EXPERIMENTAL INJECTION STRATEGY FOR SURFACTANT FLOODING ENHANCED BY BRANCHED ALCOHOL ADDITIVE

By

AHMAD SYAFIQ B MOHD NOOR

PETROLEUM ENGINEERING

11532

Dissertation submitted in partial fulfilment of
The requirement for the
Bachelor Engineering (Hons)
(Petroleum Engineering)

Jan 2012

Universiti Teknologi PETRONAS
Bandar Seri Iskandar
31750 Tronoh
Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

EXPERIMENTAL INJECTION STRATEGY FOR SURFACTANT FLOODING ENHANCED BY BRANCHED ALCOHOL ADDITIVE

by

Ahmad Syafiq B Mohd Noor

A project dissertation submitted to the

Petroleum Engineering Programme

Universiti Teknologi PETRONAS

in partial fulfilment of the requirement for the

BACHELOR OF ENGINEERING (Hons)

(PETROLEUM ENGINEERING)

Approved by,

____

(Mr. Iskandar Dzulkarnain)

Date: 15 April 2012

UNIVERSITI TEKNOLOGI PETRONAS

TRONOH, PERAK

January 2012

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

____

Ahmad Syafiq B Mohd Noor

Student ID : 11532

I/C No : 891121-03-5245

Date : 15 April 2012

Abstract

There are few limitations in using surfactant/co-surfactant such as the interfacial activity, adsorption and ionic equilibria which can be control by manipulating the formulation of the injected solution. Other limitations which can be controlled by injection strategy were chromatographic effect, mobility control, flow diversion by precipitates and emulsification. By using the optimum formulation, the first part of the limitations can be reduced. And the second part of limitations can be overcome by investigating the best or optimum method for injecting optimum formulation. The objective of this study is to find the optimum injection strategy of a well formulated surfactant and co-surfactant in enhancing residual oil recovery. Already several methods had been proposed for surfactant / co-surfactant flooding, in this study, topic will be narrowed to, to find the best injection strategy for surfactant flooding with branched alcohol as co-surfactant. Result will be presented on the percentage of residual oil recovered by using different method of injection.

Below are the injection strategies which are to be tested. Injection strategies which to be study are:

1) Surfactant and branched alcohol mixed in single formation then followed by chase water
2) Surfactant followed by branched alcohol then followed by chase water
3) Branched alcohol followed by surfactant then followed by chase water

Methodology used in this study is based on coreflooding experiment. Briefly, the experiment will be conducted using three (3) Barea cores. Each core first preflooded with synthetic brine at optimum salinity and hardness to saturate the core with brine. Core then will be flooded with crude oil to displace the brine. Then, core will undergo water flooding to displace the crude oil injected to the core. Residual oil saturation then can be calculated from the volume of water produced after the water flood, volume of oil produced during the water flood and pore volume of the core. All the cores then will be injected with chemicals using different methods. The effluent recovered will be measure and the efficiency of each method will be calculated.

Acknowledgements

Firstly, praise be to God for the strength; mentally and physically to complete the Final Year Project. A special thanks from the author to the project supervisor, Mr. Iskandar Dzulkarnain. For his guidance and supervision had contributed towards the completion of the project. The co-operation given is much appreciated and honoured.

My honest gratitude is for the whole Petroleum Engineering Department for the opportunity given and facilities provided to conduct the research. Not to be excluded, the expertise laboratory work forces for providing facilitation throughout the project.

Towards the sponsor for the faith put in me and supporting me financially. Not to be forgotten, my beloved family who had supported me morally and encouraging me in completing the project. Last but not least, my highest gratitudes is for the peoples whom had directly or indirectly facilitated, guided and supported upon the completion of the projects.

Contents

Chapter 1: Introduction ... 1
1.1 Introduction ... 1
1.2 Problem Statement ... 2
1.3 Objective ... 2
1.4 Scope of study ... 2
1.5 Relevancy of the project ... 3
1.6 Result ... 3
Chapter 2: Literature Review ... 4
2.1 Enhanced Oil Recovery ... 4
2.2 Tertiary recovery: Surfactant Flooding ... 5
2.3 Alcohol as Co-surfactant/Co-solvent ... 8
2.4 Branched Alcohol ... 9
2.5 Injection Method ... 10
Chapter 3: Research Methodology ... 12
3.1 Problem statement ... 12
3.2 Project objective ... 12
3.3 Background study ... 12
3.4 Literature Review and Theory ... 13
3.5 Data Acquisition ... 13
3.6 Data Analysis and Calculation ... 13
3.7 Discussions of Results and Recommendation ... 14
3.8 Conclusion ... 14
3.9 Project Activities ... 14
Chapter 4: Calculation and Formulas ... 18
4.1 Phase Saturation Calculations ... 18
4.2 Oil Recovery Calculation ... 19
4.3 Permeability Calculations ... 20
4.31 Brine Permeability ... 20
4.32 End-point Oil Permeability ... 21
4.33 End-point Water Permeability ... 21
4.34 End-point Oil Relative Permeability ... 22
4.35 End-point Water Relative Permeability ... 22

4.4 Mobility Ratio Calculation 23
4.41 End-point Mobility and Mobility Ratio 23
4.42 Apparent viscosity 25
Chapter 5: Results and Discussions 26
5.1 Discussions 26
Chapter 6 42
6.1 Key Milestone 42
Chapter 7: Tools and Equipment 43
7.1 Tools and Equipment 43
Chapter 8: Conclusion and Recommendation 43
8.1 Conclusion 43
8.2 Recommendation 44

