FORREST
Technical Coatings

Why Corrosion Happens
(And Why It’s Inevitable)





Corrosion is often treated as a failure - of materials, coatings, maintenance, or design. In reality, corrosion is a natural and expected process. The real challenge is not preventing corrosion entirely but understanding why it occurs and controlling the rate at which it happens.

At its most basic level, corrosion is the deterioration of a material, usually a metal, as a result of chemical or electrochemical reactions with the environment. When metals are exposed to air, moisture, chemicals, or elevated temperatures, corrosion should not come as a surprise. In fact, unless precautions are taken, it would be unusual if corrosion didn't occur.

Corrosion does not mean a material was defective or poorly manufactured. It means the material is reacting exactly as nature dictates when exposed to the environment.

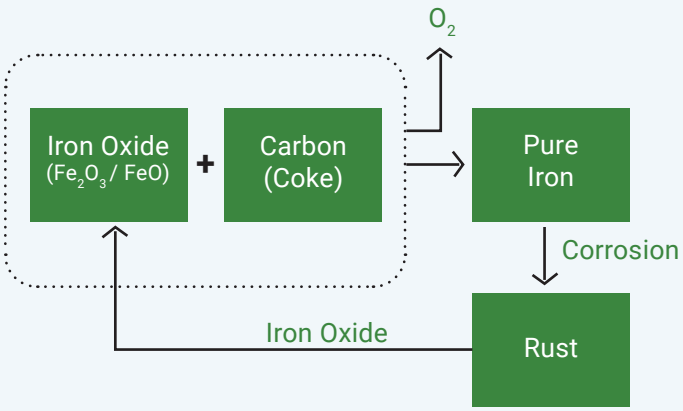


Metals Are Not Naturally Stable

Most metals do not exist in nature in their pure metallic form. They are typically found as ores, combined with oxygen, sulfur, or other elements in low-energy, stable compounds.

To produce usable metal, energy must be applied to extract it from these ores. That energy does not disappear. It is stored in the metal itself, in the form of uncompleted chemical bonds. Corrosion is simply the process by which the metal releases that stored energy and returns to a more stable, lower-energy state.

Iron provides a clear example. Iron ore is commonly found as iron oxide. When iron corrodes, it forms rust. And rust is another iron oxide. Chemically, corrosion is not creating something new; it is returning the metal to a form similar to what it was before energy was added during manufacturing - to a compound with other elements.



Metals are energy-rich materials. Corrosion is the natural release of that stored energy back into a stable chemical form.

Corrosion Is Natural, Not Accidental

Because corrosion is driven by fundamental thermodynamic forces, it is inevitable under most service conditions. This does not mean that materials are poorly made or improperly selected. It means that corrosion is part of the natural lifecycle of metals exposed to real-world environments.

Just as water naturally flows downhill unless restrained, metals naturally corrode unless steps are taken to interrupt the process. Coatings can form a protective barrier which prevents corrosion. When those protective barriers are removed through coating damage, environmental changes, or increased exposure, corrosion resumes.



The important distinction is not whether corrosion will occur, but:

- How fast it occurs
- Where it occurs
- What form it takes

> **The critical question is not "Will corrosion occur?" It is "How quickly will it occur, and where will it cause damage first?"**

Environment Controls the Rate of Corrosion

While corrosion itself is inevitable, the rate of corrosion is highly dependent on environmental conditions. Some environments are far more aggressive than others.

In general:

