List Of Contents

Title	Page
الاسد تهلاك	Ι
Acknowledgement	II
Dedication	III
Abstract (English)	IV
Abstract (Arabic)	VI
Contents	VIII
List of figures	XIV
List of tables	XVIII

Chapter one: Introduction		
1-1	Background	1
1-2	Overview of Oil Recovery Processes	2
1- 2-1	Primary Oil Recovery	2
1-2-2	Secondary Oil Recovery	2
1-2-3	Enhanced Oil Recovery	3
1-3	History and Development of Water Flooding	4
1-3-1	History of Water Flooding in Sudan	6
1-4	Problem Statement	9
1-5	The objectives of This Research	9
1-5-1	General Objectives	9
1-5-2	Specific Objective	9
1-6	Source of Data	10
1-7	Research Methodology	10

Chapter Two: Literature Review		
2-1	Definition of Water Flooding	12
2-2	Suitability of a Reservoir for Water Flooding	12
2-2-1	Reservoir Geometry	13
2-2-2	Lithology	14
2-2-3	Reservoir Depth	15
2-2-4	Porosity	16
2-2-5	Permeability (Magnitude and Degree of Variation)	16
2-2-6	Continuity of Reservoir-Rock Properties	17
2-2-7	Fluid Saturations and Distributions	18
2-2-8	Fluid Properties and Relative- Permeability Relationships	20
2-2-9	Primary Reservoir Driving Mechanisms	20
2-2-9-1	Water Drive Mechanism	21
2-2-9-2	Gas-cap Drive Mechanism	21
2-2-9-3	Solution gas drive Mechanism	22
2-2-9-4	Volumetric under-saturated oil reservoirs	22
2-3	Optimal Time of Water Flooding	22
2-4	Overall Recovery Efficiency	23
2-5	Reservoir Descriptions	25
2-5-1	Definition	25
2-5-2	Importance of Reservoir description	25
2-5-3	Petroleum Reservoir	25
2-5-4	Depositional Environments for Sandstone Reservoir	26
2-5-4-1	Importance of Depositional Environments	26
2-5-4-2	Sedimentary Environments	26
2-5-4-3	Facies and facies sequences	29
2-5-4-4	Continental Environments	30
2-5-4-5	Deltaic Environments	33
2-5-5	Structure and Geometry	35
2-5-5-1	Traps	37
2-5-6	Reservoir Rock Properties	41
2-5-6-1	Porosity	42
2-5-6-2	Permeability	44

2-5-6-3	Fluid Saturations	50
2-5-6-4	Wettability	53
2-5-6-5	Capillary Pressure	54
2-5-6-6	Rock Compressibility	58
2-5-6-7	Net Pay Thickness	59
2-5-6-8	Reservoir Heterogeneity	60
2-5-7	Reservoir Fluid Properties	62
2-5-7-1	Crude Oil Properties	63
2-5-7-2	Natural Gas	65
2-5-7-3	Reservoir Water	66
2-5-7-4	Reservoir Pressure	67
2-5-7-5	Source of Energy	68
2-5-8	Primary Producing Mechanisms	69
2-5-8-1	Rock and Liquid Expansion	69
2-5-8-2	The Depletion Drive Mechanism	70
2-5-8-3	Gas Cap Drive	71
2-5-8-4	Water Drive Mechanism	73
2-5-8-5	The Gravity Drainage Mechanism	76
2-5-8-6	The Combination Drive Mechanism	77

Chapter Three: Geological And Reservoir Engineering Review

3-1	Background	78
3-2	Geological Review	79
3-2-1	Geologic Setting	79
3-2-2	Regional Geology	80
3-2-3	Stratigraphy	81
3-2-4	Characteristics of Formation	81
3-2-4-1	Yabus Formation	81
3-2-4-2	Samaa Formation	82
3-2-5	Structures	83
3-2-5-1	Fault System	83
3-2-5-2	Sealing Capabilities	84
3-2-6	Sedimentary Facies	85
3-2-6-1	Lithology	85
3-2-6-2	Sandstone Quality	85
3-2-6-3	Grain Size	86
3-2-7	Petrophysical Evaluation	87