List of Figures

Figure 1: Schematic of Glyceryl monostearate 6
Figure 2: Incremental residual oil recovery 7
Figure 3: Schematic of Guerbet surfactant 9
Figure 4 : Typical injection sequence in chemical flooding 11
Figure 5: Schematic of Relative Permeability System 15
Figure 6: PoroPerm test result 36
Figure 7: Collected brine during oil flood at 90^oC. 37
Figure 8: Collected oil during water flood at 90^oC.. 37
Figure 9: Collected free oil during surfactant slug injection at 90^oC 38
Figure 10: Collected effluent during polymer flood experiment at 90^oC. 38
Figure 11: Pressure drop during brine flood experiment at 90^oC 39
Figure 12: Pressure drop during oil flood experiment at 90^oC 39
Figure 13: Pressure drop during water flood experiment at 90^oC 40
Figure 14: Pressure drop during chemical flooding experiment at 90_oC 40
Figure 15: Cumulative residual oil recovery from original oil saturation 41
Figure 16: Cumulative oil recovery from residual oil saturation 41

List of Tables

Table 1: Surfactant applications in petroleum industry 5
Table 2: Core dimensions 32
Table 3: Permeability and relative permeability values 32
Table 4: Saturation data 33
Table 5: Fluid viscosity 33
Table 6: Chemical concentration 33
Table 7: Flow rate, average pressure drop, injection volume data for the brine flood 34
Table 8: Flow rate, average pressure drop, injection volume data for oil flood 34
Table 9: Flow rate, average pressure drop, injection volume data for water flood.... 34
Table 10: Flow rate, average pressure drop, maximum pressure drop, and injection volume data for the chemical flood experiment 34
Table 11: Mobility ratio for water flooding experiment 35
Table 12: Mobility ration for chemical flooding experiment.................................... 35

List of Equations

Equation 1: Initial oil saturation 18
Equation 2: Residual oil saturation 18
Equation 3: Residual oil recovery 19
Equation 4: Absolute brine permeability 20
Equation 5: Oil permeability 21
Equation 6: Brine Permeability 21
Equation 7: End-point relative oil permeability 22
Equation 8: End-point relative brine permeability 22
Equation 9: Mobility of fluid 23
Equation 10: Mobility ratio 23
Equation 11: End-point mobility ratio 24
Equation 12: Apperent viscosity 25

Chapter 1: Introduction

1.1 Introduction

The use of surfactant flooding as Enhanced Oil Recovery (EOR) has been investigated for many years. One of the limitations in the surfactant flooding is the high reactivity of chemicals with reservoir rock. The effect from the condition is the increase of chemical consumptions and the formation of silicates scale at production wells. A wide variety of surfactant has been tested to investigate the suitable candidate for chemical EOR applications.

Alcohol as additives has reported to be a good co-surfactant. A study of using alcohol as co-surfactant had showed that it is capable of reducing interfacial tension (IFT) between surfactant and crude oil with less concentration of chemical [1]. The combination between surfactant and branched alcohol is expected to eliminate the problems associated with the usage of surfactant alone. In this study, branched alcohol is used as co-surfactant and it is expected to improve the residual oil recovery.

However, one of the governing factors in surfactant flooding efficiency of displacing residual oil is the injection methods applied. There are many injection strategies proposed with different effect on oil recovery and other aspect. However, injection strategies performance differ using different formulation. This study will be based on finding the best injection strategy for well formulated surfactant/co-surfactant using core flooding experiment.

1.2 Problem Statement

One of the governing aspects in enhancing the efficiency of surfactant flooding in recovering residual oil is the injection strategies applied. Already, there are several methods proposed in chemical flooding. However, for surfactant and branched alcohol formulation, the optimum injection strategies are yet to be discovered. For this experiment, the efficiency of surfactant flooding for each different method will be compared based on its capability on recovering residual oil. The term 'higher efficiency' will be referring to the method that recovers most oil during chemical flooding. Furthermore, the experiment will also measure the mobility ratio which will characterize the displacement efficiency between two fluids.

1.3 Objective

The goal of this study is to:

i. Develop efficient method of injecting surfactant formulation that will produce higher efficiency of residual oil recovery.

1.4 Scope of study

The study will be based on finding the optimum method of injection of well formulated surfactants solution with branched alcohol as co-surfactant. Three (3) different methods will be tested in the laboratory to measure the residual oil recovery for each method.

1.5 Relevancy of the project

There are two governing parameters in chemical flooding; which are equilibrium and dynamic effects. For the equilibrium part, it is made of the interfacial activity, adsorption and ionic equilibria (precipitation and complex formation). And for the second part, the dynamic effects which include chromatographic effects, mobility control, flow diversion by precipitates and emulsification. In second part, dynamic effects mostly influenced by the injection strategies of the chemicals. As from this observation, by investigating different method of injection using surfactant/co-surfactant, the dynamic effects during the flooding will take place and measurement will be made to propose the optimum injection method for the formulated solutions. Economically, this will increase the productivity of a well during tertiary recovery using surfactant flooding method.

1.6 Result

The expected result from the experiment is the various recovery performance; the residual oil recovery from each different method. By comparing the performance, the optimum will be proposed. All methods will be utilizing branched alcohol as co-surfactant in chemical solutions for each method tested.

