

A COMPARISON OF CORROSION RATES DETERMINED BY
POLARIZATION RESISTANCE MEASUREMENTS FOR ZINC AND
CADMIUM METAL IMMERSSED IN NONSTIRRED AQUEOUS PORTLAND CEMENT SOLUTION

BY

WILLIAM JAMES MOORE, JR.
B.S.E., Florida Technological University, 1973

THESIS

Submitted in partial fulfillment of the requirements
for the degree of Master of Science in Engineering
in the Graduate Studies Program of
Florida Technological University

Orlando, Florida
1975

156684

ACKNOWLEDGEMENT

I wish to express my personal thanks to the many people concerned with the completion of my Master's Degree and thesis.

Special thanks are extended to Dr. Vaniah H. Baldwin who, as my thesis director, gave his time to many helpful discussions and who has greatly contributed to my understanding and knowledge of corrosion engineering. Many thanks to the other members of the committee in charge; Drs. Ronald D. Evans, David R. Jenkins and William F. Smith, for their helpful advice and encouragement.

ABSTRACT

The effect of nonstirred aqueous portland cement solution on the corrosion rates of zinc and cadmium metal using Tafel extropolation and linear polarization measurements has been investigated.

Results indicate that for the corrosion systems under investigation, zinc metal has a higher corrosion potential and lower corrosion rate than cadmium metal.

TABLE OF CONTENTS

ACKNOWLEDGEMENT	i
ABSTRACT.	ii
TABLE OF CONTENTS	iii
LIST OF TABLES	vi
LIST OF ILLUSTRATIONS	vii
CHAPTER	
I. INTRODUCTION	1
II. RESEARCH OBJECTIVE	2
III. THEORY	3
Fundamentals of Polarization Measurements	3
Tafel Extrapolation Technique.	5
Linear Polarization Technique.	8
IV. LABORATORY APPARATUS	11
Polarization Cell.	11
Auxiliary Electrodes	13
Mercury-Mercuric Oxide Electrode	13
Platinum Electrode	15
Sample Electrodes.	15
Zinc	15
Cadmium.	15
Portland Cement.	21
Electrical Equipment	22

	Potentiostat/Galvanostat	22
	Electrometer	22
	Potentiometer	22
	Digital Multimeter	22
V.	EXPERIMENTAL PROCEDURE	24
	System Preparation	24
	Cells	24
	Electrolytes	24
	Calcium Hydroxide Solution	24
	Deaerated Cement Solution	24
	Aerated Cement Solution	25
	Aerated Cl^- Cement Solution	25
	Data Recording	25
VI.	TEST CONDITIONS	26
VII.	TEST RESULTS AND DISCUSSION	28
	Zinc in:	
	Calcium Hydroxide Solution	27
	Deaerated Cement Solution	27
	Aerated Cement Solution.	32
	Aerated Cl^- Cement Solution.	32
	Cadmium in:	
	Aerated Cement Solution	37
	Aerated Cl^- Cement Solution.	37
VIII.	CONCLUSIONS	44
IX.	RECOMMENDATIONS FOR FURTHER STUDY	45

FOOTNOTES 46

BIBLIOGRAPHY. 51

LIST OF TABLES

Table		Page
1.	Chemical Analysis of Samples Used	16
2.	Summary of Experimental Data.	43

LIST OF ILLUSTRATIONS

Figure	Page
1. Example of a Tafel plot	6
2. Example of a linear polarization curve	6
3. Diagram of a polarization cell.	12
4. Diagram of Sample and Platinum electrodes	14
5. Potential -pH equilibrium diagram for the system zinc-water at 25 °C	17
6. Potential -pH diagram for the system zinc-water free from CO ₂ at 25 °C	18
7. For solutions containing CO ₂	18
8. Influence of pH on the corrosion rate of zinc	18
9. Potential -pH equilibrium diagram for the system cadmium-water at 25 °C	19
10. Theoretical conditions of corrosion, immunity, and passivation of cadmium at 25 °C	20
11. Influence of pH on the corrosion rate of cadmium.	20
12. Schematic drawing of laboratory apparatus	23
13. Tafel plot of zinc in calcium hydroxide solution.	28
14. Linear polarization curve of zinc in calcium hydroxide solution	29
15. Tafel plot of zinc in deaerated cement solution	30
16. Linear polarization curve of zinc in deaerated cement solution.	31
17. Tafel plot of zinc in aerated cement solution	33
18. Linear polarization of zinc in aerated cement solution.	34
19. Tafel plot of zinc in aerated Cl ⁻ cement solution	35

20.	Linear polarization curve of zinc in aerated Cl^- cement solution	36
21.	Tafel plot of cadmium in aerated cement solution	38
22.	Linear polarization curve of cadmium in aerated cement solution	39
23.	Tafel plot of cadmium in aerated Cl^- cement solution	40
24.	Linear polarization curve of cadmium in aerated Cl^- cement solution	41

