

TABLE OF CONTENTS

INNER COVER	i
APPROVAL PAGE	ii
DECLARATION	iii
PERNYATAAN BEBAS PLAGIASI	iv
ABSTRACT	v
INTISARI	vi
PREFACE	viii
TABLE OF CONTENTS	xi
LIST OF FIGURES	xii
LIST OF TABLES	xvi
CHAPTER I INTRODUCTION	1
I.1 Background	1
I.2. Problem Statement	5
I.3. Objective of Research	5
I.4 Scope of Research	6
I.5 Limitation of Research	6
I.6 Previous Research and Originality	7
I.7. Benefit of Research	9
CHAPTER II REGIONAL GEOLOGY	10
II.1 Appalachian Basin	10
II.2 Tectonic and History	11
II.3 Structure	13
II.4. Stratigraphy	14
II.5 Depositional Environment	16
II.6. Berea Sandstone	17
CHAPTER III THEORY AND LITERATURE REVIEW	19
III.1 Sandstone	19
III.1.1 Particle Composition	22
III.2 Reservoir Properties	27
III.2.1 Porosity	27
III.2.2. Permeability	31
III.3. Oil Production	34
III.4. Enhanced Oil Recovery	43
III.5 CO ₂ Enhanced Oil Recovery	47
III.5.1 Effects of CO ₂ to Sandstone Reservoir	50
III.6 Microbubble	51
III.6.1 CO ₂ Microbubble for EOR Application	55
CHAPTER IV HYPOTHESIS AND RESEARCH METHODOLOGY	59
IV.1 Hypothesis	59
IV.2 Research Material	60

IV.2.1 Polymer	60
IV.2.2 Surfactant	61
IV.2.3 CO ₂ Gas	62
IV.2.4 Special Porous Filter	62
IV.2.5 Sand Packs	63
IV.2.6 Core Samples	65
IV.3 Research Equipment	66
IV.3.1 Microbubble Experiments	67
IV.3.2 Core Sample - Petrophysical Analysis	70
IV.4 Research Methodology	71
IV.4.1 CO ₂ Microbubble – EOR Analysis	71
IV.4.1.1 CO ₂ MB-CGA Generation and Analysis	71
IV.4.1.2 CO ₂ MB-CGA Diameter Size Impact to Sweep Efficiency	73
IV.4.1.3 CO ₂ MB-CGA Gas Blocking Ability Impact to Sweep Efficiency in Heterogeneous Media and Reservoir Core Sample	75
IV.4.2 Core Sample - Petrophysical Analysis	79
IV.5 Research Flowchart	80
IV.6 Research Timeline	82
CHAPTER V RESULTS AND DISCUSSION	83
V.1 CO ₂ MB-CGA Generation and Analysis	83
V.2 CO ₂ MB-CGA Diameter Size Analysis Impact to Sweep Efficiency Analysis	88
V.3 CO ₂ MB-CGA Gas Blocking Ability Impact to Sweep Efficiency in Heterogeneous Media and Reservoir Core Sample Analysis	94
V.3.1. The Dual Permeability Sand Pack Experiment and Analysis	94
V.3.2 The Core Samples Experiment and Analysis	98
V.4 Core Sample - Petrophysical Analysis	102
CHAPTER VI CONCLUSIONS AND SUGGESTIONS	108
VI.1 Conclusions	108
VI.2 Suggestions	110
REFERENCES	111
APPENDIX A MICROBUBBLE DATA	120
A.1 Diameter Size	120
A.2 Stability	124
APPENDIX B SAND PACK MEASUREMENTS	129
B.1 Porosity Measurement and Calculation	129
B.2 Permeability Measurement and Calculation	130

APPENDIX C SAND PACK FLOODING DATA	132
C.1 Sand Pack SP#1 - CO ₂ MB-CGA from 1 µm Filter	132
C.2 Sand Pack SP#2 - CO ₂ MB-CGA from 5 µm Filter	133
C.3 Sand Pack SP#3 - CO ₂ MB-CGA from 10 µm Filter	134
C.4 Sand Pack SP#4 - Polymer and Surfactant Solution	135
C.5 Sand Pack SP#5 - CO ₂ Gas	136
C.6 Dual Sand Pack LSP and HSP	137
C.6.1 Initial Oil Flooding	137
C.6.2 Secondary Recovery – Water Flooding	138
C.6.3 Tertiary Recovery - CO ₂ MB-CGA from 1 µm Filter Flooding	139
C.6.4 Total Recovery	140
APPENDIX D CORE SAMPLE MEASUREMENTS	141
D.1 Porosity Measurement and Calculation	141
D.2 Permeability Measurement and Calculation	142
APPENDIX E CORE SAMPLE FLOODING DATA	147
E.1 High Perm Core	147
E.2 Low Perm Core	148
APPENDIX F THIN SECTION JPOR - POROSITY MEASUREMENT .	149
APPENDIX G XRD ANALYSIS	155
G.1 High Perm Core	155
G.2 Fresh Core	158
G.3 Raw Data	161