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FACULTY OF MANUFACTURING ENGINEERING

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THE EFFECT OF SIMULATED ACIDIC RAIN FOR NATURAL GAS / PETROLEUM PIPELINES.

Name : **MUHAMMAD JAMIL BIN JAMALUDIN**
Course : **BACHELOR OF MANUFACTURING ENGINEERING (ENGINEERING MATERIALS) WITH HONOURS**
Year / Semester : **4/2**
No. Matrix : **B050410152**
PSM Supervisor : **MR. MOHD. ASYADI 'AZAM BIN MOHD. ABID**
Organization Name : **UNIVERSITI TEKNIKAL MALAYSIA MELAKA (UTeM)**

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Cop Rasmi:
MOHD. ASYADI AZAM BIN MOHD. ABID
Pensyarah
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka
Karung Berkunci 1200, Ayer Keroh
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Tel : 06-233 2421, Faks : 06 233 2414
Email : fkp@kutkm.edu.my

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PENYELIA PSM
Pensyarah,
Fakulti Kejuruteraan Pembuatan

DECLARATION

I hereby declare that this report entitled **"THE EFFECT OF SIMULATED ACIDIC RAIN FOR NATURAL GAS / PETROLEUM PIPELINES."** is the result of my own research except as cited in the references.

Signature	:	
Author's Name	:	MUHAMMAD JAMIL BIN JAMALUDIN
Date	:	30/04/08

APPROVAL

This report is submitted to the Faculty of Manufacturing Engineering of UTeM as a partial fulfillment of the requirements for the degree of Bachelor of Manufacturing Engineering (Engineering Materials) with honours. The members of the supervisory committee are as follow:

(Main Supervisor: Mohd. Asyadi 'Azam bin Mohd. Abid)

(Official Stamp & Date)

MOHD. ASYADI `AZAM BIN MOHD. ABID
Pensyarah
Fakulti Kejuruteraan Pembuatan
Universiti Teknikal Malaysia Melaka
Karunq Berkunci 1200, Ayer Keroh
75450 Melaka

ABSTRACT

"The effect of simulated acidic rain for natural gas and petroleum pipeline", it is a final year project on the corrosion reaction of the pipelines materials due to the solution at high acidity of simulated acidic rain. The aim of this project is to discover the simulated acid rain effects to the pipeline material and the overcome solutions of the problem occur. The objectives of this project are to examine the initial stage of corrosion behavior for pipeline steel in artificial groundwater. The methods used for this project were archival collections, and books. Information regarding the effect of simulated acidic rain for natural gas and petroleum pipeline was gathered using the methods mentioned and was verified to affirm their authenticity. The articles of acid rain from the archival collections were analyzed to show the effects of the acid rain implication due to the pipeline material. The results revealed the criteria required for successful experimental observations as well as the simulated acid rain during the preparation simulating acid rain stage. From the analysis of the experiment, there was a data collection due to the pipeline material, simulation of acidic rain using the accurate compound and the experiment testing the material. Following the data analysis, a discussion was carried out to show the effects of simulated acid rain implementation to the pipeline material and the type of defects which occurred due to the appearance of the hazardous of this environmental effect of simulated acidic rain implementation by local researchers. The corrosion products were able to identify detailed and the corrosion rate that valued 3.428×10^{-3} mm per year was recorded from the potentiostat machine in the corrosion testing. This shows that there were tendencies of corrosion happened by exposed pipeline material to the effects by the simulated acid rain. So the conclusion had been made that the API 5L X65 Carbon Steel Pipeline was effected by the simulated acidic rain and has to be prevent by applying coating materials that suitable to the pipeline materials especially deals with anions of acid rain also periodic maintenances to have an initial prevention steps on the pipeline and quick also effective alternatives to protect and make long lasting life span of the pipeline material.