3-2-7-1	Data	87
3-2-7-2	Petrophysical Parameters	89
3-2-7-3	OWC/FWL	90
3-2-8	Fluids Properties	91
3-2-8-1	Crude Oil	91
3-2-8-2	Formation Water	91
3-2-9	Reservoir Heterogeneity	91
3-2-9-1	Rhythmicity	91
3-2-9-2	Frequency of claystone interlayer	92
3-2-9-3	Permeability variation coefficient (Kv)	93
3-2-9-4	Net to Gross Distribution	93
3-2-10	Original Oil In Place (OOIP)	94
3-3	Reservoir Engineering Review	96
3-3-1	Reservoir Temperature System	96
3-3-2	Reservoir Pressure	96
3-3-3	PVT Analyses	97
3-3-3-1	Oil Density	97
3-3-3-2	Oil Viscosity	97
3-3-3-3	Bubble Point Pressure	98
3-3-3-4	Dissolved Gas-Oil Ratio	98
3-3-3-5	Oil Formation Volume Factor	98
3-3-3-6	Oil Compressibility	98
3-3-3-7	Surface Oil Property	98
3-3-4	Capillary Pressure	99
3-3-4-1	Equilibrium and Effect of Capillary Forces	100
3-3-5	Oil-water Relative Permeability Curve	101
3-3-5-1	Mobility Ratio	101
3-3-6	Wettability	102
3-3-7	Aquifer	103
3-3-8	Well Pattern & Spacing	103
3-3-9	Productivity Index	103
Chapter Four: Design Of Water Flooding Pilot For (P) Field		
4-1	Factors Affecting the Design of Water Flooding	105
4-2	Pilot Objectives	105
4-3	P Field Reservoir Characteristics	106
4-4	Selected Wells for Pilot water injection	107

