Beneficial Aspects of Corrosion

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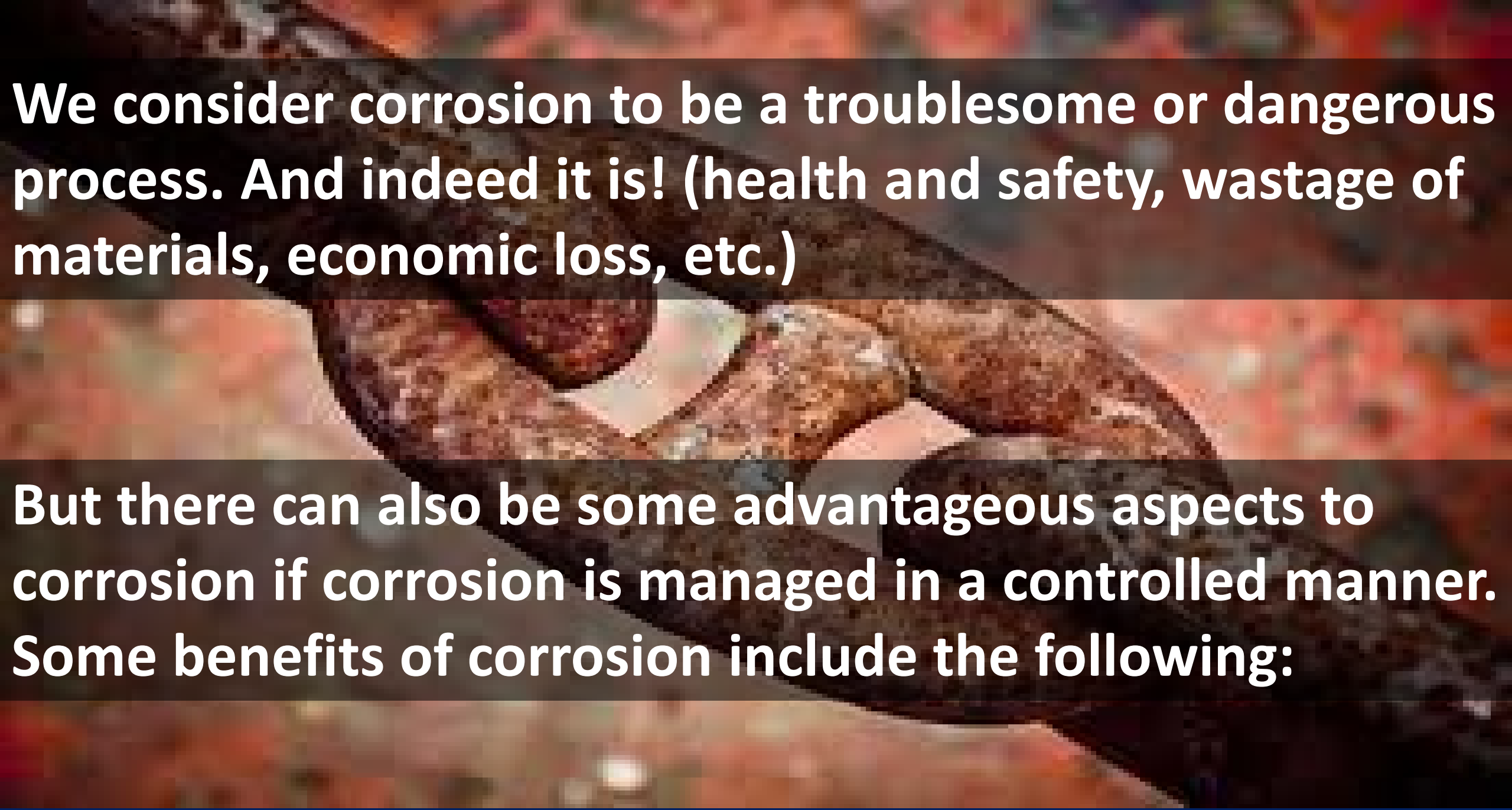
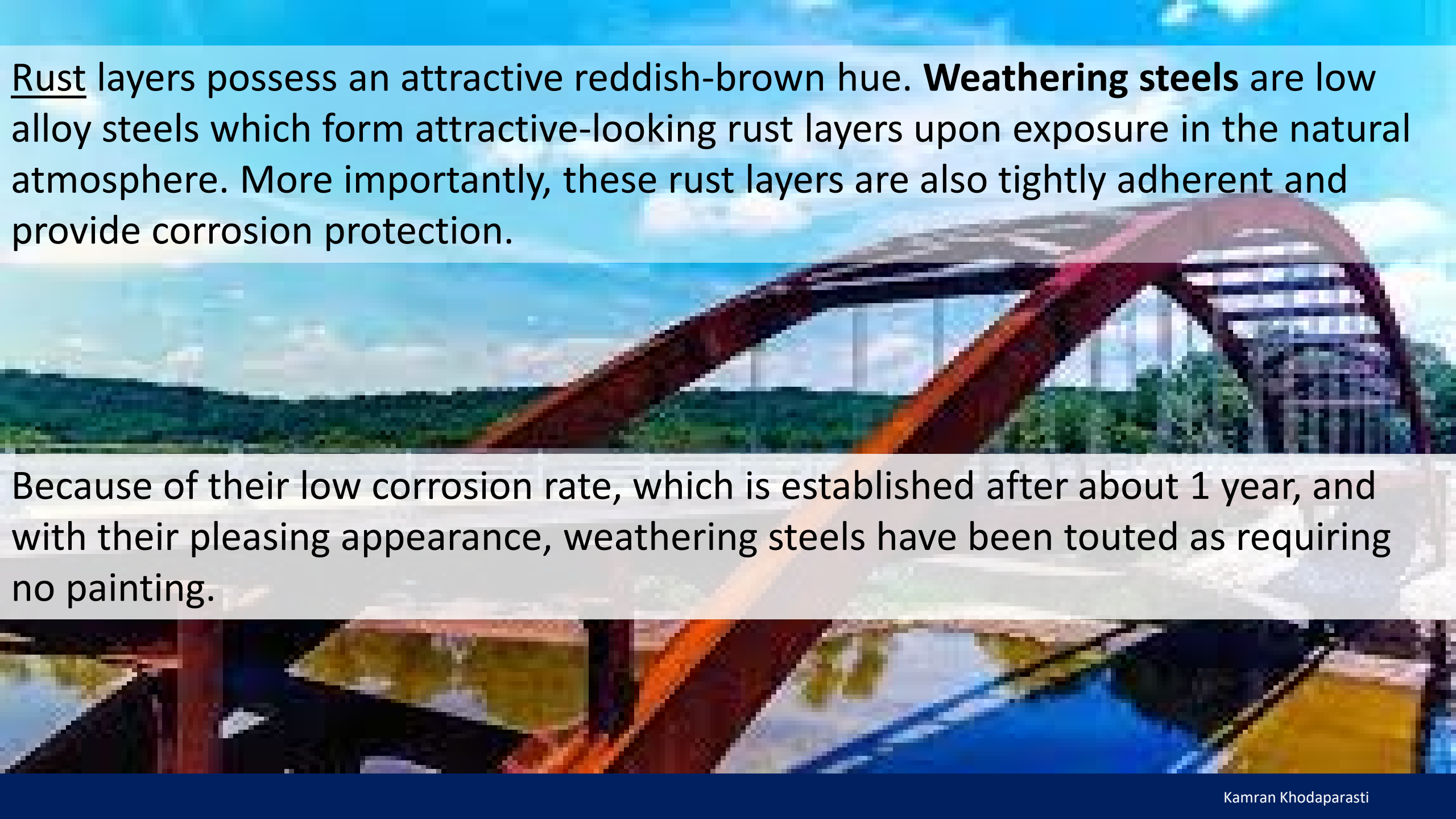


