Electrochemistry of hydrogen evolution and hydrogen permeation during corrosion of mild steel in different acids

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Based on systematic studies on the kinetics and thermodynamics, it is concluded that the best mode of comparison of the electrochemistry of hydrogen evolution and permeation during corrosion of mild steel in different acids is the common ionic strength.

Key words: Hydrogen evolution, permeation, mild steel corrosion

INTRODUCTION

G enerally corrosion rates of metals in acids are evaluated at a fixed concentration expressed in terms of normality or percentage or molarity. This comparison is objectionable since both cations and anions of these acids influence the kinetics and thermodynamics of the corrosion of metals in acids through the double layers [1–5]. Hence this study is undertaken.

EXPERIMENTAL

Corrosion rates of mild steel (C: 0.07%; P: 0.08%; Mn: 0.34%; and Fe: remainder) in different acids are determined by the weight loss, Tafel extrapolation and the hydrogen gas collection methods. The steady state hydrogen permeation current during corrosion is measured by the Devanathan- Stachurski technique [6]. Anodic and cathodic polarisation experiments are carried out for mild steel in all acids under galvanostatic conditions at constant temperature (313 ± 1 K). All solutions are prepared in conductivity water using A.R.grade chemicals.

RESULTS AND DISCUSSION

In all acids, mild steel is observed to follow the same order (Table I) namely $HCl > H_3PO_4 > H_2SO_4$, on the basis of hydrogen permeation current, hydrogen evolution rate and the corrosion rate obtained by the weight loss method and Tafel extrapolaion methods, at $\mu = 1$. At unit molarity, molality and normality of these acids, a lot of variations in the above order is observed. Kinetic parameters also confirm this observation.

CONCLUSION

It is concluded that the best comparison of the electrochemistry of hydrogen evolution and permeation

TABLE–I: Comparison of electrochemistry of mild steel in different acids

Sl. No.	Data on different phenomena—Temp 313K			
	Vol. of H_2 evolved (ml.cm^{-2} mt^{-1})	Corrosion rate (mg.cm^{-2} mt^{-1})	Hydrogen permeation (μA.cm^{-1})	Corrosion rate from kinetic parameters (mA.cm^{-2})
1. HCl				
1 μ	0.0096	0.4367	11.92	0.40
1 N	0.0096	0.4367	11.92	0.40
1 M	0.0096	0.4367	11.92	0.40
1 m	0.0033	0.1440	16.22	0.15
2. H_3PO_4				
1 μ	0.0063	0.2500	9.05	0.26
1 N	0.0056	0.2767	12.80	0.25
1 M	0.0072	0.3300	18.72	0.19
1 m	0.0079	0.3433	16.40	0.15
3. H_2SO_4				
1 μ	0.0040	0.1733	6.72	0.15
1 N	0.0043	0.1867	11.47	0.28
1 M	0.0073	0.2933	10.30	0.48
1 m	0.0082	0.3633	11.27	0.38

during corrosion of mild steel in HCl, H_3PO_4 and H_2SO_4 is to be made at a fixed ionic strength.

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