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Understanding the Corrosive Effects of Solar Salt on Austenitic Stainless Steel in Atmospheric Conditions

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DESCRIPTION

Solar salt, a mixture of sodium nitrate and potassium nitrate, is a crucial component in solar thermal energy storage systems, where it serves as a heat transfer fluid for capturing and storing solar energy. However, the corrosive nature of solar salt presents a significant challenge for the materials used in these systems, particularly austenitic stainless steel, which is commonly employed due to its high corrosion resistance. The interaction between solar salt and austenitic stainless steel in atmospheric conditions can lead to complex corrosion mechanisms that affect the performance and longevity of solar thermal energy systems. The corrosivity of solar salt is influenced by several factors, including its chemical composition, temperature, and exposure to atmospheric conditions. Solar salt typically contains impurities such as chlorides, sulfates, and other contaminants, which can promote corrosion by accelerating the degradation of protective oxide layers on metal surfaces. Additionally, the high operating temperatures in solar thermal energy systems can exacerbate corrosion reactions, leading to accelerated material degradation over time. Austenitic stainless steel is commonly used in solar thermal energy systems due to its excellent corrosion resistance and mechanical properties. However, under certain conditions, such as exposure to solar salt at elevated temperatures in the presence of atmospheric oxygen and moisture, austenitic stainless steel can undergo corrosion processes that compromise its integrity and performance. The corrosive effects of solar salt on austenitic stainless steel in atmospheric conditions are influenced by several factors, including the chemical composition of the stainless steel alloy, the surface condition of the material, and the presence of protective surface treatments or coatings. Stainless steel alloys with higher chromium and molybdenum content exhibit enhanced corrosion resistance compared to lower alloyed grades, making them more suitable for applications in corrosive environments such as solar salt. Surface condition also plays a critical role in the corrosion behavior of austenitic stainless steel exposed to solar salt. Surface defects, such as scratches, pits, or welds, can serve as initiation sites for corrosion reactions, leading to localized corrosion phenomena such as pitting or crevice corrosion. Additionally, the presence of protective surface treatments or coatings can provide an additional layer of protection against corrosion, extending the service life of austenitic stainless steel components in solar thermal energy systems. The interaction between solar salt and austenitic stainless steel in atmospheric conditions can lead to several corrosion mechanisms, including uniform corrosion, pitting corrosion, and stress corrosion cracking (SCC). Uniform corrosion occurs when the entire surface of the stainless steel corrodes at a relatively uniform rate, leading to general material loss over time. Pitting corrosion, on the other hand, involves the localized formation of pits or cavities on the stainless steel surface, which can penetrate into the material and compromise its structural integrity. Stress corrosion cracking (SCC) is a particularly concerning corrosion mechanism that can occur in austenitic stainless steel exposed to solar salt in atmospheric conditions. SCC involves the simultaneous action of tensile stress and corrosive environments, leading to the formation and propagation of cracks in the material. SCC can occur under relatively low applied stresses and can progress rapidly, posing a significant risk to the structural integrity of stainless steel components in solar thermal energy systems.

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CONFLICT OF INTEREST

The author declares there is no conflict of interest in publishing this article.

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