

TABLE OF CONTENTS

Preface, ii

Table of Contents, iii

List of Tables, ix

List of Figures, xi

CHAPTER ONE: Background and Objectives, 1

1.1 Introduction, 1

1.2 Objectives, 2

CHAPTER TWO: History of Oil and Natural Gas, 3

2.1 Introduction, 3

2.2 The Arabian Tectonic Plate, 3

2.3 History of Oil and Natural Gas in Saudi Arabia, 6

2.4 Oil and Natural Gas Reserves, 6

2.5 Crude Oil Types, 7

CHAPTER THREE: Origin and Geology of Petroleum Reservoirs, 14

3.1 Introduction, 14

3.2 Origin of Petroleum, 14

 3.2.1 Organic Origin Theory, 15

 3.2.2 Inorganic Origin Theory, 15

3.3 Geology of Petroleum Reservoirs, 15

3.4 Types of Rocks, 16

3.5 Petroleum Accumulation and Segregation, 16

3.6 Petroleum Accumulation Requirements, 17

 3.6.1 Source Rock, 17

 3.6.2 Reservoir Rock, 17

 3.6.3 Geological structures (Traps), 17

3.7 Types of Reservoir Traps, 18

 3.7.1 Structural Traps, 18

 3.7.2 Stratigraphic Traps, 18

 3.7.3 Complex (Combination) Traps, 19

3.8 Reservoir Energy Mechanisms, 19

3.9 Improved Drive Mechanisms, 23

CHAPTER FOUR: Petroleum Exploration Techniques, 24

4.1 Introduction, 24

4.2 Exploration Techniques, 24

- 4.2.1 Aerial Surveying, 24
- 4.2.2 Satellite Surveying, 24
- 4.2.3 Geological Exploration, 24
- 4.2.4 Geochemical Exploration, 25
- 4.2.5 Geophysical Exploration, 25
- 4.2.6 Electrical Exploration, 27
- 4.2.7 Drilling Exploration, 27

4.3 Contour Maps, 29

4.4 Basis of Petroleum Field Development, 30

CHAPTER FIVE: Chemistry of Petroleum, 31

5.1 Introduction, 31

5.2 Types of Chemical Compounds in Petroleum, 32

5.2.1 The Chain Aliphatic Hydrocarbons Series, 32

5.2.1.1 The Paraffin Saturated Hydrocarbons, 32

5.2.1.2 The Unsaturated Hydrocarbons, 32

5.2.2 The Naphthene Cyclic Hydrocarbons Series, 33

5.2.3 The Aromatics Cyclic Hydrocarbons Series, 34

5.3 Naming of Hydrocarbons, 34

5.4 The Importance of Hydrocarbons and its Derivatives, 34

5.5 Petrochemical Industries, 34

CHAPTER SIX: Petroleum Well Drilling Engineering, 36

6.1 Introduction, 36

6.2 Drilling Technology, 37

6.2.1 Cable Tool Drilling Method, 37

6.2.2 Rotary Drilling Method, 38

6.3 Basic Rotary Drilling Rig Components, 39

6.3.1 The Derrick, 39

6.3.2 Hoisting System, 39

6.3.3 Rotating System, 40

6.3.4 Mud Circulation System, 40

6.3.5 Pressure Controlling System, 40

6.4 Basic Functions of Drilling Fluid, 40

6.5 Typed of Drilling Fluids, 40

6.6 Optimum Drilling Fluids Density Design, 41

6.7 Casing-Bit Design, 41

6.8 Wellheads, Chocks, and Subsurface Safety Valve, 42

6.9 Petroleum Well Cementing Job, 44

6.10 Petroleum Well Completion, 44

- 6.11 Perforating, 45
- 6.12 Cores and Coring Techniques, 45
- 6.13 Offshore Drilling, 46
- 6.14 Drilling Operations Management, 46
- 6.15 Petroleum Well Drilling Cost, 47
- 6.16 Measurement While Drilling, 47

CHAPTER SEVEN: Oil and Natural Gas Reservoirs Rocks Properties, 51

- 7.1 Introduction, 51
- 7.2 Porosity, 51
 - 7.2.1 Absolute Porosity, 51
 - 7.2.2 Effective Porosity, 51
 - 7.2.3 Primary Porosity, 51
 - 7.2.4 Secondary Porosity, 52
 - 7.2.5 Induced Porosity, 52
- 7.3 Measurement of Porosity, 52
 - 7.3.1 Measurement of Bulk Volume, 53
 - 7.3.2 Measurement of Grain Volume, 55
- 7.4 Permeability, 56
 - 7.4.1 Measurement of Absolute Permeability, 56
 - 7.4.2 Measurement of Effective Permeability, 57
 - 7.4.3 Measurement of Relative Permeability, 58
- 7.5 Reservoir Fluids Saturations, 58
- 7.6 Reservoir Pressure Distribution, 58
- 7.8 Darcy Law for Linear Flow, 60
- 7.9 Darcy Law for Radial Flow, 60
- 7.9 Gas Permeability, 60
- 7.10 Permeability of Combination of Layers, 60