4-4-1	Location selection criteria	108
4-4-2	Selected Wells Reservoir Parameters	110
4-4-3	Injector well schematic	111
4-5	Injection Water Quality	112
4-6	Water Source and Requirements	113
4-7	Produced water treatments	116
4-8	Pilot Water Injection Simulation Model	116
4-8-1	Reservoir Characteristics	116
4-8-2	Simulation Principles	117
4-8-3	Design of Schemes and Reservoir Simulation	117
4-8-3-1	Model Description	117
4-8-4	Simulation Model Assumption	124
4-8-4-1	Prediction Case	124
4-8-4-2	Base Case	124
4-8-4-3	History Matching	124
4-8-4-4	Simulation sensitivity	130
	Chapter Five: Interpretation & Discussion	
	Chapter 11/cr interpretation & Discussion	
		100
5-1	Introduction	132
5-1 5-2	Introduction Methodology	132 132
5-1 5-2 5-2-1	Introduction Methodology Step 1: Recovery Approach Definition	132 132 132
5-1 5-2 5-2-1 5-2-2	Introduction Methodology Step 1: Recovery Approach Definition Step 2: Selection of Production and Injection Patterns	132 132 132 133
5-1 5-2 5-2-1 5-2-2 5-2-3	IntroductionMethodologyStep 1: Recovery Approach DefinitionStep 2: Selection of Production and Injection PatternsStep 3: Simulation Sensitivity	132 132 132 133 133
5-1 5-2 5-2-1 5-2-2 5-2-3 5-2-3	IntroductionMethodologyStep 1: Recovery Approach DefinitionStep 2: Selection of Production and Injection PatternsStep 3: Simulation SensitivityInjection Rate Sensitivity	132 132 132 133 133 134
5-1 5-2 5-2-1 5-2-2 5-2-3 5-2-3-1 5-2-3-2	IntroductionMethodologyStep 1: Recovery Approach DefinitionStep 2: Selection of Production and Injection PatternsStep 3: Simulation SensitivityInjection Rate SensitivityInjector Bottom Hole Pressure Sensitivity	132 132 132 133 133 134
5-1 5-2 5-2-1 5-2-2 5-2-3 5-2-3-1 5-2-3-2 5-2-3-3	IntroductionMethodologyStep 1: Recovery Approach DefinitionStep 2: Selection of Production and Injection PatternsStep 3: Simulation SensitivityInjection Rate SensitivityInjector Bottom Hole Pressure SensitivityWater Injection Time Sensitivity	132 132 132 133 133 134 134 134
5-1 5-2 5-2-1 5-2-2 5-2-3 5-2-3-1 5-2-3-2 5-2-3-3 5-2-3-4	IntroductionMethodologyStep 1: Recovery Approach DefinitionStep 2: Selection of Production and Injection PatternsStep 3: Simulation SensitivityInjection Rate SensitivityInjector Bottom Hole Pressure SensitivityWater Injection Time SensitivityInjection Zone Connection Sensitivity	132 132 132 133 133 133 134 134 135
5-1 $5-2$ $5-2-1$ $5-2-3$ $5-2-3-1$ $5-2-3-2$ $5-2-3-3$ $5-2-3-4$ $5-2-4$	IntroductionMethodologyStep 1: Recovery Approach DefinitionStep 2: Selection of Production and Injection PatternsStep 3: Simulation SensitivityInjection Rate SensitivityInjector Bottom Hole Pressure SensitivityWater Injection Time SensitivityInjection Zone Connection SensitivityStep 4: Simulation Results Analysis	132 132 132 133 133 133 134 134 135
5-1 5-2 5-2-1 5-2-2 5-2-3 5-2-3-1 5-2-3-2 5-2-3-3 5-2-3-4 5-2-4	IntroductionMethodologyStep 1: Recovery Approach DefinitionStep 2: Selection of Production and Injection PatternsStep 3: Simulation SensitivityInjection Rate SensitivityInjector Bottom Hole Pressure SensitivityWater Injection Time SensitivityInjection Zone Connection SensitivityStep 4: Simulation Results AnalysisSelecting the Objective-Function	132 132 132 133 133 133 134 134 135 135 135
5-1 $5-2$ $5-2-1$ $5-2-3$ $5-2-3-1$ $5-2-3-2$ $5-2-3-3$ $5-2-3-4$ $5-2-4-1$ $5-2-4-1$	IntroductionMethodologyStep 1: Recovery Approach DefinitionStep 2: Selection of Production and Injection PatternsStep 3: Simulation SensitivityInjection Rate SensitivityInjector Bottom Hole Pressure SensitivityWater Injection Time SensitivityInjection Zone Connection SensitivityStep 4: Simulation Results AnalysisSelecting the Objective-FunctionStructure or Geological level Interpretation	132 132 132 133 133 133 134 134 135 135 136
5-1 5-2 5-2-1 5-2-2 5-2-3 5-2-3-1 5-2-3-2 5-2-3-3 5-2-3-4 5-2-4 5-2-4-1 5-2-4-1 5-2-4-2 5-2-4-3	IntroductionMethodologyStep 1: Recovery Approach DefinitionStep 2: Selection of Production and Injection PatternsStep 3: Simulation SensitivityInjection Rate SensitivityInjector Bottom Hole Pressure SensitivityWater Injection Time SensitivityInjection Zone Connection SensitivityStep 4: Simulation Results AnalysisSelecting the Objective-FunctionStructure or Geological level InterpretationStructure or Geological level Discussion	132 132 132 133 133 133 134 134 135 135 136 144
5-1 5-2 5-2-1 5-2-2 5-2-3 5-2-3-1 5-2-3-2 5-2-3-3 5-2-3-4 5-2-4-1 5-2-4-1 5-2-4-2 5-2-4-3 5-2-4-3	IntroductionMethodologyStep 1: Recovery Approach DefinitionStep 2: Selection of Production and Injection PatternsStep 3: Simulation SensitivityInjection Rate SensitivityInjector Bottom Hole Pressure SensitivityWater Injection Time SensitivityInjection Zone Connection SensitivityStep 4: Simulation Results AnalysisSelecting the Objective-FunctionStructure or Geological level InterpretationStructure or Geological level DiscussionPattern level Interpretation	132 132 132 133 133 133 134 134 135 135 136 144 145
5-1 5-2 5-2-1 5-2-2 5-2-3 5-2-3-1 5-2-3-2 5-2-3-3 5-2-3-4 5-2-4-1 5-2-4-1 5-2-4-2 5-2-4-3 5-2-4-3 5-2-4-5	IntroductionMethodologyStep 1: Recovery Approach DefinitionStep 2: Selection of Production and Injection PatternsStep 3: Simulation SensitivityInjection Rate SensitivityInjector Bottom Hole Pressure SensitivityWater Injection Time SensitivityInjection Zone Connection SensitivityStep 4: Simulation Results AnalysisSelecting the Objective-FunctionStructure or Geological level InterpretationStructure or Geological level DiscussionPattern level InterpretationPattern level Discussion	132 132 132 133 133 133 134 134 135 135 136 144 145 152
5-1 5-2 5-2-1 5-2-2 5-2-3 5-2-3-1 5-2-3-2 5-2-3-3 5-2-3-4 5-2-4-1 5-2-4-1 5-2-4-2 5-2-4-3 5-2-4-3 5-2-4-3 5-2-4-5 5-2-4-5	IntroductionMethodologyStep 1: Recovery Approach DefinitionStep 2: Selection of Production and Injection PatternsStep 3: Simulation SensitivityInjection Rate SensitivityInjector Bottom Hole Pressure SensitivityWater Injection Time SensitivityInjection Zone Connection SensitivityStep 4: Simulation Results AnalysisSelecting the Objective-FunctionStructure or Geological level InterpretationStructure or Geological level DiscussionPattern level InterpretationWell level Interpretation	132 132 132 133 133 133 134 134 134 135 135 136 144 145 152 152
5-1 5-2 5-2-1 5-2-2 5-2-3 5-2-3-1 5-2-3-2 5-2-3-3 5-2-3-4 5-2-4-1 5-2-4-1 5-2-4-2 5-2-4-3 5-2-4-3 5-2-4-3 5-2-4-5 5-2-4-5 5-2-4-6 5-2-4-7	IntroductionMethodologyStep 1: Recovery Approach DefinitionStep 2: Selection of Production and Injection PatternsStep 3: Simulation SensitivityInjection Rate SensitivityInjector Bottom Hole Pressure SensitivityWater Injection Time SensitivityInjection Zone Connection SensitivityStep 4: Simulation Results AnalysisSelecting the Objective-FunctionStructure or Geological level InterpretationStructure or Geological level DiscussionPattern level InterpretationWell level InterpretationWell level Discussion	132 132 132 133 133 133 133 133 134 134 134 135 135 135 136 144 145 152 152 159

Chapter Six: Conclusion & Recommendations		
6-1	Conclusion:	162
6-2	Recommendations:	166
Appendices		
A	Abbreviations	167
В	References	169