

Gasometric investigations on the corrosion of magnesium alloy in battery electrolytes

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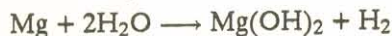
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Corrosion of magnesium alloy (AZ 31) has been studied in various battery electrolytes at different temperatures by gasometric technique. Results obtained throw light on the use of magnesium alloy as anode material in batteries.

Key words: Magnesium alloy (AZ 31), gasometric technique, corrosion, magnesium battery

INTRODUCTION

When magnesium is immersed in an electrolyte, hydrogen evolves in proportions corresponding to the metal dissolved as per the following reaction:



In the present investigation the corrosion of magnesium alloy in $\text{Mg}(\text{ClO}_4)_2$ and MgBr_2 electrolyte solutions of various concentrations (0.5 to 2.5M) and at various temperatures 303 to 318K is studied by gasometry.

EXPERIMENTAL

The design of the experimental set up and procedure are reported elsewhere [1]. Magnesium alloy plates of 9.14 cm^2 area weighing approximately 1.0 g were immersed in the experimental solution of 100 ml. In each experiment the volume of hydrogen evolved in the cell was measured at regular intervals of 20 minutes at constant temperature and at atmospheric pressure for a period of three hours. Subsequently magnesium alloy plate was removed from the cell and swilled with double distilled water and 3% sulphamic acid for three seconds and then washed with water, dried and immediately weighed. Weight loss by experiment and weight calculated from the volume of the gas collected were within an accuracy of 0-3% limit. Duplicate experiments were also made.

RESULTS AND DISCUSSION

Gas volume vs time

Gas evolution in $\text{Mg}(\text{ClO}_4)_2$ electrolyte increases with the increase of concentration as well as temperature. In all the concentrations, the gas evolution is more in first hour, and then it slows down to a limiting value in the next one hour. From these observations it can be concluded that in the initial stage, magnesium dissolution is followed by the formation of a film of $\text{Mg}(\text{OH})_2$ on the metal surface causing reduction in the rate of gas evolution [2]. The gas

evolution reaches a maximum at 303K in 1.5M solution. At higher and lower concentrations, gas evolution rate falls. At 303, 313, 318K the amount of gas evolved increases with the increase of concentration upto 2M, and after that, it shows a decreasing trend.

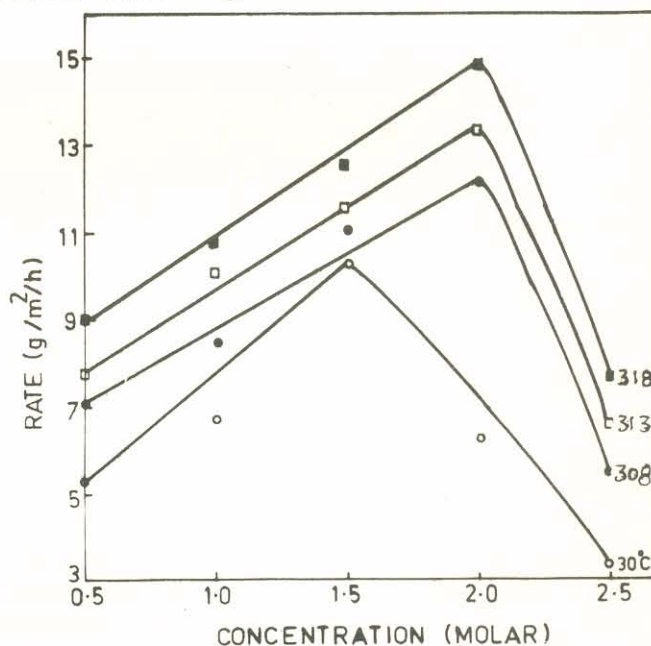


Fig. 1: Variation of rate of corrosion with concentration of $\text{Mg}(\text{ClO}_4)_2$ at different temperatures

The volume of gas evolved in the case of MgBr_2 solution is not similar to that in $\text{Mg}(\text{ClO}_4)_2$. In 0.5 and 2.5M solutions the volume of gas evolved increased with the increase of temperature upto 313K. Above 313K, it gets considerably reduced. In 1 and 2M solutions, gas evolution is maximum at 308K beyond which it is very much reduced. In 1.5M solution, the gas evolution rate decreases with the increase of temperature. At 303K, the gas evolution is maximum in 1.5M and above this concentration it falls due to the formation of passive film on the surface. At

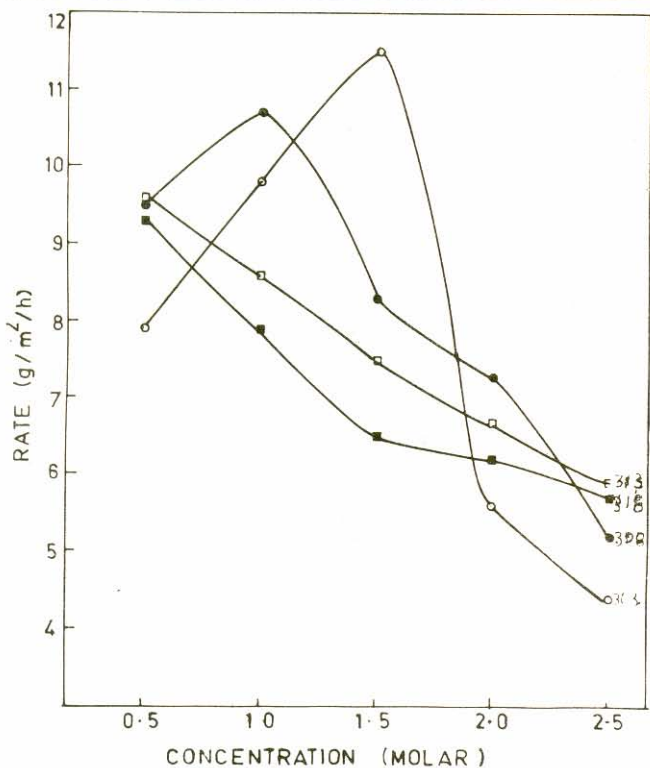


Fig. 2: Variation of rate of corrosion with concentration of $MgBr_2$ at different temperatures