ABSTRAK

"Kesan hujan asid simulasi terhadap system perpaipan gas asli dan petroleum" merupakan tajuk Projek Sarjana Muda (PSM). Projek ini adalah suatu projek berkaitan dengan pengkajian terhadap pengaratan atau reaksi kakisan kepada bahan paip dengan kandungan hujan asid simulasi yang mengandungi tahap keasidan yang tinggi. Sasaran utama projek ini adalah mengkaji kesan hujan asid simulasi ke atas bahan paip carigali minyak dan cara mengatasinya. Objektif projek ini pula, struktur pembentukan kakisan atau pengaratan pada peringkat awal terhadap paip besi kesan air hujan asid diteliti. Kaedah-kaedah yang digunakan dalam projek ini adalah menerusi pengkoleksian ilmiah, yakni termasuklah juga buku-buku. Maklumat yang berkenaan adalah dikumpul dengan pengkaedahan yang tertentu berdasarkan bahan terbitan-terbitan yang tulen iaitu bahan rujukan kepada projek ini daripada badan yang bertanggungjawab tempatan dan antarabangsa. Sebagai contoh, rencana tentang hujan asid daripada pengkoleksian ilmiah adalah mengenai analisis kesan daripada hujan asid dan implikasi terhadap bahan paip. Keputusan kajian ini dengan spesifikasi tertentu bagi penyempurnaan kajian ini adalah melibatkan pemerhatian pengsimulasian hujan asid. Dari itu, data yang terkumpul adalah berhubungkait dengan pemerhatian terhadap bahan paip yang dipilih, hujan asid simulasi yang menggunakan unsur komposisinya dari kejadian semula jadi hujan dengan langkah-langkah eksperimen yang berkenaan. Satu perbincangan akan diterbitkan daripada eksperimen dan dijadikan data berguna pada kajian ini serta menunjukkan jenis kerosakan yang bakal berlaku di atas pencemaran daripada kesan hujan asid yang pernah dikaji oleh pengkaji-pengkaji tempatan. Produk-produk pengaratan telah dikenalpasti secara teliti dan kadar pengaratan yang diperolehi daripada mesin Potentiostat adalah sebanyak 3.428×10^{-3} mm setahun. Ini menunjukkan ada kebarangkalian yang kukuh bahawasanya pengaratan berlaku dengan pendedahan paip besi API 5L X65 terhadap hujan asid. Secara kesimpulannya, paip besi jenis ini perlu diberi penyalutan lapisan antikarat yang disebabkan oleh hujan asid serta perhatian dan pencegahan yang berkala ,pantas dan berkesan di samping dapat memanjangkan tempoh penggunaan paip tersebut.

DEDICATION

This thesis is dedicated to all students who are taking of Bachelor (Hons) in Manufacturing Engineering majoring in Material Engineering batch 2005-2008 University Technical Malaysia Melaka (UTeM) that this group of pupil was the first or pioneer in this engineering course.

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LIST OF ABBREVIATIONS, SYMBOLS, SPECIALIZED NOMENCLATURE

AAGR	-Average annual growth rate
ABARE	-Australian Bureau of Agricultural and Resource Economic
ASCOPE	-ASEAN Council on Petroleum
ASEAN	-Association of Southeast Asian Nations
ASTM	-American of standard for testing material
API	-American Petroleum Institute
BCF	-Billion cubic feet
BCM	-Billion cubic meters
BCMY	-Billion cubic meters per year
BSM	-Brunei Shell Marketing Sendirian Berhad
BSP	-Brunei Shell Petroleum Sendirian Berhad
BST	-Brunei Shell Tankers Sendirian Berhad
CEERD	-Centre for Energy-Environment Research and Development, Asian Institute of Technology
CH_4	-Methane
CO_2	-Carbon dioxide
DOE	-Department of Energy
ECA	-Energy Conversion Agreement
EDMC	-Energy Data and Modeling Centre, Japan
EFS	-Environmentally Friendly Scenario
EIA	-Energy Information Administration, USA
EWG	-Energy Working Group
GDP	-Gross domestic product
GHG	-Greenhouse gas
GMSB	-Gas Malaysia Sendirian Berhad
GPP	-Gas processing plant
GSP	-Gas separation plant
HAPUA	-Heads of ASEAN Power Utilities/Authorities
IEA	-International Energy Agency

