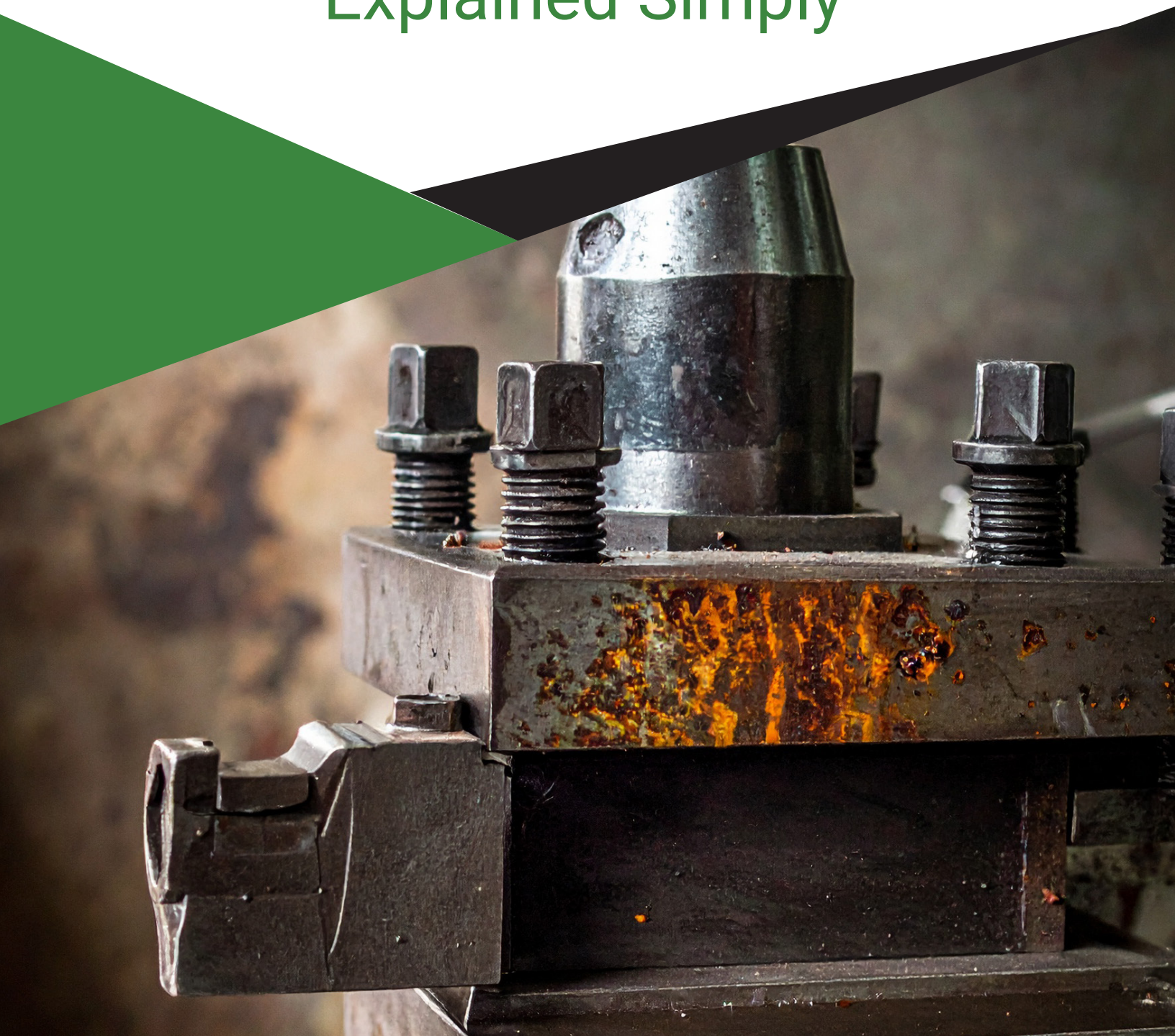
FORREST
Technical Coatings

How Corrosion Actually Works:
The Corrosion Cell Explained Simply





While corrosion can appear random, it follows a consistent and predictable process. At the center of most corrosion damage is what is known as a corrosion cell. Understanding this process helps explain why corrosion often concentrates in specific areas and why protective barriers are so effective when properly applied.

