INTERNAL SURFACE PIPE ROUGHNESS CLASSIFICATION USING HIGH FREQUENCY ACOUSTIC EVALUATION

AMAR REZA BIN MOHAMMAD FIRDAUS

BACHELOR OF ENGINEERING

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INTERNAL SURFACE PIPE ROUGHNESS CLASSIFICATION USING HIGH FREQUENCY ACOUSTIC EVALUATION

AMAR REZA BIN MOHAMMAD FIRDAUS

Report submitted in partial fulfillment of the requirements
for the award of the degree of
Bachelor of Mechanical Engineering

Faculty of Mechanical Engineering
UNIVERSITI MALAYSIA PAHANG

DECEMBER 2010

SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project and in my opinion, this project is adequate in terms of scope and quality for the award of the degree of Bachelor of Mechanical Engineering.

Signature :
Name of Supervisor : MOHD HAFIZI BIN ZOHARI
Position : LECTURER
Date :

STUDENT'S DECLARATION

I hereby declare that the work in this project is my own except for quotations and summaries which have been duly acknowledged. The project has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature :
Name : AMAR REZA BIN MOHAMMAD FIRDAUS
ID Number : MA08003
Date :

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LIST OF SYMBOLS

A	Cross sectional area
AB	Bangi number
A_{high}	RMS value at the high flow rate (low pressure)
A_{low}	RMS value at the low flow rate (high pressure)
D	Diameter
f	Friction factor
g	Gravity acceleration
h_L	Head loss
L	Length
l	Evaluation length
R_a	Roughness average
Re	Reynolds number
R_z	Mean roughness depth
R_{zi}	Single roughness depths
T	Duration
V	Flow velocity
V_{avg}	Average velocity
V_{RMS}	RMS value
$V(t)$	Voltage
Q	Volume flow rate
Z(x)	Profile ordinates of the roughness profile
ε	Roughness
μ	Dynamic viscosity

ρ	Fluid density
ΔP_L	Pressure drop
^{o}F	Degree Fahrenheit
<	Below than
>	Above than

LIST OF ABBREVIATIONS

ac	Alternating current
ADC	Analog to digital converter
AE	Acoustic emission
AED	Acoustic emission detector
Avg	Average
cm	Centimeters
dB	Decibels
eg	Example
Eq	Equation
etc	Etcetera
FYP	Final year project
HF	High frequency
Hz	Hertz
k	Kilo
kg	Kilogram
LF	Low frequency
M	Mega
m	Meters
mm	Millimeters
N	Newton
NDT	Nondestructive techniques
PC	Personal computer
RMS	Root mean square

s	Second
V	Volt
μm	Micrometers

ABSTRACT

This project was carried out using the method of acoustic emission analysis to distinguish the internal surface roughness of the pipe. Internal roughness of the pipe is referred to the level of corrosion occurring, where normally it is difficult to be monitored online. Acoustic Emission (AE) technique can be used as an alternative solution to the corrosion monitoring in pipes, especially for complex pipelines and difficult to achieve by other monitoring devices. The objective of this project is to study the AE signals emitted from internal surface pipe and to classify the internal surface pipe roughness using Bangi Number, AB. This study used the hydraulic bench to provide fluid flow at four different pressures in pipes with different internal surface roughness (rough and smooth). The main source of acoustic emission was from activity in the control valve, coupled with high pressure water flow friction in the inner surface of the pipe. The signal from these sources was detected by using the AED-2000V instrument and assisted by the Acoustic Emission Detector (AED) software. The time domain parameter; root mean square, RMS amplitude was processed and compared at different pressures for each type of internal pipe roughness at ten different locations. Based on the RMS values, Bangi Number was derived and can be used for discriminating level of internal surface pipe roughness. Internal surface pipe can still be considered as smooth if AB value is above than 1.0. Meanwhile if AB value is below than 1.0, the inner surface pipe is in rough condition. As conclusion, the acoustic emission technique offers great opportunity for new approaches in monitoring the pipe and it can be used to classify the internal surface pipe roughness.

