Corrosion of Cast Stainless Steels, Fatigue and Fracture Properties of Cast Irons

Corrosion of stainless steels in unfriendly media can occur uniformly or as pitting corrosion, crevice corrosion, integranular corrosion, or stress- corrosion cracking.

Pitting Corrosion

Pitting corrosion occurs transgranularly (across the grains) when the protective oxide film (CROX) is destroyed in small localized areas. Once begun, the attack may accelerate because of differences in electrical potential between the large area of passive surface (cathode) versus the small area of the active pit (anode). Type 304 is susceptible to pitting when exposed to halide salts. Type 316 and 317, with 2-3% and 3-4% respectively of Mo, reduce pitting tendency.

Crevice Corrosion

Crevice Corrosion is a description of pitting that results from local differences in oxygen concentration associated with crevices under gaskets, lap joints, and fasteners, and also with deposits that accumulate on metal surfaces. Once begun, attack progresses rapidly. Crevice corrosion is most frequently associated with chloride environments. Mo helps to minimize crevice corrosion. Intelligent design to avoid crevices and a periodic cleaning schedule are also necessary for long range success.

Fatigue and Fracture Properties of Cast Irons

Microstructure: The microstructure of cast iron typically consists of graphite flakes or nodules dispersed in a metallic matrix. The presence of these graphite phases significantly influences the mechanical properties, including fatigue and fracture behavior.

Graphite Morphology: The morphology of graphite in cast iron, whether it's flake graphite or nodular graphite (also known as ductile iron), affects its fatigue and fracture properties. Nodular graphite tends to improve the ductility and toughness compared to flake graphite.

Matrix Structure: The metallic matrix in cast iron can vary in composition and structure, influencing its strength, ductility, and fatigue resistance. Pearlite, ferrite, and martensite are common matrix structures found in cast irons.

Material Composition: Alloying elements such as silicon, manganese, and nickel can be added to cast iron to enhance specific properties like strength, hardness, and fatigue resistance.

Fatigue Behavior: Cast irons typically exhibit a fatigue limit, below which they can endure an infinite number of stress cycles without failure. However, above this limit, the material experiences fatigue failure after a certain number of stress cycles, depending on the applied stress level and other factors.

Fracture Toughness: Fracture toughness is a measure of a material's resistance to crack propagation. The presence of graphite in cast iron can affect its fracture toughness, with nodular graphite generally providing better toughness compared to flake graphite.

Impact Resistance: Cast irons are often used in applications requiring high impact resistance. The microstructure, particularly the graphite morphology and matrix structure, plays a significant role in determining the material's ability to absorb energy during impact.

Heat Treatment: Heat treatment processes such as annealing, quenching, and tempering can be employed to modify the microstructure and improve the fatigue and fracture properties of cast irons.