Chapter 2: Literature Review

2.1 Enhanced Oil Recovery

Enhanced oil recovery (EOR) generally refers to method introduced in recovering oil in place using other than natural energy of the reservoir [1]. Oil recovery operations are categorised into three categories; primary, secondary, and tertiary. Primary recovery is the initial production technique, using the natural reservoir drive to displace the oil. Secondary recovery are the stage that been applied to the well after the production from the first recovery had declined. Processes in secondary recovery are waterflooding, pressure maintenance, and gas injection. The tertiary recovery is applied in the third stage of production. Processes for tertiary recovery include miscible gasses, chemicals and thermal energy to displace the oil left in the reservoir after the second stage of production also known as residual oil.

Introduction of tertiary recovery techniques are driven by two factor, economics and technical factor. Tertiary recovery is being implemented to the well which production by the secondary recovery had decreased and cost to operate the well increased. Technical factor that drive the usage of tertiary recovery techniques is the limitation of using secondary technique, for example waterflooding in displacing oil in less accessible parts of the reservoir.

The successfulness of EOR procedure is measured in the amount of the residual oil that able to be displaced from trapped location to the production well.

2.2 Tertiary recovery: Surfactant Flooding

Surfactant EOR has been investigated for many years. With the surge of the crude oil process and technique, scientific researches have been conducted for the improvement of the technique. Surfactant usage well known in stimulation treatments; emulsion prevention, wettability alteration and surface tension reduction. Figure below show some of the surfactants usage in the petroleum industry .

Table 1: Example of surfactant applications in petroleum industry

System	Applications
Solid/Liquid	Reservoir wettability modifiers Reservoir fines stabilizers Tank/vessel sludge dispersants Drilling mud dispersants

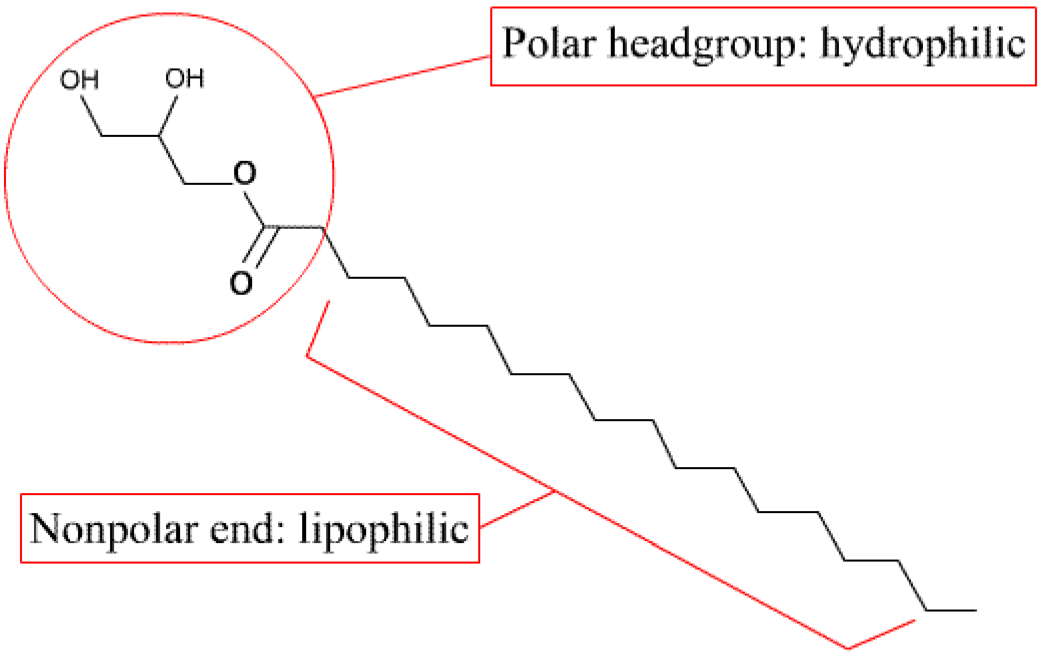
Surfactants generally contained a hydrophilic head, a hydrophobic hydrocarbon tail, and possible intermediate neutral groups [3]. Varieties of the groups are common in surfactant design. Certain structures of the surfactants have been proven can increase oil recovery performance.

Classification and Structure of Surfactants

Surfactant categories are based on the characteristic of the head group [3]. Below are the categories of surfactants:

- Anionic : Negative charge on the head groups
- Cationic : Positive charge on the head groups
- Nonionic : Does not ionize, head group is larger than tail group
- Zwitterionic : Surfactant contains two groups of opposite charge

Figure 1: Schematic of surface-active molecule [9]: Glyceryl monostearate



The most common used surfactants in chemical flooding is sulfonated hydrocarbon. Sulfonated hydrocarbons are effective in attaining low IFT, inexpensive and chemically stable [11]. Basic principle in surfactant flooding is the usage of surfactant is to displace residual oil that is trapped by high capillary forces within the porous media [4]. To drive the oil from its current place, capillary force that holding the oil in place must be decreased and increase the fluid flow viscous force. There are two key points for a surfactant to be considered success; first is by the ability of the surfactant to reduce to interfacial tension between oil and aqueous phase to ultra-low values. Second is the depletion of the surfactant flood which determines the economical success for surfactant flooding.

Limitations for surfactant flooding can be divided into two parts; one which addressed by the formulations of the surfactant/co-surfactant and the other part is addressed by the injection of the surfactant. As this study will cover on the second part; limitation governed by injection strategy of the formulation. A thorough study has been made on these limitations. Surfactant performance mainly reduced due to three factors which are precipitation, adsorption onto the porous medium and phase partitioning into a static or slow-moving phase [1]. Divalent ion of Ca^{++} and Mg^{++} are usually contained in brine. These ions are the contributor of the brine hardness which increased the tendency of surfactant to precipitates. This process occurred due to ion exchange or dissolution between the injected fluids and the divalent ion contained in brine.

