

## الآية

بسم الله الرحمن الرحيم

قال تعالى

قَالُوا سُبْحَانَكَ لَا عِلْمَ لَنَا إِلَّا مَا عَلَّمْتَنَا إِنَّكَ أَنْتَ الْعَلِيمُ الْحَكِيمُ {

سورة البقرة (32)

صدق الله العظيم

## **Acknowledgements**

I would like to express my appreciation to my supervisor (Mudither Osman Fgiri) who has cheerfully answered my queries, provided me with materials, checked my examples, assisted me in myriad ways with the writing and helpfully commented on earlier drafts of this thesis

Also, I am very grateful to my friends, family for their good humour and support throughout the production of this thesis.

## **Dedication**

This Thesis is dedicated to the spirit of my father and his mercy and forgiveness. This work is also dedicated to my dear mother I hope to enjoy the health and wellness.

# **Abstract**

Remote Terminal Unit (RTU) will be used to monitor the field through indicating status of wells and send start/stop command to it and speed control through Variable Speed Drive (VSD).

Moreover the system will be capable of transmitting the situation through radio channel to the control station an early alarm, for fast response before wells starts to shutdown, which illuminates the stopping of production and problem handling before stopping the wells.

The control room will be updated by communication tool that used to control the wells, by sending shutdown, starting, increasing or decreasing revulsion per minute (RPM). An RTU was selected as a programmable logic controller, from Emerson RTU, Control Wave Micro Hybrid RTU PLC which has the ability to communicate with Radio technology and to control the RPM of induction motors based on VSD.

## مستخلص

تم استخدام نظام وحدة التحكم عن بعد فى مراقبة آبار البترول والتحكم فى سرعتها من خلال متغير السرعة.

وعلاوة على ذلك فان النظام سوف يكون قادر على نقل حالة الآبار من خلال قناة راديو الى غرفة التحكم الرئيسية واعطاء انذار مبكر من أجل استجابة سريعة قبل توقف الإنتاج وأيضا سيتم تحديث غرفة التحكم بمعلومات الآبار من سرعة وشدهيار وغيره وارسال اشارات التحكم مثل تشغيل وايقاف البئر وتغير السرعة.

وقد تم اختيار وحدة التحكم عن بعد من شركة ايمرسون الذى لديه القدرة على التواصل مع تكنولوجيا الراديو والربط مع وحدة التحكم فى المحركات الحثية

## Table of contents

NO	Name	Page No
	<b>Chapter One</b>	
1.1	Overview	1
1.2	Problem statement	2
1.3	Objectives	
1.4	Methodology	2
1.5	Thesis Layout	3
	<b>Chapter Two</b>	
2.1	Introduction	4
2.2.1	wireless sensor networks and Atmega 2560	6
2.2.2	Using global system for mobile communications (GSM)	7
2.2.3	Using Wireless Sensor Networks based on ARM	7
2.3	Remote Terminal Units (RTU)	8
2.3.1	RTU Design for CO <sub>2</sub> Enhanced Oil Recovery	9
2.3.2	(RTU) and Gateways for Digital Oilfield dep	9
	<b>Chapter Three</b>	
3.1	Introduction	11
3.2	RTU Controller	11
3.2.1	Control processor unit	11
3.2.2	Analog input modules	13
3.2.3	Analog outputs	14
3.2.4	Digital inputs	14
3.2.5	Counter or accumulator digital inputs	15
3.2.6	Digital output module	16
3.2.7	Communication interfaces	17
3.2.8	Power supply module for RTU	18
3.3	Modbus	18
3.3.1	ASCII Mode	19
3.3.2	RTU Mode	19
3.3.3	RS485 Modbus Interface	20
3.4	Variable Speed Drive	20
3.5	Open Platform Communications	22
3.6	Control Wave Designer	23

