



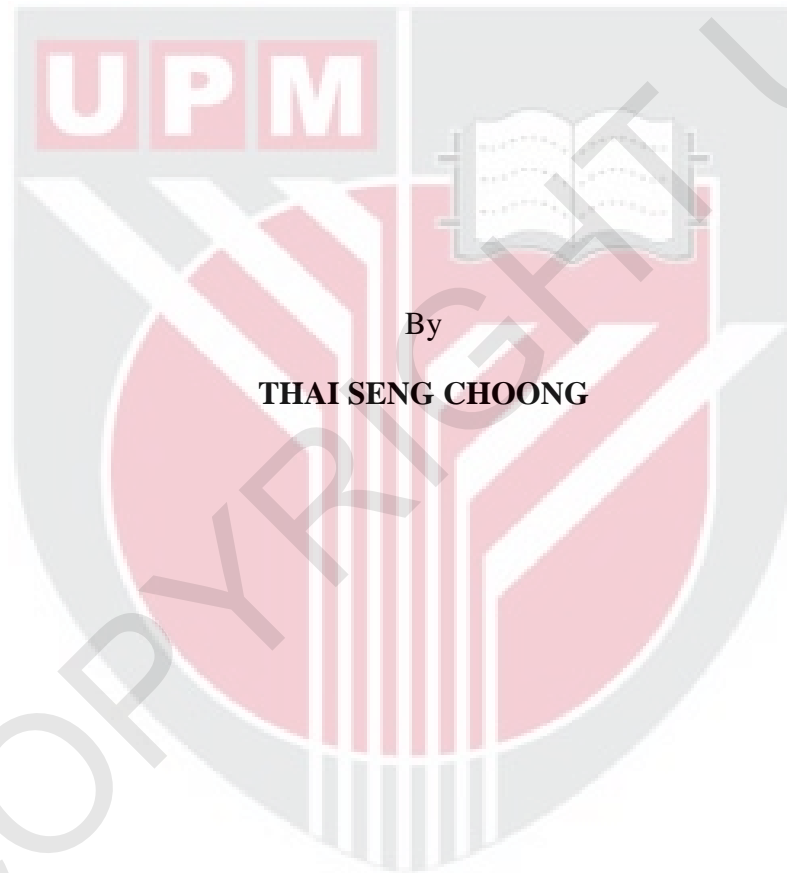
UNIVERSITI PUTRA MALAYSIA
MONITORING CATHODIC PROTECTION SYSTEM FOR
UNDERGROUND PIPELINE

THAI SENG CHOONG

FK 2013 57



**MONITORING CATHODIC PROTECTION SYSTEM FOR
UNDERGROUND PIPELINE**



By

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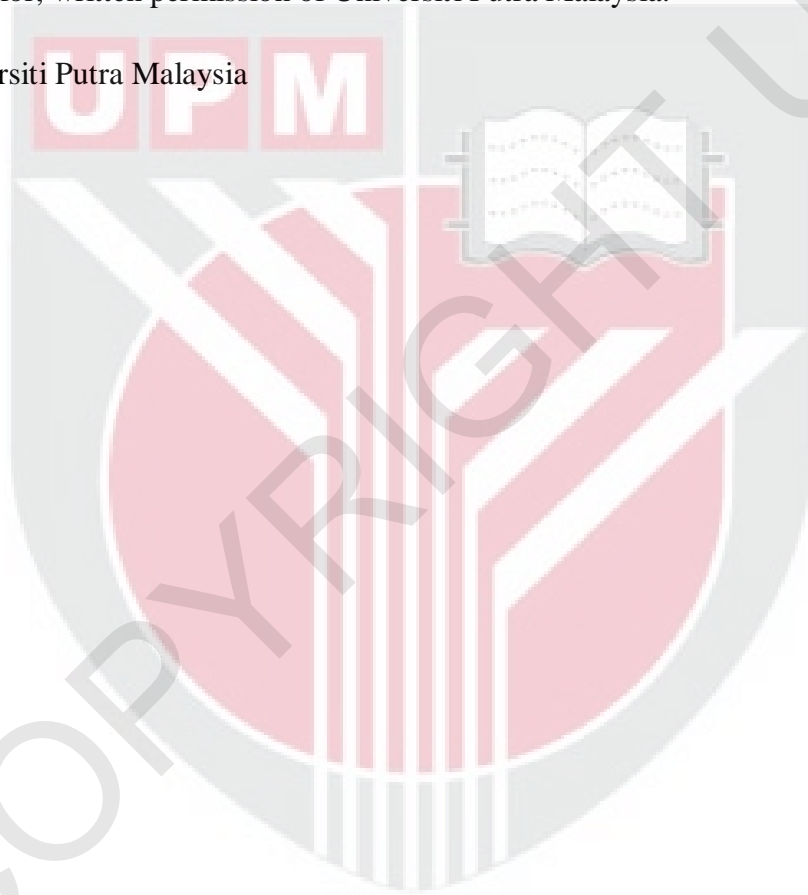
**Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia,
in Fulfillment of the Requirement for the Degree of Master Science**