Figure 2 below show the effects on incremental residual oil recovery obtained by adding surfactant to the injection solution [4]. One of the common materials added along with surfactant during chemical injection is alcohol. Co-surfactant will be further discussed in the next section.

Figure 2: Incremental residual oil recovery obtained by adding surfactant to the injection solution

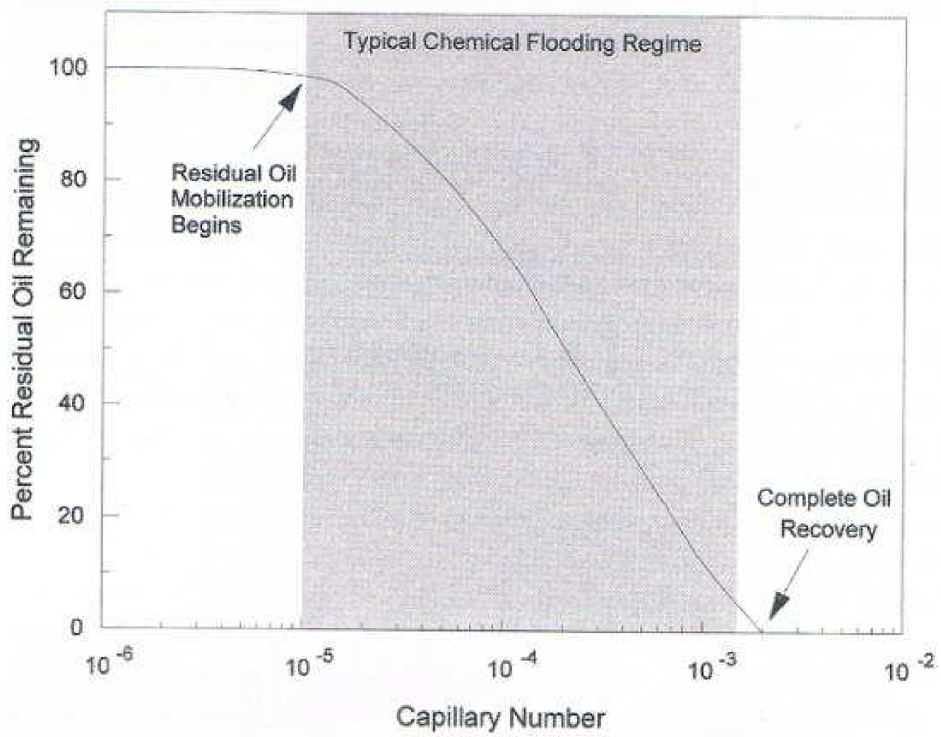


Figure 11.5 Illustration of oil mobilization and recovery due to capillary numbers achieved during chemical flooding.

2.3 Alcohol as Co-surfactant/Co-solvent

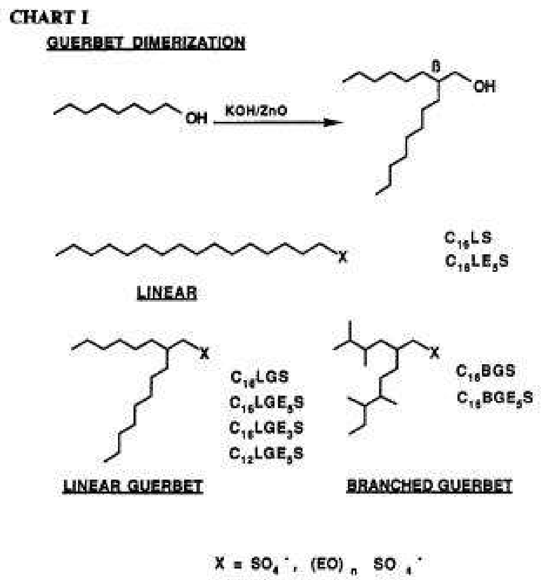
The purpose of introducing co-solvent are to introduce a small molecular weight compound to act at the oil-water interface, get between the surfactant hydrocarbon groups and reduce the viscosity of the oil/water microemulsion [10]. Alcohol is the common candidate as co-solvent. Alcohol properties; polarity, molecular weight, and water solubility differ greatly from one class to other. Alcohol as co-surfactant are effective for oil displacement as long as the two component, surfactant and co-surfactant do not separate. However, separation of this two components cannot be prevent as the retention of the surfactant is usually higher then alcohol.

Various alcohol used as co-solvent thus would have a great effect on the surfactant ability to perform [11]. Salter, J.S had conducted experiments to investigate the effect of the alcohol type and amount of alcohol co-solvent have on the solubility of surfactant alcohol mixture in brines of various salinities [11]. The results from the experiment conducted were reported as 1) the microemulsion viscosity decreases with an increase in the amount of alcohol. 2) The optimal salinity is independent of the amount of alcohol added. 3) Mass fraction of microemulsion phase which results at any salinity increases as the amount of alcohol added to the system is increased. 4) The interfacial tension measured at any salinity increases as the amount of alcohol added to the system is increased.

2.4 Branched Alcohol

Branched alcohol enhanced surfactants study by Varadaraj [7] showed that the effectiveness of surfactant in reduction of IFT in air-water interface dependent on the branching of the side chains and reduction of the total number of carbon. In the experiment, surfactants used were such as $C_{16}LGE_5S$; linear Guerbet Ethoxy surfactant, $C_{16}BGE_5S$; Branched Guerbet Ethoxy surfactant, and $C_{16}LGS$; linear Guerbet sufactant. Efficiency in reducing IFT in Air-Water interface was 5.9, 5.0 and 4.7 respectively. While in Decane -Water interface, the efficiency reported as 5.6 and 5.1 respectively. However, results showed that further branching of Guerbet surfactant, $C_{16}BGE_5S$ reduces the efficiency back to 5.0. **Figure 3** below show the schematic of Guerbet surfactant. It can be conclude that linear branching of the co-surfactant or in this case, Guerbet alcohol gave positive effects on efficiency of the surfactant performance in reducing IFT.