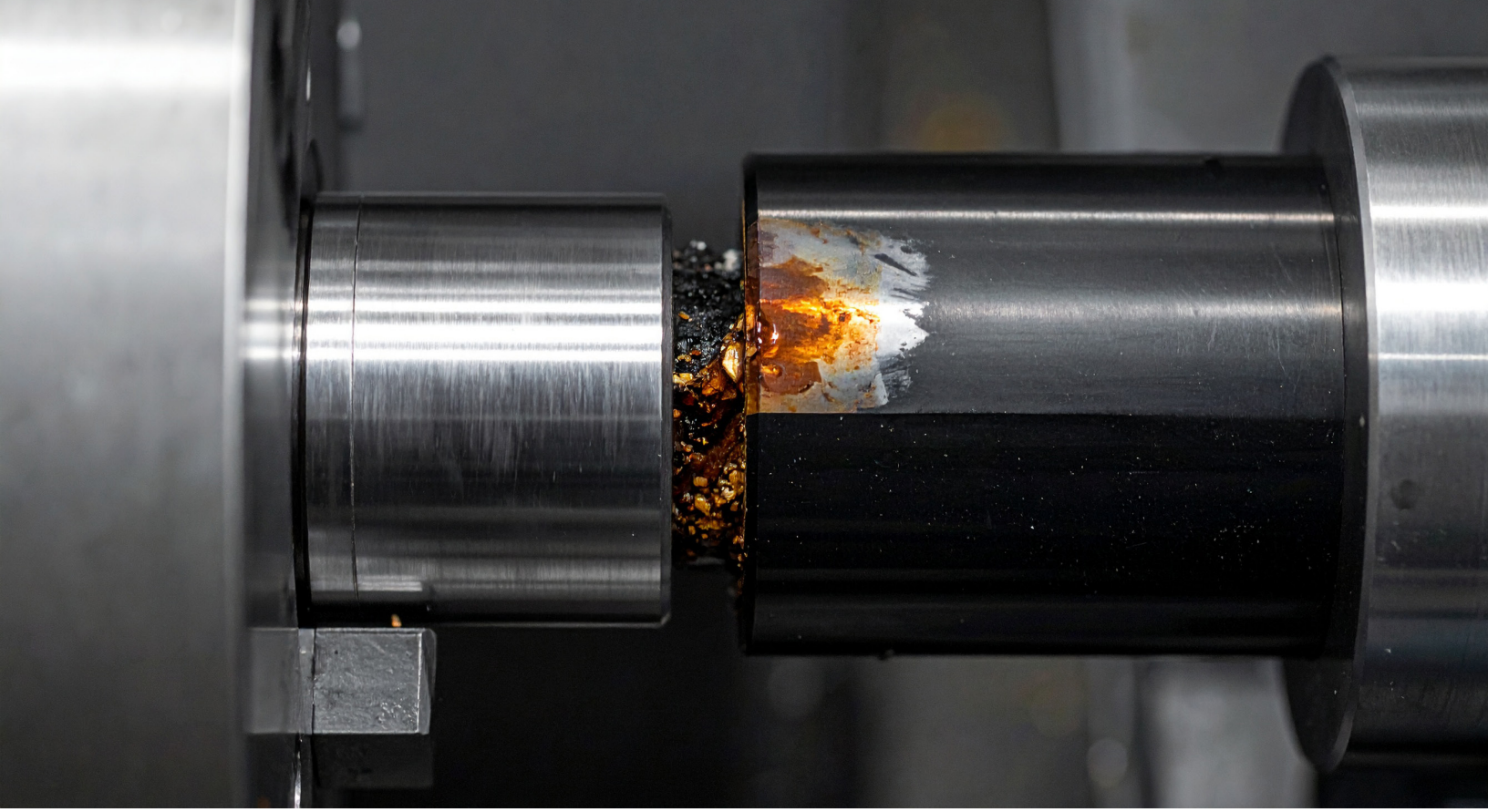
- Moist air is more corrosive than dry air
- Polluted air is more corrosive than clean air
- Salt water is more corrosive than fresh water
- Elevated temperatures in conjunction with humidity or contaminants accelerate chemical reactions

However, broad rules always have exceptions. Corrosion behavior depends on a complex interaction between the metal, the environment, and exposure conditions. This is why similar materials can perform very differently in different service locations or operating conditions.





Two identical components can experience dramatically different corrosion rates depending on exposure, moisture, contaminants, and temperature – even when made from the same metal.



Why Corrosion Often Goes Unnoticed Until Failure

In many cases, corrosion begins immediately after exposure but remains invisible for long periods of time. Early-stage corrosion may:

- Occur beneath coatings
- Develop in crevices or shielded areas
- Progress internally before external signs appear

This delayed visibility often leads to the false assumption that corrosion was sudden or unexpected, when in reality it had been developing slowly over time.

Understanding corrosion as a process, rather than an event, is critical to managing long-term equipment performance and service life.

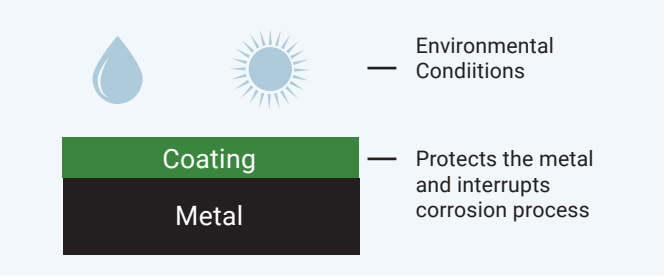
Hidden Corrosion Is the Most Dangerous.
Localized corrosion often causes failure before surface damage is visible, making early understanding and prevention essential.