3.7	Hardware structure	24
3.7.1	Well site structure	24
3.7.2	Control Room site structure	25
3.8	Software structure	26
3.8.1	Well site Software	26
3.8.2	Control Room site software structure	27
3.9	SCADA Simulation graphic	27
	<b>Chapter Four</b>	
4.1	OPC Server and SCADA Simulation	29
4.1.1	Frequency change mode	29
4.1.2	Remote local mode	33
4.1.3	Pressure high alarm	35
4.1.4	VSD status	37
4.1.5	RTU status	39
4.1.6	VSD frequency output	40
4.2	Control Wave Designer simulation result	41
4.2.1	Well side	41
4.2.2	Control room side	44
	<b>Chapter Five</b>	
5.1	Conclusion	46
5.2	Recommendation	46
	References	47
	<b>Appendices</b>	
	<b>Appendix A</b>	
A.1	Server define	49
A.2	Define client server	50
A.3	Main RTU data list	50
A.4	Auto frequency change	52
A.5	VSD main RTU communication	53
A.6	RTU communication	59
A.7	CPU communication	61
A.8	Control primary status	73
	<b>Appendix B</b>	
B.1	Define the server	74
B.2	Define client function block	74
B.3	Define data list for SCADA	75

B.4	Communicate with SCADA	78
B.5	Communication data list for well head RTU	78
B.6	Master RTU A communicate with well head RTU	80
B.7	Command setting	83
B.8	Primary CPU judge	84



## List of table

Table	Title	Page No
3.1	VSD configuration	21
3.2	OPC tags	22
4.1	Tag N008 cases	38

## List of figures

Figure	Title	Page No
2.1	General system overview	5
2.2	System topology for OPU monitoring and control	8
3.1	Typical RTU hardware structure	12
3.2	Block diagram of a typical analog input module	13
3.3	Typical analog output modules	14
3.4	Digital input circuits with flow chart of operation	15
3.5	Pulse input module	16
3.6	Digital output module	17
3.7	VSD communication	20
3.8	System structure	24
3.9	well site structure	25
3.10	Control Room Structure	26
3.11	well overview	27
3.12	RTU panel	28
3.13	VSD operation	28
4.1	Auto/ main tag	29
4.2	Frequency mode	30
4.3	Auto frequency change	31
4.4	Start frequency OPC tag	31
4.5	End frequency OPC tag	32
4.6	Timer OPC tag	32
4.7	Remote/local mode depend on C002	33
4.8	Remote/local mode depend on C3	34
4.9	Remote/local simulation window	34
4.10	High pressure alarm	35
4.11	High pressure alarm reset	36
4.12	High alarm simulation window	36
4.13	VSD word status Screen	37
4.14	VSD word status	38
4.15	OPC configuration of RTU status	39
4.16	RTU status	40
4.17	Output frequency SCADA window	40
4.18	OPC configuration of VSD frequency	41
4.19	Input ports	42
4.20	Variables values case 1	42

4.21	PLC program simulation case 1	43
4.22	Variables values case 2	43
4.23	PLC simulation case 2	44
4.24	MTU variables status	45
4.25	MTU analog variables	45
A.1	Slave Modbus function block	49
A.2	Master Modbus function block	52
A.3	PLC ladder diagram for CPU A	58
A.4	PLC ladder diagram for CPU B	59
A.5	VSD communication data list	61
B.1	Master Modbus function block	75
B.2	Slave Modbus function block	76
B.3	Communication module port	76

## Abbreviation

VSD	Variable Speed Drive
RTU	Remote Terminal Unit
RPM	Revelation per mints
SCADA	Supervisory Control and Data Acquisition
HMI	Human Machine interface
OPC	Open Platform Communications
GSM	Global System for Mobile
MTU	Master Terminal Unit
DCS	Distributed Control System
DI	Digital Input
PLC	Programmable logic Controller
ASCII	American Standard Code for Information Interchange
LD	Ladder Diagram
SFC	Sequential Flow Chart
FBD	Function Block Diagram
DC	Direct Current
AC	Altercative current