Figure 3: Schematic of Guerbet surfactant



2.5 Injection Method

Injection strategies are one of the aspects for optimization in surfactant flooding. Injection strategies for formulation of surfactant/co-surfactant have a great effect in the chromatographic effect, mobility control, flow diversion by precipitates and emulsification [8]. Different injection methods of surfactant/co-surfactant into the well have been proposed [10]. Studies have been made using Alkaline Surfactant Polymer (AFP) to investigate the effect injection strategies. Examples of the injection method commonly used in AFP are:

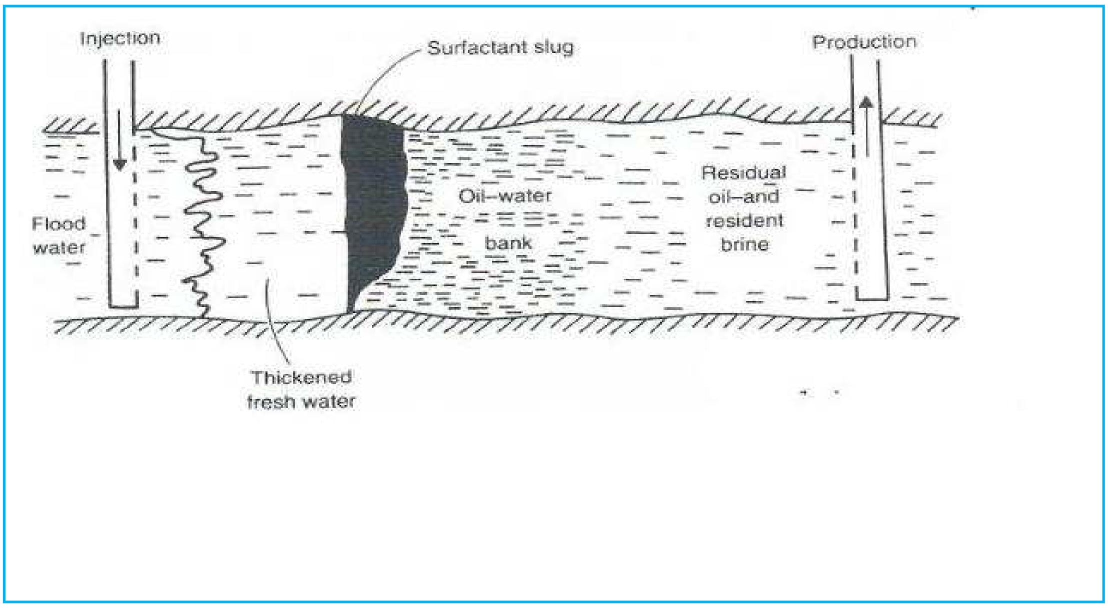
1. By combining of alkali, surfactant and polymer into a single slug followed by more polymer
2. By combining alkali and surfactant into a single slug, followed by polymer
3. Preinjection of alkali to condition the reservoir
4. Surfactant followed by alkaline polymer
5. Injection of oil soluble acids followed by alkali

Experiment conducted by Troy R. French and Charles B. Josephson [8] to investigate the effect of injection strategy on ASP. Chemical used in the experiment was Petrostep B-110, Petrostep B-105 surfactant, $NaHCO_3$, Na2CO3, NaCl and Flocon 4800-CX biopolymer. Core flooding experiment was conducted using Barea core and crude oil from Tucker sand of Hepler field. Methods tested in the experiment were:

1. Surfactant followed by polymer
2. Surfactant followed by alkaline polymer
3. Alkaline surfactant followed by polymer
4. Alkali, surfactant and polymer mixed in single formulation.

The observation from the experiment shows that using method three (3); alkaline surfactant followed by polymer give the highest oil recovery. Below is figure that shows the typical injection sequence in chemical flooding:

Figure 4 : Typical injection sequence in chemical flooding



However, no extensive works have been done using branched alcohol instead of alkaline. From the result of the AFP experiment, it is clearly shows that injection strategies of the chemicals contribute in the surfactant flooding performance. Thus, it is logical to perform a study for finding the best injection strategy for an optimized formulation of surfactant/co-surfactant.

Chapter 3: Research Methodology

3.1 Problem statement

Calculate the residual oil recovery for different method of injection strategies using well formulated surfactant/co-surfactant solution.

3.2 Project objective

Provide the optimum injection method for surfactant by utilizing branched alcohol as co-surfactant. The optimum injection method will be indicated by the amount of residual oil recovered from core flooding experiment.

3.3 Background study

Oil recovery operation can be divided into three stages; primary recovery, secondary recovery, and tertiary recovery. This study is included under Enhanced Oil Recovery (EOR) for tertiary recovery. Tertiary recovery is the third stage in the oil recovery processes. The first stage, primary recovery is the displacement of oil from reservoir to production well by the mean natural drive; water drive, gas drive and gravity drainage. After depletion in production under the first stage, the second stage of recovery is introduced to the well. The most common methods of secondary recovery are water flooding, pressure maintenance and gas injection. However, in secondary recovery stage, water flooding is more widely used. The study conducted falls under the third category of EOR which is tertiary recovery. Methods used in tertiary recovery are by injecting chemicals, thermal energy and miscible gasses. Chemicals injected into the wells have different effect on the oil recovery. Upon using the optimum formulation of chemical, the strategies of injection also greatly influence the flooding efficiency. The background of the study conducted is to measure the residual oil recovery in tertiary EOR by using different methods of injection. Chemicals formulations to be used in this study are assumed to be at optimum condition.

