

From Weld to Finish: The Role of Pickling and Passivation in Metal Integrity

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Abstract

Pickling and passivation are essential chemical processes used to treat metal surfaces, particularly stainless steel and high-performance alloys, to enhance corrosion resistance and ensure surface cleanliness. This presentation offers a comprehensive technical overview of the chemical mechanisms, formulations, and industrial relevance of these treatments. Pickling involves the removal of mill scale, oxides, and other surface contaminants using acid-based solutions, typically composed of nitric acid, hydrofluoric acid, or proprietary blends. Passivation, in contrast, is a non-destructive chemical process that restores and strengthens the protective chromium oxide layer on stainless steel surfaces, thereby improving their resistance to corrosion without altering the metal's physical properties.

These processes find widespread application across multiple industries. In the pharmaceutical sector, pickling and passivation are critical for maintaining sterile and contamination-free surfaces in stainless steel equipment, especially in grades such as SS 316L and SS 304. The food and beverage industry relies on these treatments to ensure hygienic conditions in processing lines, storage tanks, and piping systems. Aerospace applications demand high-performance surface integrity for components made from alloys like SS 321 and Duplex stainless steels, where fatigue resistance and corrosion protection are paramount. In the oil and gas industry, pickling and passivation are used to protect pipelines, valves, and offshore structures exposed to aggressive environments, often involving Super Duplex and high-nickel alloys. Power generation facilities utilize these treatments for turbine components, condensers, and heat exchangers to ensure long-term reliability and efficiency. Automotive and railway sectors also benefit from these processes to improve the durability and corrosion resistance of exhaust systems, structural parts, and underbody components.

The presentation further explores the compatibility of pickling and passivation chemicals with various grades of stainless steel and alloys, including SS 304, SS 316, SS 321, Duplex, Super Duplex, and nickel-based alloys. It emphasizes the importance of selecting appropriate chemical formulations based on the alloy composition, surface condition, and intended application. Environmental and safety considerations are also addressed, highlighting the industry's shift toward eco-friendly, biodegradable chemical alternatives and the need for compliance with international standards such as ASTM A967, ASTM B600, and EN ISO 16048. This technical session aims to equip professionals with the knowledge required to implement effective surface treatment strategies that ensure optimal performance, longevity, and regulatory compliance of metal components across diverse industrial sectors.

Keywords: Pickling, Passivation, Stainless Steel, Duplex Stainless Steel, Corrosion resistance, Surface treatment
