# **TABLE OF CONTENTS**

# **Chapter-1, Introduction to Petroleum Engineering**

1.2 History of Petroleum	
IIW IIIUVOI   OI I VUOIVUIII	
1.3 Definition of Petroleum.	
1.4 Where Does Petroleum Occur	
1.4.1 Igneous Rocks	
1.4.2 Sedimentary Rocks	
1.4.3 Metamorphic Rocks	
1.5 How Does Petroleum Occur.	
1.5.1 Inorganic Theory	
1.5.2 Organic Theory	
1.6 Formation of Petroleum.	6
1.7 The Migration of Petroleum Hydrocarbons	
1.8 Oil and Gas Migration	
1.9 Traps	
1.9.1 Anticline Trap	
1.9.2 Fault Trap	
1.9.3 Combination Trap	
1.10 Unconformities.	
1.11 Measuring the properties of rocks	12
1.11.1 Magnetism	13
1.11.2 Gravity	
1.11.3 Seismic waves	
2- Chapter-2, Classification of Petroleum Hydrocarbons	
2.1 Alkanas	15
2.1Alkanes	
2.2 Alkenes	16
2.2 Alkenes2.3Alkynes	16 16
2.2 Alkenes      2.3Alkynes      2.4 Cylic Aliphatic Hydrocarbons	16 16 17
2.2 Alkenes2.3Alkynes	16 16 17
2.2 Alkenes      2.3Alkynes      2.4 Cylic Aliphatic Hydrocarbons	16 16 17
2.2 Alkenes	16 17 18
2.2 Alkenes 2.3 Alkynes 2.4 Cylic Aliphatic Hydrocarbons. 2.5 Aromatics  3- Chapter-3, Reservoir Rock Properties  3.1 Porosity	
2.2 Alkenes 2.3Alkynes 2.4 Cylic Aliphatic Hydrocarbons 2.5 Aromatics  3- Chapter-3, Reservoir Rock Properties  3.1 Porosity 3.2 Methods of Packing Spheres and the Type of Porosity	
2.2 Alkenes. 2.3 Alkynes. 2.4 Cylic Aliphatic Hydrocarbons. 2.5 Aromatics.  3- Chapter-3, Reservoir Rock Properties  3.1 Porosity. 3.2 Methods of Packing Spheres and the Type of Porosity. 3.2.1 Cubic Packing	
2.2 Alkenes 2.3 Alkynes 2.4 Cylic Aliphatic Hydrocarbons 2.5 Aromatics  3- Chapter-3, Reservoir Rock Properties  3.1 Porosity 3.2 Methods of Packing Spheres and the Type of Porosity 3.2.1 Cubic Packing 3.2.2 Hexagonal Packing	
2.2 Alkenes. 2.3 Alkynes. 2.4 Cylic Aliphatic Hydrocarbons. 2.5 Aromatics.  3- Chapter-3, Reservoir Rock Properties  3.1 Porosity. 3.2 Methods of Packing Spheres and the Type of Porosity. 3.2.1 Cubic Packing 3.2.2 Hexagonal Packing 3.2.3 Rhombohedral Packing	
2.2 Alkenes 2.3 Alkynes 2.4 Cylic Aliphatic Hydrocarbons 2.5 Aromatics  3- Chapter-3, Reservoir Rock Properties  3.1 Porosity 3.2 Methods of Packing Spheres and the Type of Porosity 3.2.1 Cubic Packing 3.2.2 Hexagonal Packing	
2.2 Alkenes. 2.3 Alkynes. 2.4 Cylic Aliphatic Hydrocarbons. 2.5 Aromatics.  3- Chapter-3, Reservoir Rock Properties  3.1 Porosity. 3.2 Methods of Packing Spheres and the Type of Porosity. 3.2.1 Cubic Packing. 3.2.2 Hexagonal Packing. 3.2.3 Rhombohedral Packing. 3.2.4 Total Porosity. 3.2.5 Effective Porosity.	
2.2 Alkenes 2.3 Alkynes 2.4 Cylic Aliphatic Hydrocarbons 2.5 Aromatics  3- Chapter-3, Reservoir Rock Properties  3.1 Porosity 3.2 Methods of Packing Spheres and the Type of Porosity 3.2.1 Cubic Packing 3.2.2 Hexagonal Packing 3.2.3 Rhombohedral Packing 3.2.4 Total Porosity 3.2.5 Effective Porosity 3.2.6 Primary Porosity	
2.2 Alkenes. 2.3 Alkynes. 2.4 Cylic Aliphatic Hydrocarbons. 2.5 Aromatics.  3- Chapter-3, Reservoir Rock Properties  3.1 Porosity. 3.2 Methods of Packing Spheres and the Type of Porosity. 3.2.1 Cubic Packing. 3.2.2 Hexagonal Packing. 3.2.3 Rhombohedral Packing. 3.2.4 Total Porosity. 3.2.5 Effective Porosity.	
2.2 Alkenes. 2.3 Alkynes. 2.4 Cylic Aliphatic Hydrocarbons. 2.5 Aromatics.  3- Chapter-3, Reservoir Rock Properties  3.1 Porosity. 3.2 Methods of Packing Spheres and the Type of Porosity. 3.2.1 Cubic Packing. 3.2.2 Hexagonal Packing. 3.2.3 Rhombohedral Packing. 3.2.4 Total Porosity. 3.2.5 Effective Porosity. 3.2.6 Primary Porosity. 3.2.7 Secondary Porosity.	
2.2 Alkenes. 2.3 Alkynes. 2.4 Cylic Aliphatic Hydrocarbons. 2.5 Aromatics.  3- Chapter-3, Reservoir Rock Properties  3.1 Porosity. 3.2 Methods of Packing Spheres and the Type of Porosity. 3.2.1 Cubic Packing. 3.2.2 Hexagonal Packing. 3.2.3 Rhombohedral Packing. 3.2.4 Total Porosity. 3.2.5 Effective Porosity. 3.2.6 Primary Porosity. 3.2.7 Secondary Porosity. 3.2.7.1 Solution Porosity.	