JDA	-Joint Development Authority (Malaysia – Thailand)
KBD	-Kilo barrels per day
KL	-Kuala Lumpur
Km	-Kilometer
Ktoe	-Kilo-tonnes of oil equivalent
LA	-Loan agreement
LNG	-Liquefied natural gas
LPG	-Liquefied petroleum gas
MBOE	-Million barrels of oil equivalent
MEPE	-Myanmar Electricity Power Enterprise
MERALCO	-Manila Electric Company, Philippines
MMBTU	-Million metric British thermal units
MMCM	-Million metric cubic meters
MMCMD	-Million metric cubic meters per day
MMCMY	-Million metric cubic meters per year
MODB	-Ministry of Development, Brunei Darussalam
MTBE	-Methyl-tertiary-butyl-ethylene
MTJA	-Malaysia-Thailand Joint Authority
Mtoe	-Million tonnes of oil equivalent
MW	-Megawatts (= 1,000 kilowatts)
NACE	-National Association of Corrosion Engineers
NECB	-National Energy Coordinating Board, Indonesia
N_2O	-Nitrous oxide
NEPC	-National Energy Policy Council, Thailand
NEPO	-National Energy Policy Office, Thailand
NG	-Natural gas
NGCC	-Natural gas combined cycle
NGV	-Natural gas vehicle
NOCs	-National oil companies
NOGCs	-National oil and gas companies
NO_X	-Nitrogen oxides
NPC	-National Power Company, Philippines
NRE	-New and renewable energy
OCA	-Overlapping Claims Area (Cambodia - Thailand)

ODA	-Overseas Development Agency, Japan
OPEC	-Organization of Petroleum Exporting Countries
PCSB	
PETRONAS	-Carigali Sendirian Berhad, Malaysia
PERTAMINA	-National Petroleum Company of Indonesia
PETRONAS	-National Petroleum Company of Malaysia
PGN	-Perum Gas Negara Ltd, Indonesia
PGU	-Peninsular Gas Utilization
PLN	-Perusahaan Listrik Negara, Indonesia
PNG	-Pipeline natural gas
PNOC	-Philippines National Oil Company
PNOC	-EC-Philippines National Oil Company-Exploration Corporation
PPA	-Power purchase agreement
PSC	-Production sharing contract
PSC	-Protracted Crisis Scenario
PTT	-Petroleum Authority of Thailand
PUB	-Public Utility Board, Singapore
SAR	-Simulated Acidic Rain
SESB	-Sabah Electricity Sendirian Berhad, Malaysia
SESCO	-Sarawak Electricity Supply Company, Malaysia
SO_X	-Sulphur oxides
TAC	-Technical assistance contract
TCF	-Trillion cubic feet
TNB	-Tenaga Nasional Berhad, Malaysia
Toe	-Tonne of oil equivalent
TAGP	-Trans ASEAN Gas Pipeline
TPA	-Third-party access
TPEC	-Total primary energy consumption
TTM	-Trans-Thailand Malaysia
US	-United States (of America)

CHAPTER 1
INTRODUCTION

1.1 Background

Recently, energy problems have become the most important issues to be discussed in the whole world. Natural gas which is one of the main sources in the earth is mainly consumes widely from the world requirement is transported from gas field that made the pipeline is needed. Pipeline steel not just being damages by the earth crust vacillation and corrosion, but also suffered from the corrosion caused by anions cumulated from the acidic rain naturally. Acid rain is a problem of increasing agricultural, environmental, and the ecological concerns worldwide. This study investigated impacts of simulated acid rain (SAR) on the natural gas and petroleum pipelines. In addition, impacts of the SAR on cation leaching depended not only on the SAR pH but also on the original soil pH. Also called acid precipitation or acid deposition, acid rain is precipitation containing harmful amounts of nitric and sulphuric acids formed primarily by nitrogen oxides and sulphur oxides released into the atmosphere when fossil fuels are burned. It can be wet precipitation (rain, snow, or fog) or dry precipitation (absorbed gaseous and particulate matter, aerosol particles or dust). Acid rain has a pH below 5.6. Normal rain has a pH of about 5.6, which is slightly acidic. So, this investigation is conducted in Malaysia in order to get the new observation on local environmental and the technical of the pipelines effects due to the corresponding problems that will be faced later on. Basically in this final year project report, it covers "Projek Sarjana Muda 1 (PSM 1)" and "Projek Sarjana Muda 2 (PSM 2)" with code of subject (BMFG 4913), it is mainly covered six

