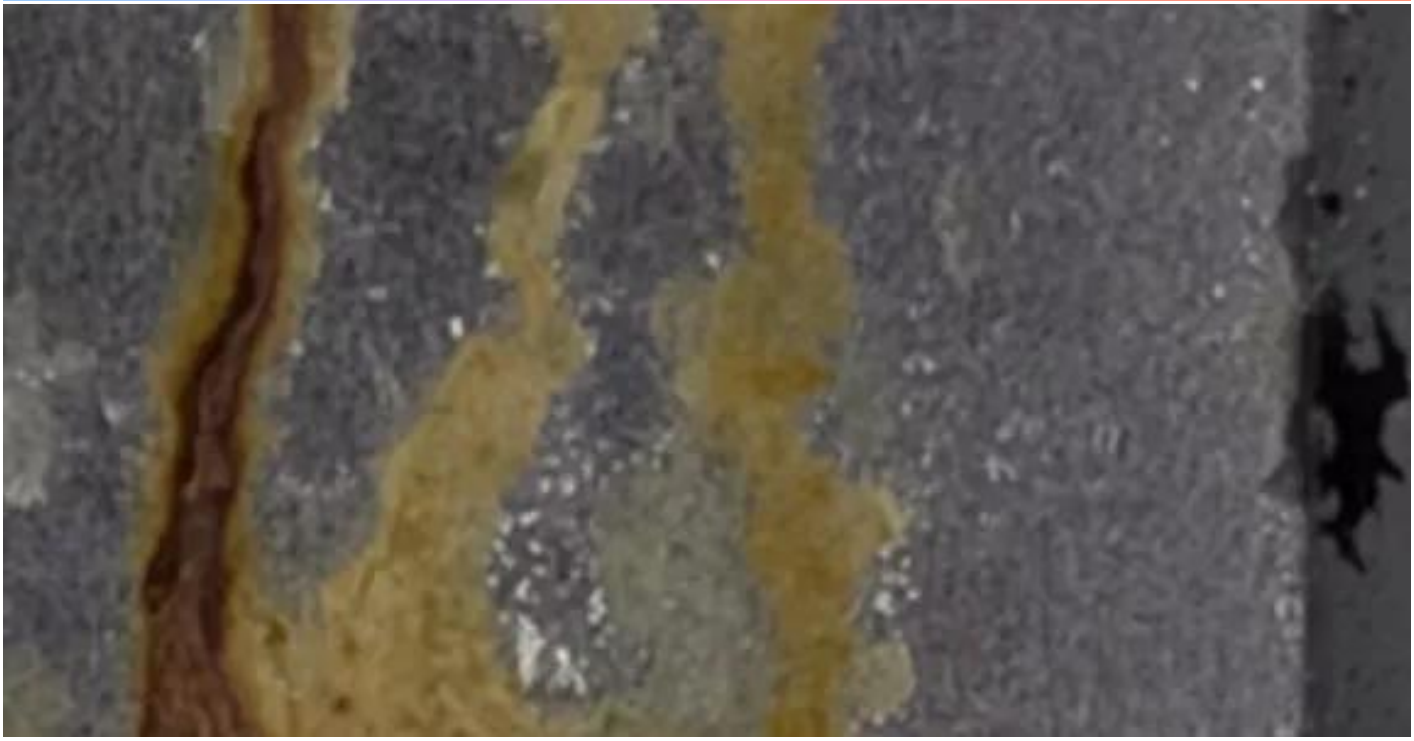


Bio-based anticorrosion additives part 1

20 January 2026, 14:21

Pieter Samyn

Context, mechanisms and system-level insights

Corrosion remains one of the most persistent challenges for metal-based systems in industry, infrastructure, transport and energy. It reduces service life, increases maintenance costs and can compromise safety and environmental performance. At the same time, corrosion protection itself is under pressure to change. Regulatory constraints, sustainability targets and shifts in coating technology are reshaping the choice of materials.

This first article examines:

- Why bio-based anticorrosion additives are gaining attention
- How they function at system level
- Which drivers and constraints shape their adoption

In the second article, the focus shifts to concrete applications, sectors, biomass sources and formulation logic.

Explore all articles in this series

- Small but powerful ingredients of eco-friendly coatings
- Bio-based additives: make use of your residual waste
- From Field Residue to High-Performance Coatings
- Repurposing eggshell waste as functional coating fillers
- From agricultural waste to performant coatings
- Are bio-based isocyanates in polyurethane coatings a good idea?
- Bio-based anticorrosion additives part 1 ? *Current article*
- Bio-based anticorrosion additives part 2
- Smarter coating formulation with analytics
- How to select bio-based binders for coatings

Why corrosion protection needs to evolve

Corrosion is an electrochemical degradation process driven by interactions between metals and their environment. Moisture, oxygen, salts, acids and pollutants act together to initiate and accelerate material loss. The economic impact is substantial, but the environmental footprint is equally relevant. The replacement of corroded steel alone accounts for an estimated 1.6–3.4% of global CO? emissions.