3.3 Porosity Determination Techniques	24
3.3.1 Buoyancy Technique	
3.3.2 Gas Expansion Method	
3.3.3 Pycnometer Method	
3.4 Permeability	
3.5 Fluid Saturations	
3.6 Compressibility	
3.7 Subsurface Pressure	
3.7.1 Hydrostatic Pressure	31
3.7.2 Formation Pressure	31
3.7.3 Overburden Pressure	32
3.8 Subsurface Temperature	32
3.9 Example Problems	
4- Chapter-4, Reservoir Fluid Properties	
4.1 Crude Oil	
4.1.1 Crude Oil API Gravity	
4.1.2 Oil Formation Volume Factor	
4.1.3 Oil Viscosity	
4.2 Natural Gas	
4.2.1 Wet Gas	
4.2.2 Sour Gas	
4.2.3 Sweet Gas	
4.2.4 Gas Oil Ratio	
4.2.5 Gas Formation Volume Factor	
4.2.6 Gas Specific Gravity	
4.2.7 Gas Density	
4.3 Example Problems	41
5- Chapter-5, Reservoir Drive Mechanisms	
5.1 Solution Gas Drive Reservoirs	44
5.2 Gas Cap Drive Reservoirs	44
5.3 Water Drive Reservoirs	45
5.4 Gravity Drainage	46
5.5 Fluid and Rock Expansion	46
6- Chapter-6, Phase Behavior of Hydrocarbon Fluids	
6.1 Phase Behavior of Single-Component Systems	47
6.2 Phase Behavior of Multi-Component Systems	
6.3 Phase Behavior of Low Shrinkage Reservoir Fluids	
6.4 Phase Behavior of Retrograde Condensate Reservoir Fluid	
6.5 Phase Behavior of Dry Gas Reservoir Fluid	
6.6 Phase Behavior of Wet Gas Reservoir Fluid	

# 7- Chapter-7, Drilling

7.1 The Companies	52
7.2 The Drilling Crew	
7.3 Rig Components	
7.3.1 Power System.	
7.3.2 Hoisting System.	
7.3.3 Circulation System.	
7.3.3.1 Component of the Circulation System	
7.3.4 Rotary System	
7.4 Drilling Bits	
7.4 Diffing Bits. 7.5 Well Control System.	
7.6 Well-Monitoring System.	
· ·	
7.7 Drilling Operations.	
7.7.1 Drilling a Well	07
8- Chapter-8, Completion, Production and Reservoir Engineering	
o chapter of compression, 11 outdeston and 10001 for Engineering	
8.1 Casing	70
8.1.1 Drive Pipe or Conductor Casing	
8.1.2 Structural Casing.	
8.1.3 Surface Casing.	
8.1.4 Intermediate Casing	
8.1.5 Liners	
8.1.6 Production Casing.	
8.2 Cementing.	
8.3 Examining Cuttings.	
8.4 Well Logging.	
8.5 Drill Stem Testing	
8.6 Coring	
8.7 Completing the Well	
8.8 Perforating.	
8.9 Installing the Christmas Tree.	
8.10 Drawdown and Productivity Index.	
8.11 Acidizing.	
8.12 Fracturing.	
8.13 Flowing Well Performance	
8.14 Artificial Lift Methods.	
8.15 Reservoir Engineering.	
8.16 Enhanced Oil Recovery (EOR).	
on billianced on receivery (Borty)	
9- Chapter-9, Storage, Transportation and Refinery	
9.1 Storage of Crude Oil.	87
9.2 Transportation of Crude Oil	
9.3 Pipelines.	
9.4 Refineries	
9.5 Basic Distillation.	