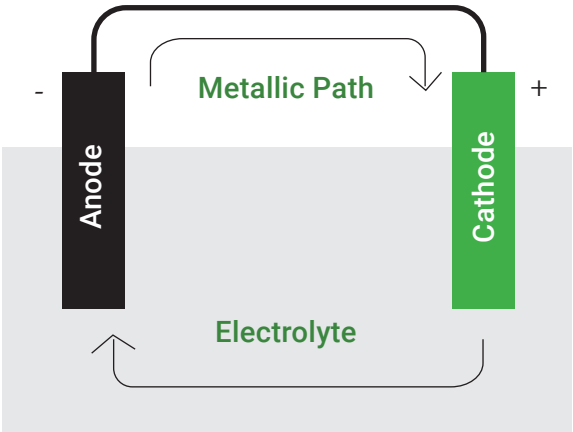
The Basic Corrosion Cell

For corrosion to occur, four elements must be present at the same time:

1. An anode, where metal loss occurs
2. A cathode, where a reduction reaction takes place
3. An electrolyte, usually moisture containing dissolved salts or contaminants
4. A metallic path, allowing electrons to flow through the metal

When all four elements exist together, corrosion reactions can proceed.

If any one of these elements is removed or interrupted, corrosion slows significantly or stops altogether.



Typical Corrosion Cell

Corrosion Requires a Complete Circuit
No anode, no cathode, no electrolyte, or no metallic path means corrosion cannot continue.

Anodes and Cathodes Can Exist on the Same Surface

A common misconception is that corrosion only occurs when two different metals are in contact (galvanic corrosion). In reality, anodic and cathodic areas can form on the surface of a single piece of metal.



Small differences in surface condition can create corrosion cells, including:

- Variations in oxygen concentration
- Differences in moisture exposure
- Surface deposits or contaminants
- Microstructural differences in the metal

These small variations explain why localized corrosion such as pitting often develops even on uniform materials.

One Metal, Many Corrosion Cells
Even a single steel component can support hundreds of microscopic corrosion cells across its surface.



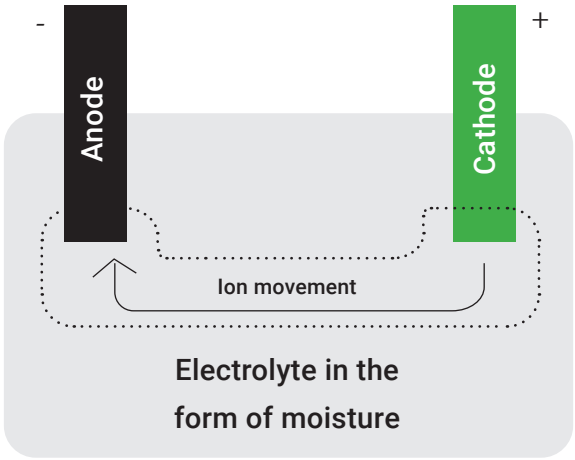
The Role of the Electrolyte

The electrolyte is typically a thin layer of moisture that enables ion movement between anodic and cathodic areas. This moisture does not need to be visible or continuous to be effective.

Electrolytes may form from:

- Condensation
- High humidity
- Rain or washdown water
- Absorbed moisture beneath deposits or coatings

When contaminants such as chlorides or acidic compounds dissolve in moisture, the conductivity of the electrolyte increases, accelerating corrosion reactions.



Thin Moisture Layers Are Enough
A barely visible film of moisture can sustain corrosion if contaminants are present.



Why Corrosion Concentrates in Specific Areas

Corrosion cells naturally focus attack where conditions favor anodic behavior. Areas that are oxygen-deprived, shielded from airflow, or subject to moisture retention often become anodic relative to surrounding surfaces.



Common anodic sites include:

- Crevices and tight joints
- Areas beneath surface deposits
- Damaged or thin coating areas
- Locations with frequent wetting and slow drying

Once a localized corrosion cell forms, metal loss accelerates at that site while nearby areas remain relatively unaffected.