CHAPTER EIGHT: Oil and Natural Gas Reserves Estimation, 62

- 8.1 Introduction, 62
- 8.2 Types of Reserves, 62
- 8.3 Reserves Estimation Techniques, 63
 - 8.2.1 Material Balance Method, 63
 - 8.2.2 Production Decline Method, 63
 - 8.2.3 Volumetric Method, 63
- 8.4 Evaluation of Reserves Estimation Parameters, 64
- 8.5 Estimation of Oil and Gas Reserves Depletion, 66

CHAPTER NINE: Petroleum Production and Formation Evaluation, 68

- 9.1 Introduction, 68
- 9.2 Components of the Production System, 68
- 9.3 Production Equations, 69
- 9.4 Formation Damage and Skin Factor, 69
- 9.5 Artificial Lift, 69
- 9.6 Remedial Well Work, 70
- 9.7 Processing of Produced Fluids, 71
- 9.8 Formation Evaluation Techniques, 71

CHAPTER TEN: Natural Gas Properties, 74

- 10.1 Introduction, 74
- 10.2 Natural Gas Types, 74
- 10.3 Natural Gas Volume Calculation, 75
- 10.4 The General Gas Law, 75
- 10.5 Evaluation of Gas Deviation Factor, 76

CHAPTER ELEVEN: Storage and Transportation of Petroleum, 80

- 11.1 Introduction, 80
- 11.2 Strategic Storage of Petroleum, 80
- 11.3 Liquefied Natural Gas Transportation, 81
- 11.4 Petroleum Transportation Methods, 81
 - 11.4.1 Sea Tankers, 81
 - 11.4.2 Pipelines, 82
 - 11.4.3 Railways, 82
 - 11.4.4 Tank Truck, 82
- 11.5 Evaluation of Petroleum Transportation Methods, 83

CHAPTER TWELVE: Offshore Pollution by Petroleum, 84

- 12.1 Introduction, 84
- 12.2 Behavior of Oil Spill in Marine Environments, 84
- 12.3 Effects of Oil Spills, 86
- 12.4 Major Classification of Oil Spill, 86
 - 12.4.1 Offshore Oil Production Spill, 86
 - 12.4.2 Oil Transport Spill, 86
 - 12.4.3 Oil Refining Spill, 86
- 12.5 Oil Pollution Treatment Techniques, 86
 - 12.5.1 Skimming Treatment Process, 87

- 12.5.2 Adsorption Treatment Process, 87
- 12.5.3 Chemical Treatment Process, 87
- 12.5.4 Bacterial Treatment Process, 87
- 12.5.5 Burning Treatment Process, 87
- 12.6 Pollution Control and Treatment Capabilities in Saudi Arabia, 87
- 12.7 Waste Management, 87
- 12.8 Well Abandonment, 89
- 12.9 Some of the Major Global Marine Oil Spills, 89
- 12.10 Oil Spill Response in Saudi Arabia, 90
- CHAPTER THIRTEEN: Basics of Petroleum Refining, 91**
- 13.1 Introduction, 91
- 13.2 Refining Process, 91
 - 13.2.1 The Separation Process, 91
 - 13.2.2 The Conversion Process, 92
 - 13.2.3 The Treatment Process, 92
- 13.3 The Main Refinery Products, 92
- 13.4 Petrochemical Products, 94
- 13.5 Jubail and Yanbu Industrial Complexes, 94
- CHAPTER FOURTEEN: Basics of Petroleum Economics, 95**
- 14.1 Introduction, 95
- 14.2 Organization of Petroleum Exporting Countries (OPEC), 95
- 14.3 Organization of Arab Petroleum Exporting Countries (OAPEC), 96
- 14.4 International Energy Agency (IEA), 97
- 14.5 History of Oil Prices, 97
- 14.6 Forms of Petroleum and Minerals Ownerships, 98
- 14.7 Types of Petroleum Well Drilling Contracts, 98
- 14.8 Reservoir Development Practices, 99
- 14.9 Principles of Engineering Economics, 99
 - 14.9.1 Net Present Value, 100
 - 14.9.2 Payout Time, 101
- 14.10 Reservoir Management Economics, 101
- 14.11 Cost-Per-Drilled Foot Analysis, 101
- 14.12 Oil Pricing Methods, 103

14.13 Equivalent Oil Barrel Price, 103

CHAPTER FIFTEEN: Units and Conversion Factors, 104

15.1 Introduction, 104

15.2 Basic symbols in Petroleum Engineering, 105

15.3 Linear Interpolation, 105

15.4 Conversion Factors, 106

15.4.1 Equations Balancing, 106

15.4.2 Basic Conversion Factors, 107

15.5 Measurement of Oil and Natural Gas Volumes, 110

PETROLEUM GLOSSARY TERMS, 111

REFERENCES, 116