3.4 Literature Review and Theory

Literature of this project was conducted by based on the research papers produced on the particular topic. Papers that reviewed were regarding the experiments that had been conducted on the surfactant, co-surfactant and injection strategies of formulations. Also included was, the experimental procedures conducted for Barea coreflooding and the experiment for various injection methods using chemicals. Calculations for determining compulsory items in oil recovery in coreflooding experiment also reviewed.

3.5 Data Acquisition

Coreflooding experiment will be conducted in the laboratory for each strategies of injection. 4 Barea cores will be used throughout the experiments. The data from the cores; bulk volume, diameter, length and dry mass will be recorded. In the preflood process, initial brine saturation, initial oil saturation, residual oil saturation and permeability will be recorded for each core. During chemical flooding, residual oil recovery will be recorded. All experiments will be conducted in the same duration to eliminate inconsistent in data acquisitions.

3.6 Data Analysis and Calculation

Efficiency of residual oil displacement will be calculated based on the data collected during chemical flooding. Efficiency of the displacement will be compared to the injection method used. Data will be represented in graph.

3.7 Discussions of Results and Recommendation

The outcomes of the experiment conducted will be analysed. The optimum method of injecting chemicals into the core will be discussed further on the relevancy to be used in the field work. Possible enhancement in the study carried will be proposed for a better outcome.

3.8 Conclusion

The objective of the project will be reviewed. Project will proposed the best method in injecting chemicals into the core.

3.9 Project Activities

To achieve the objective of the project, core flood experiment needed to be performed. Listed below is the summary of activities to be done in conducting laboratory experiment of coreflooding:

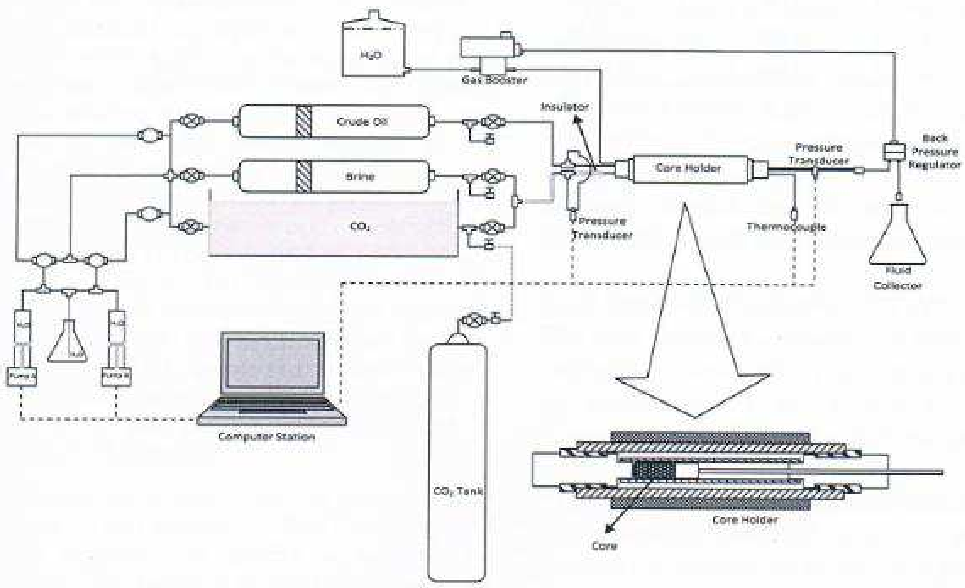
1. Core preparations; using 3 cores, each for different method. Cores were labelled as ID 1, ID 2 and ID 3.
2. Preflooding of the core; brine flooding, crude flooding and water flooding
3. Chemical flooding; using the various injection method proposed
4. Collection of residual oil recovered by chemical flooding
5. Calculations on the efficiency of each methods of injection

Apparatus

Porosity is measured using **PoroPerm Equipment.** The equipment utilizes Nitrogen gas for confining pressure and valves operating, and Helium gas as the measurement fluid. The measurement principal is based on the unsteady state method (pressure fall-off) and the pore volume is determined using the Boyle’s Law technique.

Core flooding equipment that is used in this experiment is **Relative Permeability Test System Equipment (RPS)**. Schematic of the equipment is as per **Figure 5.** This equipment can provide core displacement operation by injecting fluids from accumulators into the provided core holder. Three separated accumulator are installed to gather each of injection fluids that could endure pressure to 10,000 psig.

Figure 5: Schematic of Relative Permeability System



Core cleaning

Core to be clean in CO_2 core cleaning machine which use toluene to remove dissolved hydrocarbon and using methanol to remove dissolved mineral.

Pre-flood Procedure

1. Brine flooding.

- Core first saturated with brine for a period of 8 to 10 hours and under 1200 psig of pressure.
- The flooded core then weighs to measure mass of saturated core for pore volume and porosity.
- Core then flooded with brine at 1 mL/min, back pressure of 1500 psig and confining pressure of 2000 psig.
- The flushed core then use to obtain a brine permeability value.

2. Crude oil flooding.

- Core then will be flooded with crude oil at flow rate of 0.8 mL/min until no more water is produced and the core is saturated with oil.
- Effluent from the core then is collected using a measuring tube.