ABSTRAK

Projek ini dijalankan dengan menggunakan kaedah analisis pancaran akustik untuk membezakan kekasaran permukaan dalaman paip. Kekasaran dalaman paip dijelaskan sebagai tahap kakisan yang berlaku, di mana kebiasaanya sukar untuk dipantau. Teknik pancaran akustik (AE) boleh digunakan sebagai penyelesaian alternatif untuk pemantauan kakisan dalaman paip, terutama untuk paip yang kompleks dan sukar untuk dipantau oleh alat pemantauan lain. Objektif projek ini adalah untuk menyelidik isyarat akustik yang dipancarkan dari permukaan dalaman paip dan juga untuk mengklasifikasikan kekasaran permukaan dalaman paip menggunakan nombor Bangi, AB. Penyelidikan ini menggunakan meja kerja hidrolik untuk mengalirkan empat tekanan air yang berbeza ke dalam paip yang mempunyai permukaan dalaman yang berbeza (kasar dan licin). Punca utama pancaran akustik berasal daripada aktiviti di injap kawalan, ditambah dengan geseran aliran tekanan air yang tinggi pada permukaan dalaman paip. Isyarat yang terpancar daripada punca tersebut dikesan dengan menggunakan alat AED-2000V dan dibantu oleh perisian Acoustic Emission Dectector (AED). Parameter “root mean square”, RMS amplitud diproses dan dibandingkan pada tekanan yang berbeza untuk setiap jenis kekasaran dalaman paip di sepuluh lokasi yang berbeza. Berdasarkan daripada nilai-nilai RMS, nombor Bangi dapat diperoleh dan digunakan untuk membezakan tahap kekasaran permukaan dalaman paip. Permukaan dalaman paip masih boleh dianggap licin sekiranya nilai AB adalah lebih tinggi daripada 1.0. Manakala jika nilai AB lebih rendah daripada 1.0, maka permukaan dalaman paip itu berada dalam keadaan kasar. Sebagai kesimpulan, teknik pancaran akustik menawarkan peluang besar bagi pendekatan baru dalam pemantauan paip dan boleh digunakan untuk mengklasifikasikan kekasaran permukaan dalaman paip.

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Pipes are used widely in our domestic and industries. Pipes is the most important part in human life because piping system is a mechanism of delivering or transporting a fluid (liquid or gas), mixture of fluids and other from one location to another. It will give the basic of human need, such as for drink, cooking, cleaning and others. The term pipe is defined as a closed conduit, usually of circular cross section. It can be made of any appropriate material such as steel or plastic. The term pipeline refers to a long line of connected segments of pipe, with pumps, valves, control devices, and other equipment needed for operating the system (Lui, 2003).

Pipes that used must always need to monitor in order to determined damage to the pipe and its associated equipment, maximize the efficiency and safety of the pipeline, minimize potential accidents, and safeguard company and public interests (Lui, 2003). There have many researches about to monitoring the condition of the piping system. Normally of the company will mark on the nondestructive technique (NDT) because it has many advantages of saving time and easier to inspection.

For this study, the acoustic emission (AE) technique was used to monitor the internal pipe surface roughness. The surface roughness commonly refers to the level of rust or corrosion that occurs inside the pipe. Internal pipe corrosion normally difficult to be detected online especially when it involved a large, complex shape and long piping system. In some of the oil and gas companies, scanning for corrosion need to be done offline, therefore affect the profits. The Acoustic Emission method; one of the most

recent nondestructive techniques (NDT), offers a very good alternative of online internal surface pipe monitoring. This high frequency acoustic application was widely used as a tool for condition monitoring in various engineering area.

AE is commonly detects the sources from natural event like earthquakes and rock burst. Acoustic emission is a phenomenon frequently encountered in everyday life. An example of acoustic emission is the sound of a pencil being broken or wood being split. Acoustic emission is the elastic energy that is spontaneously released by materials when they undergo deformation. A pipe under mechanical stress may deform and generate noise (Richards, 2003). This noise is an acoustic emission can be monitored.

1.2 PROBLEM STATEMENT

Nowadays, the maintenance engineers and inspectors have faced problem where corrosion on piping system is occur. When the corrosion occurs, there will be cracking and defect at some part of the piping system. The internal flow velocity of pipe automatically will change and disturb the system's flow of the whole industries. Oil and gas industries had suffer lost every year through the pressure drop in their transportation systems due to corrosion. Beside, internal surface corrosion in pipe also can cause the leakage and can be catastrophic for piping system that contains hazardous gases such as ammonia and nitrogen dioxide.

These serious consequences have become a problem because it can causes plant shutdowns, waste of valuable resources, loss or contamination of product, reduction in efficiency, costly maintenance, and expensive over-design. It can also jeopardize safety and inhibit technological progress. So, all the pipes that used need to be monitor periodically using suitable device such as acoustic emission technique in order to safeguard company and public interests.

1.3 OBJECTIVES

For this project, the main objectives are:

i. To study the acoustic emission (AE) signals emitted from internal surface pipe.
ii. To classify the internal surface pipe roughness using Bangi Number, AB.

1.4 SCOPE OF THE PROJECT

In order to ensure the project is always on track with its objective, the scope of the project has been determined. This study used the hydraulic bench to provide fluid flow at different pressures in pipes with different internal surface roughness (smooth and rough). The signal was detected by using the AED-2000V instrument and assisted by the Acoustic Emission Detector (AED) software. The time domain parameter; root mean square, RMS amplitude was processed and compared at different pressures for each type of internal pipe roughness at ten different locations of sensor. Then, Bangi Number was derived from RMS values and can be used for discriminating level of the internal surface pipe roughness.

1.5 IMPORTANT OF THE STUDY

This study is important to give the alternative method in determining the conditions of the piping system especially classify the internal pipe surface roughness. It can be use in analysis of AE characteristics or parameters to be used in pipe surface roughness analysis and suitable for practical application. It also can be an important for further research in analysis of AE features for internal surface pipe classification.

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