



Chapter 7

Effects of Corrosion in Aerospace Applications

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ABSTRACT

Corrosion processes can have a substantial impact on structural materials' integrity and are commonly related with aircraft aging. Corrosion in airplane structures can develop due to the variety of materials utilized, conditions, and stresses hitting the planes. As many airplanes are expected to remain in operation for decades, preventing and mitigating corrosion-related hazards is critical. Corrosion issues can result in costly repairs and downtime for aircraft, and there are worries about the safety of historical coatings and chemicals used to combat corrosion. This chapter describes a recent strategy for overcoming the corrosion effect in aircraft.

INTRODUCTION

In aerospace, where precision and reliability are of significant concern, corrosion stands as an unwavering foe, posing a constant threat to the structural soundness of aircraft, spacecraft, and the infrastructure supporting them. Whether it is the outer layers of spacecraft exposed to the unforgiving vacuum of space or the intricate components of aircraft facing challenges, corrosion presents a formidable hurdle with potentially catastrophic implications arising from various environmental influences. Aqueous electrolytes, such as sea spray during coastal flights or at low altitudes over the ocean, along with leaks from hydraulic oils, coolant fluids, or common spillages within the cabin (such as soup, coffee, or mineral

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water), contribute significantly to the corrosion-promoting factors. The presence of soluble salt contaminants further intensifies the risk, particularly when the relative humidity (RH) surpasses the deliquescence relative humidity (DRH) of the specific salt contamination. In the context of aircraft operation across different climate zones and altitudes, rapid fluctuations in temperature and RH expose them to condensation. When coupled with salts or other contaminants, this condensation can form a corrosive solution. This type of corrosion occurs when the electrolyte exists as a thin film or tiny droplets on the metal surface. The chapter embarks on an in-depth exploration of corrosion within the aerospace realm, delving into its materials, types, role of technology, development in corrosion with experimental setup and procedure for understanding atmospheric corrosion underlying its causes, strategies for identifying, mitigating and far-reaching consequences.

Aljibori et. al. (2023) carried a comprehensive review on advances in corrosion protection coatings techniques and methods. Bai et. al. (2023) conducted a review on applications of magnesium alloys for aerospace Industry. Brandoli et. al. (2021) analysed the aircraft fuselage corrosion detection using artificial intelligence. Bakan et. al. (2020) investigated on burner rig testing of environmental barrier coatings for aerospace applications. Chen et. al. (2024) studied the effects of tartaric acid on the structure and corrosion resistance for anodizing films of aerospace aluminium alloys.

LITERATURE REVIEW

Aircraft aluminium alloy 2024 T3, frequently utilized in aerospace applications, has been subject to comprehensive analysis concerning its corrosion behaviour. Investigates various aspects of corrosion, encompassing its initiation, progression, and impact on material properties. Additionally, it explores novel protection methods and compares them with conventional techniques. Exfoliation corrosion tests employing NaCl, KNO_3 , and HNO_3 have revealed the initiation of corrosion, progressing from pitting to intergranular and exfoliation corrosion. Metallographic features evolve with exposure time, leading to the degradation of strength and ductility properties. A comparative study investigates the effect of corrosion on carbon ion implanted 50Ni aerospace bearing steel, revealing superior corrosion resistance compared to untreated counterparts. The potentiodynamic polarization method analysis confirms the efficacy of carbon implantation in mitigating corrosion. Provides a comprehensive overview of conventional and advanced surface treatment methods employed to protect aluminium alloys from corrosion. These include chromate conversion coatings, rare-earth element-based coatings, and nanotechnology-associated approaches. Provides theoretical insights into corrosion mechanisms occurring in aircraft structures, focusing on the detrimental effects on material integrity and strength. Case studies of aircraft failures attributed to corrosion underscore the importance of corrosion mitigation strategies. The review encompasses recent advancements in corrosion science, engineering, and technology pertinent to the aeronautical industry. Studies on electrochemical noise analysis, chromate coating alternatives, and the corrosion behaviour of various alloys are discussed. Provides novel methodologies for automatic corrosion detection utilizing deep neural networks and graphene-based sensors. The method aims to enhance corrosion monitoring and maintenance practices in aircraft structures. Discuss recent corrosion protection developments, including

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