We consider corrosion to be a troublesome or dangerous process. And indeed it is! (health and safety, wastage of materials, economic loss, etc.)

But there can also be some advantageous aspects to corrosion if corrosion is managed in a controlled manner. Some benefits of corrosion include the following:



Rust layers possess an attractive reddish-brown hue. **Weathering steels** are low alloy steels which form attractive-looking rust layers upon exposure in the natural atmosphere. More importantly, these rust layers are also tightly adherent and provide corrosion protection.

Because of their low corrosion rate, which is established after about 1 year, and with their pleasing appearance, weathering steels have been touted as requiring no painting.

Patina is a thin layer that variously forms on the surface of copper, brass, bronze and similar metals and metal alloys (tarnish produced by oxidation or other chemical processes)

The Statue of Liberty gets its famous green color from the natural patina formed on its copper surface.

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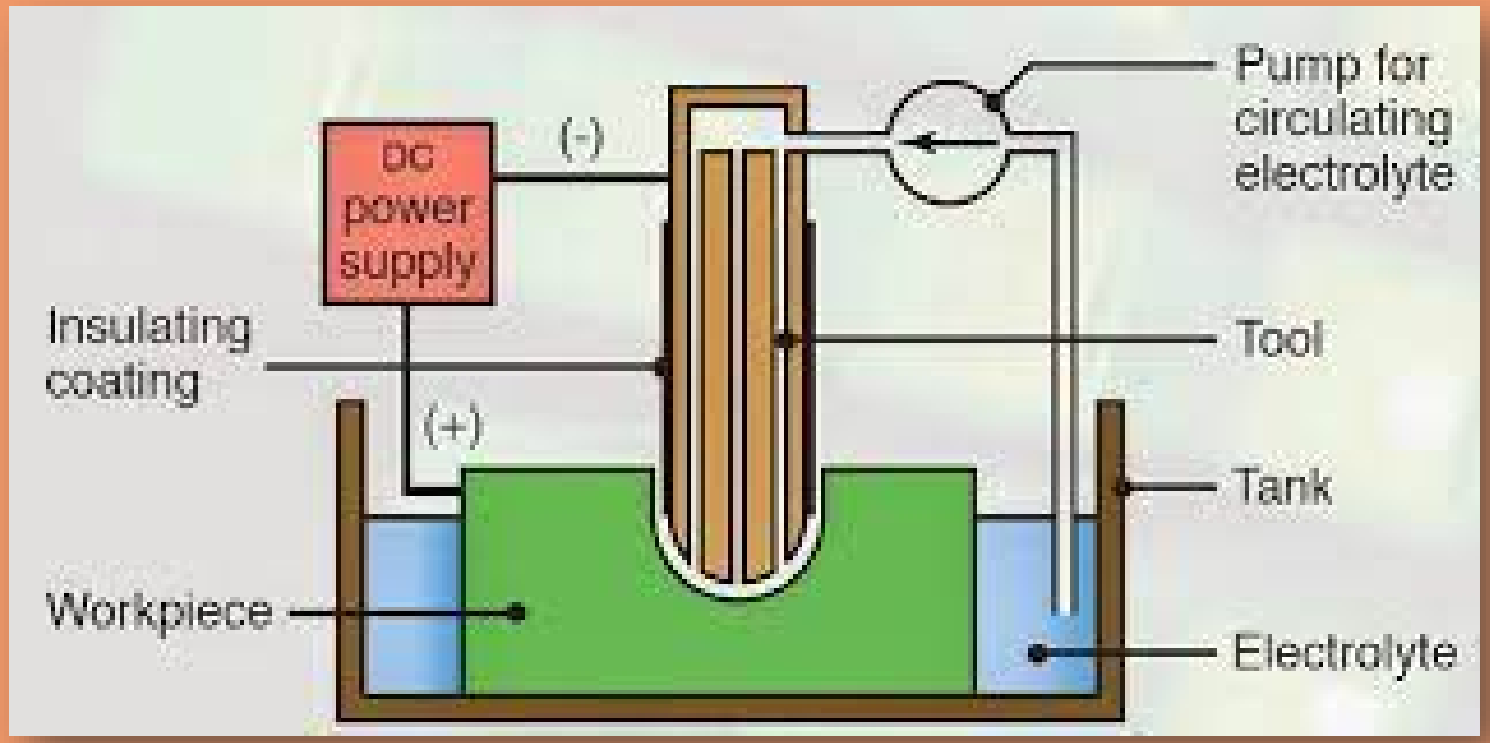
Cathodic protection by a sacrificial anode is another example of benefits of corrosion.