Interrupting the Corrosion Cell

Effective corrosion control is based on interrupting one or more elements of the corrosion cell. This can be accomplished by:

- Removing moisture or limiting time of wetness
- Isolating the metal from the environment
- Reducing surface contamination
- Applying protective barriers

Among these methods, protective coatings are widely used because they simultaneously block moisture, isolate the metal surface, and disrupt the electrochemical pathway.

Why Coatings Work

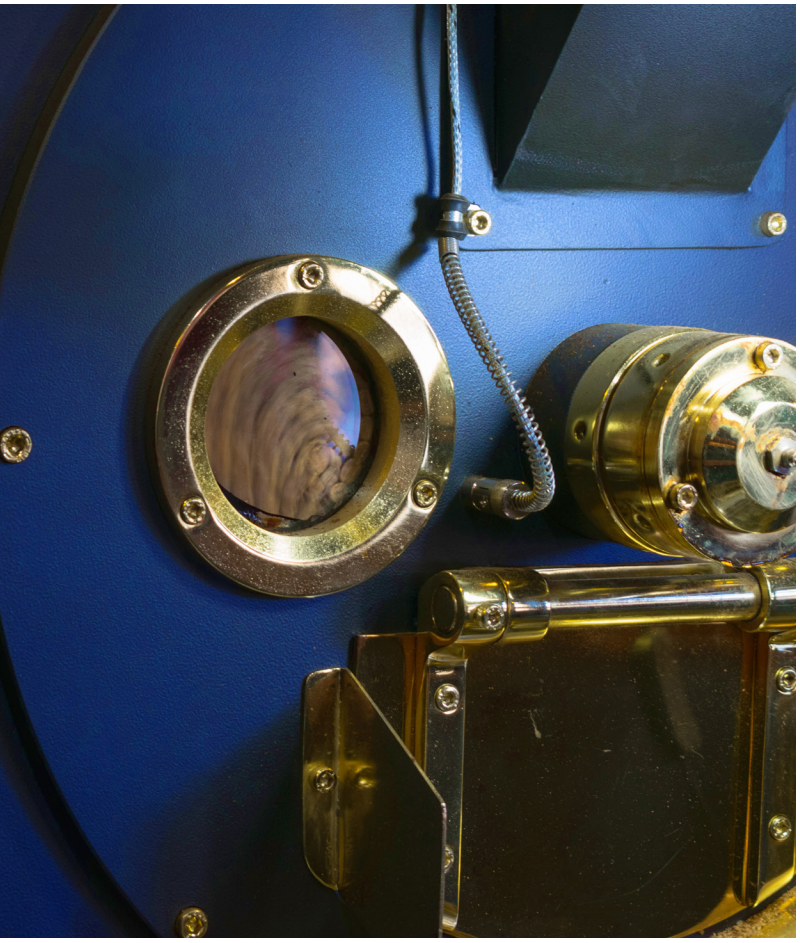
Protective coatings interrupt corrosion by separating the metal from the environment and preventing the corrosion cell from forming.

When the Corrosion Cell Changes

At elevated temperatures, corrosion mechanisms may change. Moisture-based electrochemical cells become less dominant, while direct chemical reactions between metal and gases take over. These conditions are addressed in detail later in this guide.

Understanding the basic corrosion cell, however, remains essential even in high-temperature service, as many failures occur during startup, shutdown, or cooldown when moisture is present.





Implications for Corrosion Control

Recognizing corrosion as an electrochemical process highlights why surface preparation, coating continuity, and environmental exposure all matter. Breaks in protective barriers or changes in exposure conditions can re-establish corrosion cells and accelerate damage.

Effective corrosion control focuses on preventing corrosion cells from forming rather than reacting after damage becomes visible.

Key Takeaway

Corrosion is not random. It follows a repeatable electrochemical process that requires specific conditions to exist. By understanding how corrosion cells form and how they are interrupted, it becomes possible to design protection strategies that address the root cause of corrosion, not just its symptoms.

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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