9.6 Thermal Cracking	93
9.7 Alkylation and Catalytic Cracking	
9.8 Oil Refining and Fractional Distillation	
10- Chapter-10, Environment and Safety	
10.1 Introduction	96
10.2 Ergonomics Approach to Health and Safety	97
10.2.1 General Purpose of the Ergonomics	98
10.3 Factors of the Accidents in Drilling Operations	98
10.3.1 Human Factors	
10.3.2 Machine Equipment Factor	99
10.3.3 Environmental Factor	
10.4 Environmental Protection	99
10.4.1 Air Pollution	99
10.4.2 Water Pollution	100
10.4.3 Land Pollution	101
10.4 Pollution Prevention	101
10.5 Causes of Accident	102
10.5.1 Energy Sources	102
10.5.2 Hazardous Material	102
10.5.3 Indirect Causes of the Accidents	102
10.5.4 Unsafe Conditions	103
References	
104	
Appendix-1	104
••	
Appendix-2	107
••	
Appendix-3	110

#### **LIST OF TABLES and FIGURES**

### LIST OF TABLES

<u>Chapter-2</u>	
Table 2-1 Alkanes, Alkenes and Alkynes.	17
<u>Chapter-4</u>	
Table 4-1 Values of Gas Constant.	39
<u>Chapter-7</u>	
Table 7-1 Ranges of Drill Pipe	61
LIST OF FIGURES	
<u>Chapter-1</u>	
Figure 1-1 Sequence of Oil Deposits.  Figure 1-2 Anticline Trap.  Figure 1-3 Fault Trap.  Figure 1-4 Combination Trap  Figure 1-5 Seismic Waves.	10 11
<u>Chapter-2</u>	
Figure 2-1 Classes and Homologous Series of Hydrocarbons	16 17 18
<u>Chapter-3</u>	
Figure 3-1 Cubic Packing  Figure 3-2 Hexagonal Packing  Figure 3-3 Rhombohedral Packing  Figure 3-4 Permeability Measurements.	21

# **Chapter-4**

Figure 4-1 Determination of Gas Constant	40
<u>Chapter-5</u>	
Figure 5-1 Schematic of a Typical Gas Cap Reservoir	
<u>Chapter-6</u>	
Figure 6-1 Vapor Pressure Curves for Two Pure Components and Phase Diagra	am for a
50:50 Mixture	
Figure 6-2 Phase Diagram of Low Shrinkage Oil	
Figure 6-3 Phase Diagram of Retrograde Condensate Gas	
Figure 6-4 Phase Diagram of Dry Gas	
Figure 6-5 Phase Diagram of Wet Gas.	51
Chapter-7	
Figure 7-1 Rotary Drilling Rig	54
Figure 7-2 The Diesel Engines	55
Figure 7-3 Hoisting System	
Figure 7-4 Drilling Fluid	
Figure 7-5 Components of the Circulating System	
Figure 7-6 Schematic diagram of Drill String Components and Bit	
Figure 7-7 Three Cone Roller and Diamond Bit	
Figure 7-8 The Mousehole	67
<u>Chapter-8</u>	
Figure 8-1 Typical Casing String Relationships	71
Figure 8-2 Cementing the Casing: A-The Job in Progress; B- The Finished Job	
Figure 8-3 An Electrical Log.	
Figure 8-4 Principles of Drill Stem Testing	78
Figure 8-5 Bottomhole Pressure Record of a Drill Stem Test	78
Figure 8-6 The Perforating Gun	
Figure 8-7 Christmas Tree of Control Valves is Positioned on the Completed Well	
Figure 8-8 Acidizing; Several Pump Trucks Send Acid Down the Well	
Figure 8-9 Fracturing; Several Pump Trucks Force Fluid Containing a Proppant dow	
Well and into the Perforations in the Casing	
Figure 8-10 Sketch of Typical Completed Well.	83
Chapter-9	
Figure 9-1 The View of a Basic Tanker	89
Figure 9-2 Basic Distillation Units	
Figure 9-3 Petrochemical Industry	93

# INTRODUCTION TO PETROLEUM ENGINEERING

Dr. Mustafa Verşan KÖK