Historically, corrosion protection has relied on highly effective but problematic chemistries. Chromates, phosphates, nitrites and zinc-rich systems have delivered long-term performance, yet many of these substances face restrictions due to toxicity, carcinogenicity or environmental persistence. At the same time, the coating industry is transitioning toward waterborne systems and lower volatile organic compound (VOC) content, which changes the transport and activation of inhibitors.

These developments converge into a structural challenge: how to maintain corrosion performance while reducing environmental and regulatory risks.

Drivers behind the shift to bio-based additives

The growing interest in bio-based anticorrosion additives is not driven by a single factor. It results from the interaction of regulation, market expectations and sustainability strategies.

Key drivers include:

Regulatory pressure

Substances of concern face increasing restrictions under chemical legislation and discharge limits.

Corporate sustainability goals

Many companies commit to decarbonisation, circular economy principles and safer chemistry frameworks.

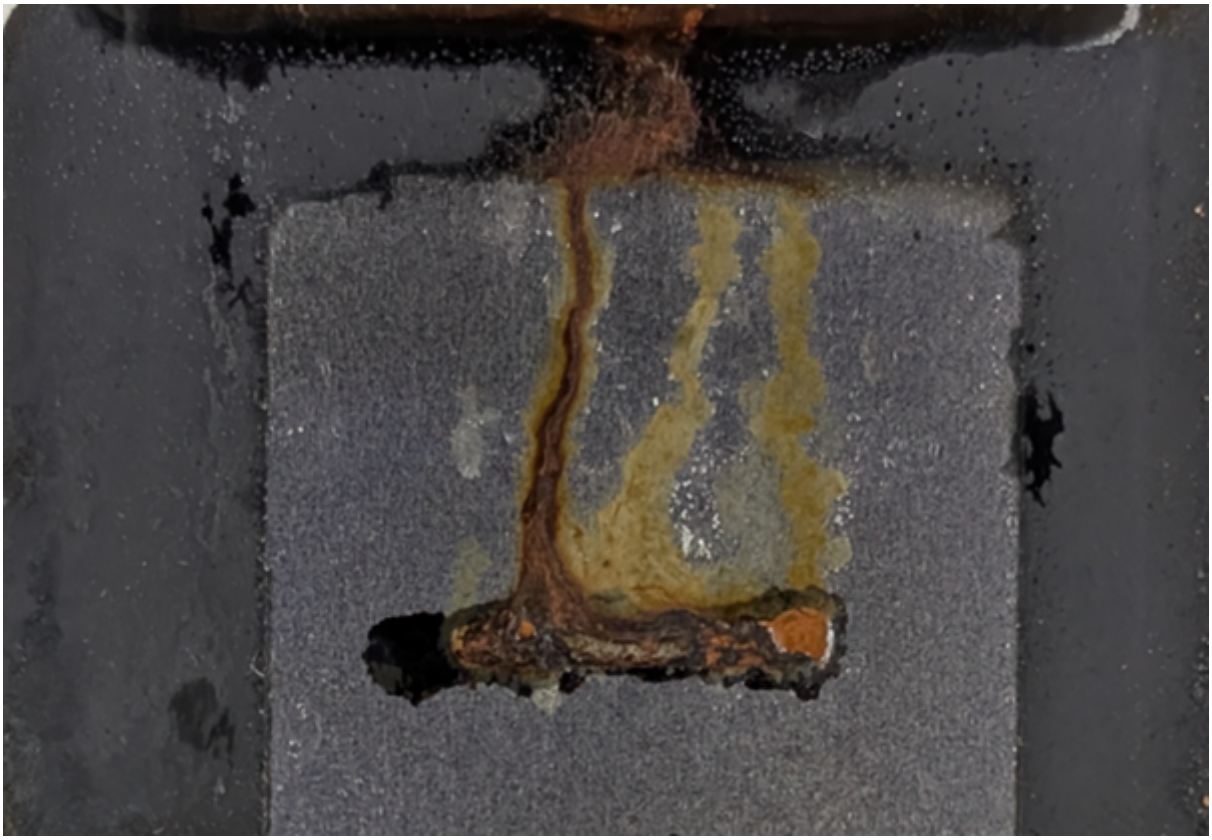
Technology shifts in coatings

Waterborne and low-VOC formulations require additives that function in different chemical environments.