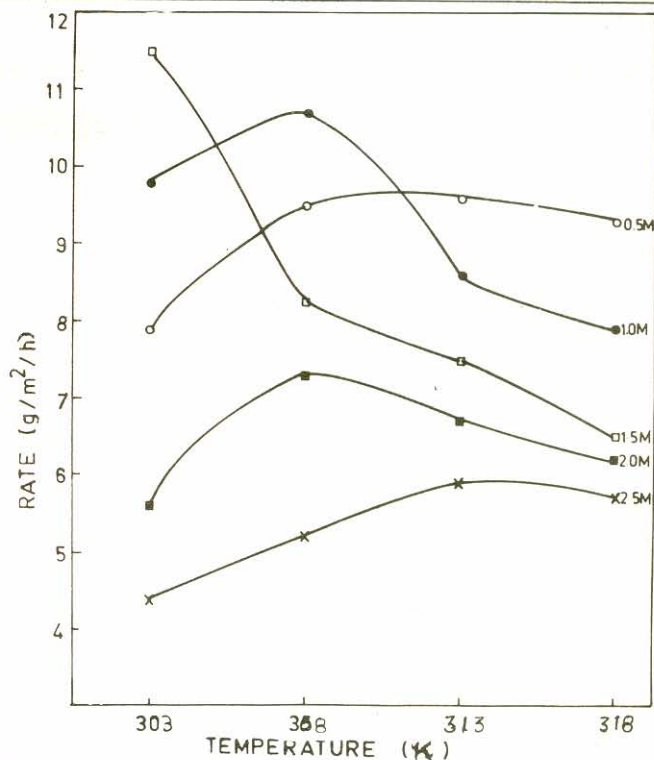


Fig. 4: Variation of rate of corrosion with temperature for different concentrations of $MgBr_2$

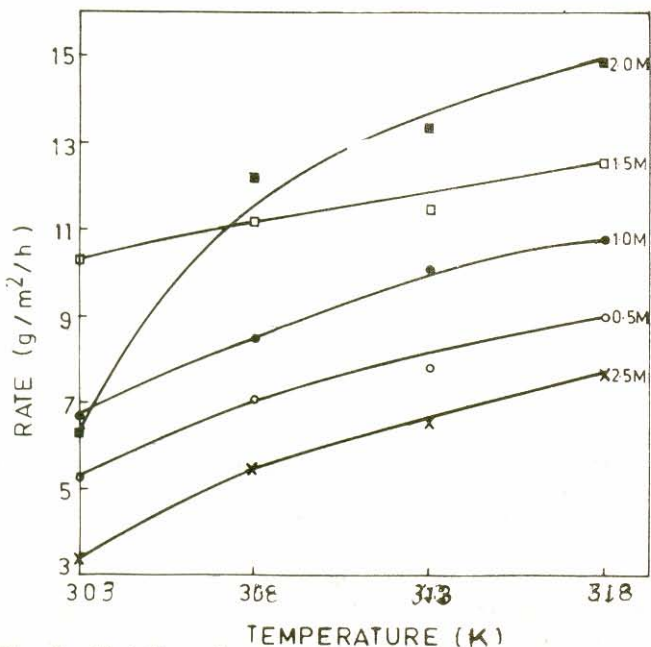


Fig. 3: Variation of rate of corrosion with temperature for different concentrations of $Mg(ClO_4)_2$

308K the volume of gas evolved attains a maximum value in 1.0M and at 313K and 318K the gas evolution decreases above 0.5M. At these temperatures the film growth on magnesium is faster with increasing concentration.

Corrosion rates

Corrosion rates ($g/m^2/hr$) are calculated from the total volume of gas evolved during the experiment. The rate vs concentration curves for $Mg(ClO_4)_2$ and $MgBr_2$ are shown in Figs. 1 and 2. In the case of $Mg(ClO_4)_2$ the corrosion rate increases with the increase of concentration and falls beyond a critical concentration of 2M. In the case of $MgBr_2$ the corrosion rate is not uniform with respect to concentration. The corrosion rates vs temperature for $Mg(ClO_4)_2$ and $MgBr_2$ electrolytes are plotted in Figs. 3 and 4. Corrosion rate increases with increase of temperature for $Mg(ClO_4)_2$. In the case of $MgBr_2$ solutions, the corrosion rates, are not uniform with respect to temperature.

CONCLUSION

The results indicate that $Mg(ClO_4)_2$ electrolyte is more suitable than $MgBr_2$ for high discharge rate magnesium batteries.

REFERENCES

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2. D A Vermilyea and C F Kirle, *J Electrochem Soc*, 116 (1969) 1487