Environmental Effects of Oxidation on Iron, Copper, and Zinc and the Electrochemical Reduction of Resulting Corrosion Products

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Metals tarnish due to oxidation reactions with their environment. While oxidation leads to corrosion, we don't fully understand how different metals corrode under the same conditions. This experiment investigated how iron, copper, and zinc oxidize when exposed to the same environments and whether electrochemical reduction can reverse the corrosion products. Understanding corrosion helps in preserving infrastructure, tools, and improving safety. Equal samples of iron, copper, and zinc were exposed to different conditions: air, water, and saltwater. We then observed them over several days to compare the rate and appearance of tarnish formation. The saltwater samples produced the most oxidation, which makes sense considering the dissolved ions increase the solution's conductivity, therefore; accelerating oxidation. The most tarnished metals (saltwater samples) were connected in a circuit as the cathode, while a sacrificial aluminum strip acted as the anode. Iron showed the most visible corrosion since rust forms a porous layer, allowing oxidation to continue. Copper tarnished more slowly because it formed a stable oxide layer of patina that limited further reaction. Zinc formed a thin protective oxide coating that reduced corrosion, slower than iron but faster than copper. During electrochemical treatment, we noted measurable current flow and visible surface changes that indicated that some corrosion products were reduced as electrons were supplied to the cathode. These results show environmental conditions strongly influence corrosion rates and electrochemical reduction can partially reverse tarnish, suggesting potential applications for corrosion restoration.

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