parts. For additional information, PSM 1 consists of 3 early chapters which are chapter 1, 2 and 3 while for PSM 2 includes chapter 4, 5, and 6. Chapter 1 is about introduces the problem, problem statement, main objective of the project and also the scope of the project. In the Chapter 2, it will cover the Literature Reviews of the project and the methods used. Next chapter will be Chapter 3 that consists of the methodology of the project. Chapters 4 will be covering the results; chapter 5 is the discussion, suggestion; and chapter 6 summary and conclusion.

1.2 Problem Statement of the project

Currently, energy crisis has become such an essential topic to be talk about. Natural gas is primarily transported from gas field that made the pipeline so important in the industry of petrochemical transportations. Pipeline steel not just received damages by earth shell variation and corrosion, but also suffered from the corrosion caused by anions came from acidic rain. In this study, early stage of corrosion behavior for pipeline steel in artificial groundwater will be examined. The analysis will use anodic polarization measurement with Potentiostat and observation analysis through Scanning Electron Microscope (SEM). By using this system, formation and dissolution process of corrosion product in simulated acidic rain could be examined. The acid rain had been such tremendous disaster to the world in terms of the damages to the nature of forest, mankind health, even tough to the non-living things like the materials. In this case, pipelines also expose to the unlimited acid rain everyday. This system transportation consider as major system to take care of the natural gas and petroleum distribution all around the world. Imagine if the pipeline did not been take care of, the world will face a global problem due to energy consumption decreases. The natural resources will no longer been extruded from the well systematically and distributed it to the plants and also to the delivery sections to the customers in the end. There is no particular easy and express way to determine the corrosion defects to the pipeline of the petrochemical fields especially due to the pH influences from the acid rain which not really studied the

effects in this country. So, the pipeline will be continued used until certain time it will burst and covered a lot of damages and costs. In local, this kind of difficulties might not be serious but in future it might cause a number of lost to the country like Malaysia who rely on the fully subsidiary resources from the petrochemical company. So never underestimate the power of mass destructions of the small factors that will end up a big disaster to the humankind in here after.

1.3 Objectives

The objectives of this project research are:-

1) To examined initial stage of corrosion behavior for pipeline steel in artificial groundwater which is the simulated acidic rain.
2) To make analysis using anodic polarization measurement with Potentiostat and observation analysis through Scanning Electron Microscope (SEM) in order to detect the formation and dissolution process of corrosion product in simulated acidic rain.
3) To observe the phenomena occurred and the change in the oxide film thickness of effected pipeline due to the simulated acidic rain.

1.4 Scope

In order to understand the workings of the acid rain, it is necessary to explain the theory, effects especially negative effects which are important in any environment around us. The definition will be put out in brief and will include various diagrams for better understanding. This scientific study will conducted in the Material Laboratory of Manufacturing Faculty, Universiti Tun Hussein Onn Malaysia (UTHM) and Petronas Scientific Research Centre (PRSS) in Malaysia. The preparation of the simulated acid rain will be focus just on the solution of dilute sulphur dioxide (SO_x) plus dilute nitrogen

dioxide (NO_x) only with different concentrations and pH as the environmental solution for the related material testing and at the same time the selection of materials types of the pipelines is according to the most used in the researches among the petrochemical industry. Although that, the predictions and assumptions will be discussed between the supervisor to ensure the hypothesis about the problems raised will be accurately identified and came up the better solutions. Overall the main job scope for this final year project is to understand the title needs, take initial plan to engage with materials selection, studies the behavior of the simulated acid rain which accumulated for certain time period which give such impact to the pipelines of natural gas and also the petroleum as well.