When a zinc anode is electrically connected to an iron structure, the zinc, which has the more negative open-circuit potential, becomes the anode in the iron/zinc couple. Thus, the sacrificial zinc anode is allowed to intentionally corrode, but in so doing, it provides protection to the more valuable structure iron (or steel), which may be a bridge, a pipeline, or a ship.

Electrochemical machining utilizes controlled anodic dissolution (i.e., corrosion) between a workpiece (anode) and a "tool" (cathode) in an electrolytic cell. The shape of the machined work piece is controlled by moving the tool electrode through the electrolyte in a prescribed path.



Scale-covered or rusted metals can be cleaned prior to surface treatment by immersing them in acid solutions (pickling).

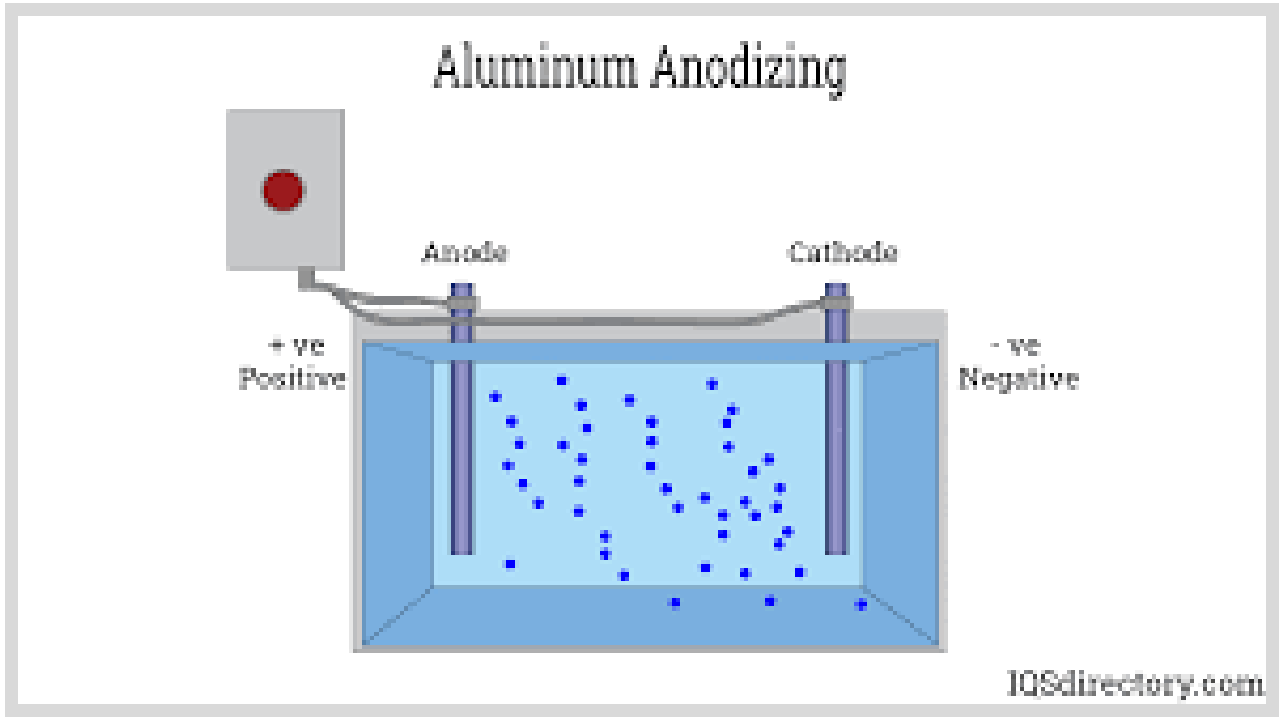
In studies on the metallography of metals or alloys, specimens are etched in appropriate solutions (often acids) to allow the specimen to corrode in a controlled manner in order to bring out the grain boundary structure. (Etching)

