



FINAL YEAR PROJECT REPORT

BACHELOR ENGINEERING (HONS) IN MECHANICAL ENGINEERING

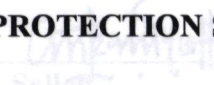
FACULTY OF MECHANICAL ENGINEERING

MARA UNIVERSITY OF TECHNOLOGY


SHAH ALAM

A report submitted to the Faculty of Mechanical Engineering, Mara University of Technology, in partial fulfillment of the requirements for the Bachelor Engineering (HONS) in Mechanical Engineering.

**CORROSION CONTROL AND DESIGN OF CATHODIC
PROTECTION SYSTEM FOR STEEL GAS PIPELINE**

Signed: 
Aziram B. Mat Salleh
UTM ID: 96298721

Date: 11/11/99


Signed: 
Rosdi B. Baharuddin
UTM ID: 96298792

BY

Date: 11/11/99

AZIRAM BIN MAT SALLEH

96298721


Approved: 
Dr. Mohamad Nor Bin Berhan
Project Advisor,
Faculty of Mechanical Engineering
Mara University of Technology
Shah Alam

Date: 16/11/99

ROSDI BIN BAHARUDDIN

96298792

PROJECT ADVISOR

Approved: 
Prof. Madya Ir. Dr. Shahrudin Bin Haji Yusoff
Dean,
Faculty of Mechanical Engineering
Mara University of Technology
Shah Alam

Date: 16/11/99

DR. MOHAMAD NOR BIN BERHAN

NOV 1999

ACKNOWLEDGEMENT

Assalamualaikum w.h.w.

“**Corrosion Control and Design of Cathodic Protection System for Steel Gas Pipeline**” project and report could not have been completed without the assistance and support of many individuals and organizations that we want to extend our sincere thanks and gratitude.

First of all, we would like to convey our thanks to our Project Advisor, Dr. Mohamad Nor Berhan for his concerned and valuable suggestions and advice in preparing the text has had a significant and positive impact on the quality of the report and for making this project successful. We wish to recognize the very helpful insights provided by colleagues at our respective university.

We are also grateful to Gas Malaysia Sdn. Bhd. for the use of their facilities and gathering the latest information related to the Corrosion Technology towards to the new millenium. Also Thanks to Gas Malaysia Personnel and their contractors for assistance, cooperation and information during our visit to site project, which is very helpful in completion, our project report.

Thanks to Mara University of Technology for give us an opportunity to continue our study in Part Time Basis and complete our degree in Mechanical Engineering program, also to all lecturer and staff of UiTM for their help and contributions.

Finally, we would like to thank our respectable parents for educating and supporting us and last but not least we wish to extent our deepest gratitude to our wife for their understanding, encouragement, patient and caring during our study for the past 3 ½ years to complete our studies in UiTM.

Wassalam.

TABLE OF CONTENTS

	Page
Preface	i
Acknowledgements.	ii
Table of Contents	iii
 CHAPTER 1 – INTRODUCTION	
1.1 Corrosion	1
1.2 Basic Corrosion Mechanism	7
1.3 Type Of Corrosion Cells on Pipeline	12
1.3.1 Dissimilar Metal Corrosion Cells	12
1.3.2 Corrosion Resulting From Dissimilar Soils	13
1.3.3 Differential Aeration Corrosion Cells	14
1.3.4 New Pipe and Old Pipe	14
1.3.5 Mill Scale Corrosion	15
1.4 Corrosion Reaction	23
1.15 Method of Corrosion Control	27
1.5.1 Design	27
1.5.2 Materials Selection	30
1.5.3 Coatings	31
1.5.4 Alter the Surrounding Environment	32
1.5.5 Cathodic Protection	33
1.5.6 Anodic Protection	33
1.5.7 Corrosion Inhibitors	34
 CHAPTER 2- THE PRINCIPLES OF CATHODIC PROTECTION	
2.1 Cathodic Protection	35

2.2	Process of Cathodic Protection	36
2.2.2	Operation	39
2.2.3	Properties of Metals	40
2.3	Criteria of Cathodic Protection	44

CHAPTER 3- DESIGN AND SPECIFICATION FOR CATHODIC PROTECTION

3.1	Factors To Be Considered	51
3.1.1	Soil Condition	53
3.1.2	Others	56
3.2	Design Requirement	57
3.2.1	Soil Resistivity Measurement Procedure	57
3.2.2	Primary Parameter	63
3.2.3	Current Requirements	67
3.2.4	Anode Requirement and Selection	71
3.2.5	For Impressed Current Ground Bed	74
3.2.6	Cathodic Protection Current Confinement	86
3.2.7	Special Consideration for Onshore Cathodic Protection	91

CHAPTER 4 – CASE STUDY: CATHODIC PROTECTION FOR BURIED STEEL PIPES

4.1	Design Basis	94
4.1.1	Pipe Details	94
4.1.2	Soil Resistivity Survey Detail	94
4.1.3	Cathodic Protection System Design	95
4.2	Material Specification	106
4.3	Installation and Construction Specification	109
4.3.1	General	109

INTRODUCTION

1.1 CORROSION

Corrosion can be defined as:

The deterioration or degradation of materials, usually metals, because of a reaction with the environment.

Corrosion has been classified in many different ways. One method recommended by Fontana is to divide corrosion into low-temperature and high-temperature corrosion. Another separates corrosion into direct combination (or oxidation) and electrochemical corrosion. The preferred classification here is (1) wet corrosion and (2) dry corrosion.

Wet corrosion occurs when a liquid is present. This usually involves aqueous solutions or electrolytes and accounts for the greatest amount of corrosion by far. A common example is corrosion of steel by water. Dry corrosion occurs in the absence of a liquid phase or above the dew point of the environment. Vapors and gases are usually the corrodents. Dry corrosion is most often associated with high temperatures. An example is attack on steel by furnace gases.

The presence of even small amounts of moisture could change the corrosion picture completely. For example, dry chlorine is practically noncorrosive to ordinary steel, but moist chlorine, or chlorine dissolved in water, is extremely corrosive and attacks most of the common metals and alloys. The reverse is true for titanium-dry chlorine gas is more corrosive than wet chlorine.