

Principles of
Corrosion
Engineering
and Corrosion
Control

ZAKI AHMAD

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PRINCIPLES OF CORROSION ENGINEERING AND CORROSION CONTROL

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I dedicate this book to the memory of my most beloved son Intekhab Ahmad who breathed his last on April 20, 2004.



“We are from Almighty God and unto him we return”

Intekhab was the greatest driving force behind this book and may Almighty God rest his soul in peace and grant him the highest level in paradise.

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PREFACE

The phenomenon of corrosion is as old as the history of metals and it has been looked on as a menace which destroys metals and structures and turns beauty into a beast. Our human civilization cannot exist without metals and yet corrosion is their Achilles heel. Although familiarity with corrosion is ancient, it has been taken very passively by scientists and engineers in the past. Surprisingly, it is only during the last six decades that corrosion science has gradually evolved to a well-defined discipline. Corrosion Science and Engineering is now an integral part of engineering curriculum in leading universities throughout the world. With the rapid advances in materials in the new millennium, the demand for corrosion engineering courses has dramatically increased. This has necessitated the need for the publication of new books. Professor U. R. Evans, Prof. H. H. Uhlig and Prof. M. Fontana wrote a classical generation of basic text books covering the fundamentals of corrosion science and engineering. These books served as texts for decades and some of them are still being used. Several new books in corrosion have been published in recent years to cater to the needs of corrosion science and engineering students. As a teacher of corrosion engineering for the last twenty-five years, I found the material to be deficient in corrosion engineering content. However, sufficient coverage was given to the understanding of corrosion science. In this book, chapters on cathodic protection, materials selection, concrete corrosion and coatings have been written to cater to the needs of corrosion engineering students as well as corrosion engineers. These chapters contain simple and sufficient information to enable students to design corrosion preventive measures. A large number of illustrative problems are given in the chapter on cathodic protection to show how simple cathodic protective systems may be designed. The chapter

on material selection is devoted to an understanding of the art of selection of materials for corrosive environment and applying the knowledge of corrosion prevention – the objective of corrosion engineering students. Concrete corrosion is a global problem and of particular interest to civil, chemical and mechanical engineering students. The chapter on boiler corrosion would be of specific interest to corrosion engineering students and corrosion engineers who desire to refresh their knowledge of the fundamentals of boiler corrosion and water treatment. The chapter on concrete corrosion has been added in view of the global interest in concrete corrosion. It presents the mechanism of rebar corrosion, preventive measures and evaluation methods in a simplified form with eye-catching illustrations. And the unique feature of the book is the follow-up of each chapter by keywords, definitions, multiple-choice questions, conceptual questions and review questions. A solution manual will soon be available to students containing solutions of problems and answers to multiple-choice questions. These are intended to test the readers comprehension of the principles covered in the text. I have put all my lifetime teaching experience into writing this book for corrosion engineering students in the sophomore or junior year. Graduate students lacking background in corrosion will also benefit from the book. It is expected that the students would be able to understand the principles of corrosion science and engineering in a simple and logical manner and apply them for solutions to corrosion engineering problems. This book is written with a new approach and new philosophy and it is hoped that it will fulfill their aspirations. While writing this book, I passed through the most turbulent period of my life with the loss of my most beloved son Intekhab Ahmad who passed away suddenly on April 20, 2004 leaving

a sea of unending tears and sadness in my life. It was followed by my own sickness, operation and desertions of some of my closest ones. I am grateful to Almighty Allah that I passed through this traumatic period and am able to complete the book. The success of my efforts will depend

on how well this book is received by the students and the corrosion community. This book will not only be found very useful by corrosion engineering students but also by corrosion scientists and engineers in their problems in their professional capacity and those interested in corrosion.

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Leeds University, who inspired me to adopt corrosion as my career. I have been inspired by the works of Prof. Mars G. Fontana, R. N. Perkins, R. W. Staehle, P. A. Schweitzer, Prof. Ronald M. Latanision, Prof. A. Ashby and do not claim any originality of ideas. The author wishes to thank the numerous publishers, professional societies and corrosion consultants for granting permission for copyrighted photographs and figures. Special thanks to American Society of Metals (ASM), American Society of Testing and Materials (ASTM), National Association of Corrosion Engineers (NACE), British Corrosion Journal, British Standard Institute, John Wiley and Sons Inc., McGraw Hill, Chapman & Hall and others. I appreciate the cooperation of Corrintec, USA and Texaco, Houston Research Center and Sigma Paints Company for permission to use figures. I appreciate the moral support given by my sons Manzar Ahmad, Assistant Professor, SSUET, Karachi and Intessar Ahmad, University of Adelaide, Australia. Finally, I thank my creator, God the Almighty, who gave me the strength and patience to complete this book.

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