Market expectations

Automotive, construction and marine sectors increasingly value environmentally responsible material choices.

Bio-based additives, derived from renewable biological feedstocks, align with these trends while offering corrosion protection mechanisms comparable to conventional systems.



How corrosion protection works at coating level

Corrosion protection in coatings relies on three complementary mechanisms:

1. Barrier protection

The coating forms a physical barrier that slows the diffusion of water, oxygen and ions toward the metal surface. Cross-linked binders and crystalline structures increase resistance, while fillers and additives extend diffusion pathways.

2. Inhibitive protection

Active pigments or chemical additives interact with the metal surface to form protective layers. These substances may dissolve partially in the presence of moisture and migrate toward corrosion sites, where they suppress electrochemical reactions.

3. Sacrificial protection

In galvanic systems, a more electrochemically active metal corrodes preferentially, protecting the underlying substrate.

Bio-based additives do not replace these principles. Instead, they combine several mechanisms, often within a single additive package, creating cooperative effects that enhance durability.

Functional roles of bio-based additives

Bio-based additives are sourced from plants, algae, microorganisms or bio-derived side streams. Their role in anticorrosion systems typically falls into three categories:

1. Corrosion inhibitors

Molecules that adsorb onto metal surfaces, chelate metal ions or promote passivation.

2. Functional fillers

Bio-derived particles that improve barrier properties, adhesion and mechanical stability.

3. Smart additives

Systems that respond to environmental triggers such as pH or moisture, enabling controlled release or self-healing effects.

Their effectiveness depends on chemical structure, compatibility with the coating matrix and dispersion quality. Particle size, surface chemistry and uniformity strongly influence adhesion and barrier performance.

Integration into coating systems

Bio-based anticorrosion additives can be integrated into protection systems in several complementary ways. They may function as soluble or slightly soluble inhibitors in waterborne or solvent-borne coatings and in process fluids, where they actively suppress corrosion reactions. In coating formulations, they are also used as functional fillers or polymer modifiers that improve hydrophobicity and limit the ingress of oxygen and water. In addition, bio-based additives can serve as surface treatment agents, forming protective conversion layers or primers on metal substrates. Finally, they can be incorporated as encapsulated active components, allowing controlled release when corrosive conditions arise and extending long-term protection.

This flexibility allows formulation strategies that combine performance and environmental considerations.

Bio-based versus fossil-based additives: system-level comparison

Compared to conventional fossil-based systems, bio-based additives show different strengths and limitations:

- They often provide mixed-mode protection, combining adsorption, barrier effects and antioxidant behaviour
- They align well with waterborne and low-VOC architectures, which dominate future coating developments
- Toxicity and environmental impact profiles are generally more favourable, improving worker safety and waste-water management

At the same time, performance maturity varies by application. Hybrid systems that combine bio-based and synthetic components frequently deliver the most robust results.

Benefits and points of attention

Key advantages:

Sustainability

Renewable feedstocks and the use of biomass side streams reduce fossil dependency.

Regulatory alignment

Lower toxicity and improved compliance with green procurement criteria.

Multifunctionality

Many natural molecules combine corrosion inhibition with UV stabilisation, adhesion promotion or antioxidant activity.

Lifecycle impact

Potential reductions in carbon intensity and improved end-of-life profiles.

Key considerations:

Feedstock variability

Natural materials vary by geography and season, requiring quality control and standardisation.

Colour and odour

Some bio-based compounds affect appearance and are better suited for primers or pigmented layers.

Processing behaviour

Viscosity changes or foaming may require formulation adjustments.

Long-term durability

Moisture sensitivity and thermal stability can limit some biopolymers, making hybrid or encapsulated systems preferable.

A look ahead in the series

Bio-based anticorrosion additives are no longer experimental concepts. They are becoming functional components in primers, topcoats, surface treatments and process fluids. By combining adsorption, chelation, hydrophobic film formation and antioxidant stabilisation, they offer protection while supporting sustainability goals.

As discussed in the second article of this series, practical implementation depends on application context, sector requirements, biomass sources and formulation logic. Continued collaboration between material scientists, formulators and industrial users remains essential for scaling these solutions.

Discover the other article in the series:

- Part 2: applications, sectors, biomass sources and formulation logic

Discover the VLAIO COOCK+ AddBIO project

Sirris is involved in research on the conversion of residual biomass into functional anticorrosion and hydrophobic additives within the VLAIO COOCK+ AddBIO project.

Discover the VLAIO COOCK+ AddBIO project

Are you considering bio-based solutions for corrosion protection?

Get in touch with Pieter Samyn to exchange insights and assess opportunities together.

Contact us

Authors



Pieter Samyn