July 2013

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DEDICATION

**TO MY BELOVED - WIFE WONG PEI LING, MY BELOVED DAUGHTER -
JOSEBELLE THAI YEE XUEN, MY BELOVED PARENTS AND MY
FAMILY.**



Abstract of thesis presented to Senate of Universiti Putra Malaysia in fulfillment of the requirements for the degree of Master of Science

MONITORING CATHODIC PROTECTION SYSTEM FOR UNDERGROUND PIPELINE

By

THAI SENG CHOONG

July 2013

Chairman: Professor Ishak b. Aris, PhD

Faculty: Engineering

The world we live in today is greatly affected by corrosion issues and therefore multiple methods of continuous monitoring of a structure can help investigate the corrosion process. Till today, engineers have found that Cathodic Protection is one of the most reliable solutions to overcome corrosion problems. The principle of cathodic protection is a process of placing an external anode to the metal of the pipe in order for its metal surface to become cathodic and thus preventing corrosion. The most common cathodic protection technique used is sacrificial or impressed current method. Sacrificial method is normally used in smaller scale protection and impressed current method is suitable in a dynamic environment or larger scale of protection. In an impressed current method, a DC power source from a rectifier power is required to maintain the drain point voltage within a specific range so the electrons can flow from the buried anode to the cathode. However, there are many malfunctions in the cathodic protection especially in the remote areas had remained undetected until the structure that was supposed to be protected corrodes and leaks. In this research, a software algorithm is created to be able to sense the readings of

drain point, shunt current, transformer rectifier voltage, temperature, humidity and to response to multiple levels of CP malfunctions using interactive graphical method and mapping system. A multiple platform of remote data communication was proposed to improve the current CP monitoring system.

A brief study on Petronas underground gas pipeline system was made to help understand the current technology used in monitoring CP and to analyze the problem faced by the current CP monitoring system. As the world is emerging into mobile technology, an innovative plan was made to combine traditional monitoring system into smart phones mobile application. An electronic prototype were designed, fabricated and tested to monitor the pipelines drain point voltage, transformer rectifier voltage, shunt current, humidity and temperature using a local server system whereby all the data collected are stored on a local storage before synchronizing to the internet's web server database using the cloud system.

In the software development, a mobile application was implemented on an Android platform to enable mobile users to view and monitor the cathodic protection seamlessly from anywhere around the world. A local server running on windows platform was used to capture and display the readings on graph. The local server uses push emails and short message service (SMS) to alert to the user whenever there is a malfunction detected. The test results indicated that the proposed system is able to reduce the overall operating cost, increase service productivity in maintaining the system and reduce the need for manpower. Furthermore, the integration with a smart phone device is considered to be more user friendly, increase data portability and easy to access using various platform.

Abstrak thesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Master Sains

**MEMANTAU SISTEM PERLINDUNGAN KATODIK TALIAN PAIP
BAWAH TANAH**

Oleh

THAI SENG CHOONG

Julai 2013

Pengerusi: Professor. Ishak b. Aris, PhD

Fakulti: Kejuruteraan

Dunia yang kita hidup pada hari ini amat dipengaruhi oleh isu-isu hakisan dan tidak syak lagi seseorang boleh mengatakan bahawa puncanya disebabkan oleh alam sekitar. Sehingga hari ini, jurutera telah mendapati bahawa perlindungan katod adalah salah satu penyelesaian yang paling boleh dipercayai untuk mengatasi masalah hakisan. Prinsip perlindungan katod adalah satu proses meletakkan anod luaran kepada logam paip dalam usaha untuk permukaan logam menjadi katod dan sekaligus mencegah hakisan. Teknik perlindungan katod yang paling biasa digunakan adalah korban atau kaedah arus tertekan. Kaedah korban biasanya digunakan dalam perlindungan skala yang lebih kecil manakala kaedah arus tertekan sesuai digunakan di dalam persekitaran yang dinamik atau skala perlindungan yang lebih besar. Dalam kaedah arus tertekan, sumber kuasa DC dari penerus kuasa diperlukan untuk mengekalkan voltan titik saliran dalam julat yang tertentu bagi menghasilkan aliran electron dari anod yang dikebumikan ke katod. Walau bagaimanapun, terdapat banyak kerosakan berlaku dalam perlindungan katod terutama di kawasan pedalaman di mana struktur yang sepatutnya dilindungi mengalami pengurangan dan kebocoran. Dalam kajian ini, kaedah pemantauan

perlindungan katod dalam sistem talian paip gas bawah tanah dan beberapa kemajuan kepada sistem semasa telah dikaji semula.