The Role of Protective Barriers

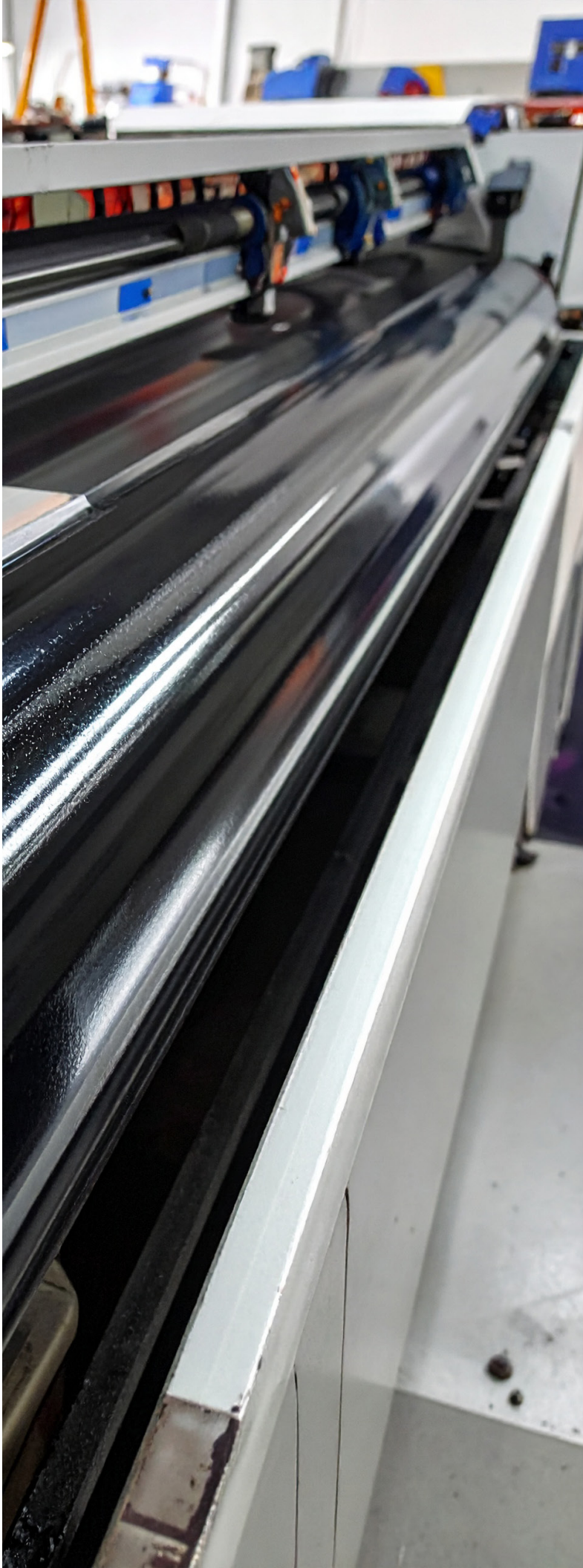
Some metals naturally form thin oxide layers that slow further corrosion. Aluminum, stainless steel, and certain alloys develop surface films that partially isolate the underlying metal from the environment. While these layers can be effective under certain conditions, they are often insufficient in aggressive or variable service environments.

Ordinary carbon steel does not form a naturally protective oxide layer. Instead, rust allows oxygen and moisture to continue penetrating the surface, accelerating further corrosion unless a protective barrier is applied.

This is where engineered corrosion control methods, particularly protective coatings, become essential. By isolating the metal from its environment, coatings interrupt the corrosion process and significantly extend service life. The effectiveness of this protection, however, depends on how well the coating system is matched to the environment and exposure conditions.



Protective coatings do not change the nature of corrosion. They interrupt the conditions that allow it to proceed.



Key Takeaway

Corrosion is not a defect or a surprise. It is a predictable outcome of placing energy-rich metals into real-world environments. The true challenge is not understanding that corrosion occurs, but how to best protect surfaces and substrates so corrosion is slowed, controlled, or prevented from taking hold.

Because corrosion is driven by exposure to moisture, contaminants, and temperature, effective protection depends on isolating the metal from those conditions. When properly selected and applied, protective barriers such as coatings interrupt the corrosion process and significantly extend service life.

Managing corrosion successfully means recognizing it as a natural process and focusing on intentional protection strategies that match the environment and service conditions.

About Forrest Technical Coatings

For more than 50 years, Forrest Technical Coatings has manufactured specialty coating systems designed to perform in demanding service environments. Based in the United States with a global customer footprint, Forrest works closely with equipment manufacturers, engineers, and operators to address corrosion, heat, and environmental exposure challenges across a wide range of industries.

Forrest's portfolio includes industrial and high-temperature coating systems for applications such as biomass processing, exhaust and thermal equipment, power generation, and other corrosion-prone environments. Products such as the INFERNEX® high-temperature coating systems are engineered to withstand elevated temperatures, aggressive atmospheres, and real-world operating conditions.

As a manufacturer, Forrest focuses on understanding how the environment, substrate, and service conditions interact, and on formulating coatings that align with those realities.

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