Batteries physically separate the anode and cathode in order to provide an electromotive force between the two electrodes. In lead acid batteries (automobile batteries), the reactions are as follows:

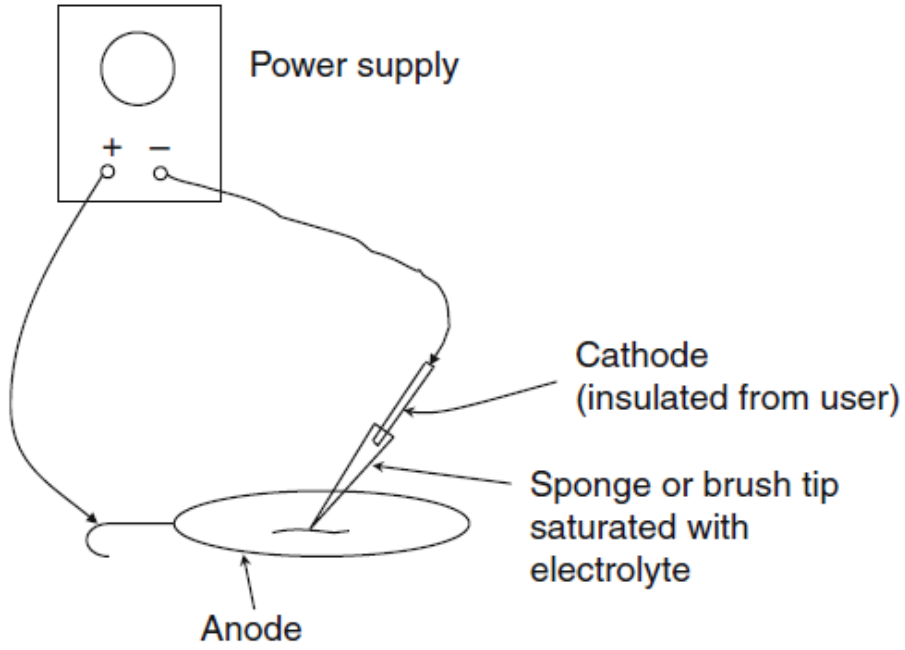
$$\text{Anode: } Pb + H_2SO_4 \rightarrow PbSO_4 + 2H^+ + 2e^-$$
$$\text{Cathode: } PbO_2 + H_2SO_4 + 2H^+ + 2e^- \rightarrow PbSO_4 + 2H_2O$$
$$\text{Overall: } Pb + PbO_2 + 2H_2SO_4 \rightarrow 2PbSO_4 + 2H_2O$$

Thus, in order for this battery to operate, the lead anode must undergo oxidation (corrosion). Six cells are used in series to produce a total cell voltage of approximately 12 V. (This battery can be recharged, a process which reverses the half-cell reactions above.)

Anodizing is a special form of passivation in which an oxide film of tens to hundreds of microns in thickness is formed anodically in an electrochemical cell. Such anodized oxide coatings provide improved corrosion protection, increased abrasion, or enhanced adhesion of paints or other organic coatings.



Titanium is a gray-colored metal, but it is often used in jewelry and art pieces. This is because titanium can be colored by the process of anodizing to produce oxide films of various beautiful colors, including yellow, blue, green, and violet. The color of the oxide film depends on the applied voltage and on the thickness of the film. Specimens can be anodized by immersion into an electrochemical cell, or selected areas can be anodized with a brush which brings the electrolyte and the cell to the metal. In this case, a brush tip or sponge is saturated with the electrolyte, and the wetted brush or sponge is in contact with a metal cathode (which is insulated). The desired pattern and color is then "painted" onto the titanium surface.



This presentation was developed by Kamran Khodaparasti.

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References:

Introduction to Corrosion Science, E. McCafferty

Internet documents

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