Satu kajian ringkas mengenai sistem talian paip gas Petronas bawah tanah telah dibuat untuk membantu memahami teknologi semasa yang digunakan dalam memantau perlindungan katod dan kaedah yang digunakan untuk memberi amaran kepada pengguna jika berlaku kerosakan. Satu prototaip elektronik telah direkacipta, difabrikasi dan diuji untuk memantau voltan titik saliran paip, penguat voltan penerus, arus selari, kelembapan dan suhu menggunakan satu sistem pelayan tempatan di mana semua data yang dikumpulkan akan disimpan pada tempat simpanan tempatan sebelum diselaraskan kepada rangkaian pangkalan data menggunakan sistem awan di internet. Satu aplikasi mudah alih telah dilaksanakan pada platform Android bagi membolehkan pengguna telefon bimbit untuk melihat dan memantau perlindungan katod secara terus menerus dari mana-mana sahaja di seluruh dunia.

Dalam pembangunan perisian, pelayan tempatan digunakan pada platform windows digunakan bagi merakam dan memaparkan bacaan pada graf. Pelayan tempatan menggunakan tolakan e-mel dan khidmat pesanan ringkas (sms) untuk memberi amaran kepada pengguna apabila terdapat kerosakan yang dikesan. Keputusan ujian menunjukkan bahawa sistem yang dicadangkan berjaya mengurangkan kos operasi, meningkatkan pengeluaran perkhimatan di dalam penyelenggaraan sistem dan megurangkan keperluan tenaga pekerja. Seterusnya pengabungan dengan telefon pintar mudah alih didapati lebih mesra pengguna, data dan pengeluaran mudah dicapai melalui pelbagai platform.

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I certify that a Thesis Examination Committee has met on 03 July 2013 to conduct the final examination of Thai Seng Choong on his thesis entitled “Monitoring Cathodic Protection System on Underground Pipeline” in accordance with Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the Degree of Master Science.

Members of the Examination Committee are as follows:

Norhisam bin Misron , PhD

Associate Professor

Faculty of Engineering

Universiti Putra Malaysia

(Chairman)

Suhaidi bin Shafie, PhD

Senior Lecturer

Faculty of Engineering

Universiti Putra Malaysia

(Internal Examiner)

Wan Zuha bin Wan Hasan, PhD

Senior Lecturer

Faculty of Engineering

Universiti Putra Malaysia

(Internal Examiner)

Mohd Rizal bin Arshad , PhD

Associate Professor

Faculty of Engineering

Universiti Sains Malaysia

(External Examiner)



NORITAH OMAR, PhD

Associate Professor and Deputy Dean

School of Graduate Studies

Universiti Putra Malaysia

Date: 19 September 2013

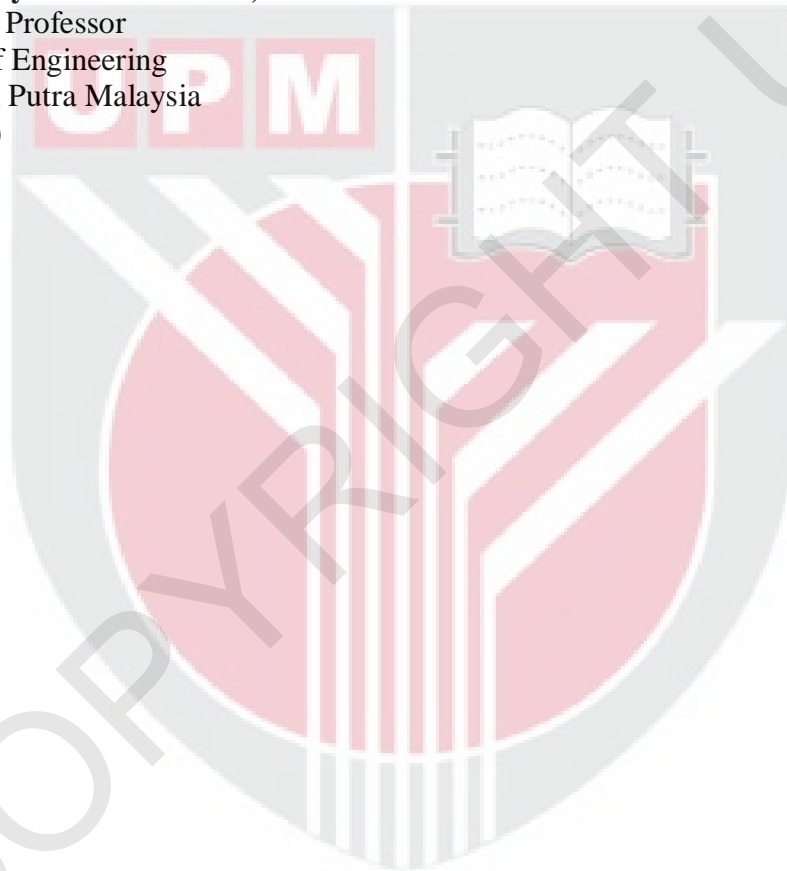
This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the degree of Master Science. The members of Supervisory Committee were as follows:

Ishak bin Aris, PhD

Professor
Faculty of Engineering
Universiti Putra Malaysia
(Chairman)

Tinia Idaty bt Mohd. Ghazi, PhD

Associate Professor
Faculty of Engineering
Universiti Putra Malaysia
(Member)



BUJANG BIN KIM HUAT, PhD

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DECLARATION

Declaration by graduate student

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