Corrosion and Wear Analysis of Aluminium 6082 Under Sodium Sulphate Environment

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Abstract

The present investigation focuses on the corrosion and wear behavior of Aluminium 6082 alloy under a sodium sulphate environment. Experimental work involved preparation of specimens, heat treatment, and immersion in a 0.5M Na_2SO_4 solution for various durations. Specimens were evaluated for corrosion effects through visual inspection and mechanical tests including impact, bending, and sliding wear tests. The results revealed that prolonged exposure increases corrosion severity and affects mechanical strength. Taguchi orthogonal array and ANOVA methods were used to analyze the parameters influencing wear rate. The study provides insights into the influence of sodium sulphate exposure and heat treatment on the degradation behavior of Aluminium 6082.

Keywords: Aluminium 6082; Sodium sulphate; Corrosion; Wear rate; Taguchi method; ANOVA

1. Introduction

Aluminium and its alloys are widely used in aerospace, marine, and structural applications due to their excellent strength-to-weight ratio, corrosion resistance, and formability. However, in aggressive environments such as sulphate-rich media, aluminium alloys undergo degradation, affecting surface integrity and mechanical performance. The Aluminium 6082 alloy, containing magnesium and silicon as primary alloying elements, is known for its good machinability and high tensile strength. This study aims to understand the combined effects of sodium sulphate environment and heat treatment on the corrosion and wear characteristics of Aluminium 6082.

2. Experimental Work

Experimental work involves preparation of specimens, heat treatment, and corrosion tests under sodium sulphate environments. Aluminium 6082 cylindrical specimens were machined to ASTM standards and subjected to various machining and polishing operations. Heat treatment included solutionizing at 200°C and 400°C followed by quenching and ageing processes. Corrosion testing was carried out by immersing specimens in a 0.5M sodium sulphate (Na_2SO_4) solution for 2, 4, and 6 days respectively. After immersion, corrosion behavior was visually analyzed. White patches and salt deposits appeared on specimen surfaces, indicating the formation of aluminium sulphates and oxides. Bending, impact, and wear tests were conducted on both corroded and age-hardened specimens to evaluate mechanical degradation. Wear behavior was analyzed using a pin-on-disc apparatus under varying load, speed, and distance conditions according to Taguchi L27 and L9 orthogonal arrays.

3. Results and Discussion

The specimens exposed to sodium sulphate solution showed progressive corrosion with increasing exposure duration. After 2 days, minor white corrosion patches appeared, while after 6 days, pitting corrosion and oxide scaling were prominent. Impact test results indicated a reduction in absorbed energy due to surface weakening. Bending tests revealed lower deflection values for corroded samples compared to non-corroded ones, confirming loss of ductility. Wear rate analysis demonstrated that load and sliding speed were significant parameters influencing wear rate, as confirmed by ANOVA results. Regression equations developed for predicting wear rate showed strong correlation with experimental data. Age hardening improved resistance against wear due to refined grain structure, but prolonged exposure to sodium sulphate reduced this advantage.

4. Conclusion

The experimental investigation demonstrated that Aluminium 6082 undergoes notable corrosion and wear degradation when exposed to sodium sulphate environments. The study concluded that heat treatment followed by ageing enhances wear resistance, but prolonged immersion increases corrosion susceptibility. Among wear parameters, load and speed were found to be most influential. Future studies should include microstructural and electrochemical analyses for deeper insight into corrosion mechanisms.

References

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