3. Water flooding.

- Core then will be flooded with formation water at the flow rate of 1 mL/min. The process will be continued until no more oil is produced. Pressure drop, volume of oil and brine are recorded..
- The effluent collected in measuring tube can be used to calculate the recovered oil volume.

Chemical Flooding Procedure

1. Surfactant flooding.

- Different methods of injecting surfactant and co-surfactant will be used to test the most optimum method in injecting the surfactant.
- A specified amount of surfactant and co-surfactant will be chosen as the optimum formulations.[1]
- Below are the proposed method for injecting the surfactant:

• Surfactant and branched alcohol mixture prior to injection of chase water
• Surfactant injection followed by branched alcohol and followed chase water
• Branched alcohol injection followed by surfactant and then chase water

Effluent Analysis

Effluent collected in the measuring tube based on each method will be in the form of microemulsions. To break the microemulsion phase, effluent will be heated using hot plate. Produced result from the heating process is oil and aqueous phase. The effluent collected will be poured into glass vials and heated to 120 ^oC for 24 hours. The recovered oil volume then can be measured. Volume of residual oil recovered is more accurate measured in the liquid phase instead of microemulsion phase.

[1] Based on Experimental Study of The Benefits of Branched Alcohol On Surfactant for Enhanced Oil Recovery : Fluid – Fluid Study by Nik Mohd Qusyairi b Zulkifli

Chapter 4: Calculation and Formulas

4.1 Phase Saturation Calculations

Brine saturated core were flooded with oil to residual brine saturation and the flooded with brine to residual oil saturation. Calculating these residual saturation values is important for modelling relative permeability curves and for determining the volume of oil which is recoverable during chemical flood experiment.

After oil flood, the volume of water recovered can be used to calculate the initial oil saturation. The recovered water volume is replaced by oil in the core and represents the oil volume that saturates the core. Initial oil saturation therefore the ratio of recovered over water to total pore volume. During the water flood, a significant amount of oil will be recovered which can be use in calculating the residual oil saturation by subtracting from initial oil. These equations are as below:

Equation 1: Initial oil saturation

After oil flood:

$$So = \frac{Vw}{Vp}$$

Equation 2: Residual oil saturation

After water flood:

$$Sro = \frac{Vw - Vo}{Vp}$$

S_o = Initial Oil Saturation

S_{ro} = residual oil saturation

V_w = Produced water during oil flood

V_o = Produced oil volume during water flood

V_p = Pore Volume

4.2 Oil Recovery Calculation

Chemical flooding will recover the residual oil remaining after the water flood. Effluent is collected in several glass tubes, with oil recovered in two phases, free oil or microemulsion phase. Free oil volumes are easily measured from the markings on the tube, while microemulsions are first broken through heating before measuring the free oil volume. The percentage of the residual oil recovered is given as:

Equation 3: Residual oil recovery

$$\%Recovery = \frac{Vo,i}{SorVp}\ X\ 100\%$$

%Recovery = Percent residual oil recovered

$V_{o,i}$ = Volume of oil collected from effluent after heated on hot plate

S_{ro} = Residual oil saturation

V_p = Pore volume

4.3 Permeability Calculations

4.31 Brine Permeability

Core initially saturated with synthetic brine. Further flooding with brine conducted to measure the absolute brine permeability of the core sample. The core has no oil saturation at this time, a single phase Darcy's Law is rearranged as such:

Equation 4: Absolute brine permeability

$$Kbrine = \frac{q\mu L}{A\Delta P}$$

Kbrine = Absolute brine permeability

Q = Brine flow rate

ΔP = Total pressure drop (steady-state)

μ = Brine viscosity

L = Core length

A = Core cross sectional area

4.32 End-point Oil Permeability

Brine saturated core then will undergo crude oil flooding to displace the core until containing only connate water or residual brine saturation end-point has been reached. Flow at this point is assumed to be steady–state, single phase and constant pressure and flow rate. Based on the assumptions made, Darcy's law is used to calculate the permeability of the oil phase as:

Equation 5: Oil permeability

$$Ko = \frac{qo\mu oL}{A\Delta P}$$

K_o = Permeability to oil

Q_o = Oil flow rate (steady state)

μ_o = Oil viscosity

4.33 End-point Water Permeability

As the core passed the crude oil flooding, it will further undergo a water flooding. In which will displace the crude inside the core up to residual oil saturation end point. Using the same assumptions as the above equation but using oil, brine phase permeability is defined as K_w to distinguish it from total permeability of K_{brine}.

Equation 6: Brine Permeability

$$Kw = \frac{qw\mu wL}{A\Delta P}$$

K_w = Permeability to brine phase

Q_w = Brine flow rate (steady-state)

μ_o = Brine viscosity

4.34 End-point Oil Relative Permeability

End point relative permeability is given as the ratio of a certain phase permeability to the total brine permeability at the point where Sw = 1. Calculation for both, oil and brine end-point relative permeability are given as below:

Equation 7: End-point relative oil permeability

$$Kro = \frac{Ko}{Kbrine}$$

K_{ro} = End-point relative oil permeability

K_o = Oil phase permeability

K_{brine} = total brine permeability

4.35 End-point Water Relative Permeability

Equation 8: End-point relative brine permeability

$$Krw = \frac{Kw}{Kbrine}$$

K_{rw} = End-point relative brine permeability

K_w= Brine phase permeability

K_{brine} = Total brine permeability

4.4 Mobility Ratio Calculation

4.41 End-point Mobility and Mobility Ratio

The mobility ratio is a dimensionless number that helps characterize the displacement efficiency between two fluids. For each fluid, mobility value for itself is defined as:

Equation 9: Mobility of fluid

$$\lambda i = \frac{Ki}{\mu i}$$

λ_i = Mobility of fluid i

μ_i = Viscosity of fluid i

K_i = effective permeability to fluid i

Equation 10: Mobility ratio

$$M = \frac{\lambda displacing\ fluid}{\lambda displaced\ fluid}$$

M = Mobility ratio

λ displacing fluid = Mobility number for the displacing fluid

λ displaced fluid = Mobility number for the displaced fluid

During core flood procedure, effective permeability values of oil and water phases were measure as end-point permeability values relative to the total brine permeability and these end-point relative permeability values can be used to calculate an end-point mobility ratio such as:

Equation 11: End-point mobility ratio

$$M^o = \frac{\lambda w}{\lambda o} = \frac{Kw/\mu w}{Ko/\mu o}$$

M^o = End-point mobility ratio

K_o = Oil relative permeability

K_w = Water relative permeability

μ_o = Oil viscosity

μ_w = Water viscosity

For core flood experiment, a mobility ratio less than one is favourable in displacement while the value greater than one is considered unfavourable. This is due to the oil relative permeability is generally larger than the water relative permeability, a water viscosity higher than the oil viscosity is necessary to obtain a mobility ratio favourable for displacement.

4.42 Apparent viscosity

In designing surfactant and polymer, apparent viscosity must be predetermined to be equal or greater than the inverse of the total relative mobility. This is to ensure that the mobility ratio less than one during the flooding process. The apparent viscosity can be calculated as given:

Equation 12: Apperent viscosity

$$\mu app = \frac{1}{\lambda trm} = \frac{1}{\frac{Krw}{\mu rw} + \frac{Kro}{\mu o}}$$

μ_{app} = Apparent viscosity

λ_{app} = Total relative mobility

μ_{w} = Brine viscosity

μ_{o} = Oil viscosity

K_{rw} = Relative brine permeability

K_{ro} = Relative oil permeability

Chapter 5: Results and Discussions

5.1 Discussions

A core flood experiment was conducted to test whether the selected chemicals, the ratio of chemical; surfactant and co-surfactant and the method of injection are capable of recovering a significant volume of residual oil from a core. The core flood experiment conducted for this study mainly to measure the recovery of the residual oil for different method of injection using the same chemical formulation. It was uncertain about the effect of the method of injection to percentage of oil recovered. However, due to limited chemical stock; branched alcohol, the experiment was only able to be conducted using the first method. The reason for the shortage of the chemical is due to the equipment used in conducting the experiment required a minimum volume of liquid before can flooded into the core. Thus, only the first method was able to be performed and below is the data and discussion from the experiment conducted.

Core Data

A sandstone core was used in the core flood experiment and property data used to characterize the core are shown in **Table 2, 3 & 4.** These property data covering; core dimensions and pore volume, permeability and relative permeability and initial and residual saturation values. The crude used in the core flood experiment, Dulang crude oil is produced from Dulang field where the well temperature is 90^{o}C, thus the core flood experiment was conducted at the particular temperature.

The core was 3.9 cm long and 3.8 cm in diameter with 17.4% porosity giving the total pore volume of 7.715 mL. Porosity and air permeability was measured using Poroperm equipment which used Nitrogen gas as the medium. Air permeability for the core was reported as 51.1 mD.

As the flooding experiment follow set of preliminary flooding; brine flood, crude flood, water flood and chemical flood, permeability and relative permeability values can be calculated from collected pressure drop and flow rate data. During brine flooding, the core which was initially saturated with synthetic brine of 58000 ppm of NaCl (optimum salinity) was flooded with brine. The calculated permeability gives the total brine permeability of the core which was 21.3mD. End-point oil permeability can be calculated when the core contained residual water saturation. Calculation gave the value as 17.4mD. During water flood, the end-point brine permeability can be calculated which give the value of 9.7mD. Using both, end-point permeability for oil and water, relative end-point permeability for oil and water can be calculated which gave the value of 0.82 and 0.46 respectively.

Initial and residual saturation values were calculated from recovered oil and water volumes during the oil and water flood experiments. The oil flood experiment showed the initial oil saturation of 0.774 with a residual water saturation of 0.226. The water flood experiment rendered an residual oil saturation value of 0.52 thus giving the initial water saturation of 0.48. The core then was ready to be flooded with chemical and the recovering of the residual oil then can be achieved which is the main objective of the experiment.

Injected Fluid data

Synthetic Formation Brine

Synthetic brine used in the experiment initial to saturate the dry core and to flood the core during the brine flood and water flood experiments. Brine formation used in the experiment consisting of Na^{+} and Cl^{++} ions which however neglected other major hardness contributors which are Mg^{++} and Ca^{++}. The brine viscosity was measured using a Viscometer which provides the value of 3cp (shown in **Table 5)**. The measurement however conducted at room temperature of 25^{o}C due to limited facility.

Surfactant Slug and Polymer Drive

In the experiment conducted, the main purpose was to investigate how much of residual oil can be recover using surfactant and branched alcohol in different method of injections. For the first method; surfactant and branched alcohol mixed prior injection of polymer. Surfactant used was Dimethyloctadecyl Ammonio and branched alcohol of 2-Methyl 1-Butanol. The selection of chemical was based on good phase behaviour experiment conducted in fluid-fluid study. The concentration for the surfactant was 2 wt% while for the alcohol was at 0.3 wt% and brine concentration was 5.8wt% NaCl. The ratio based on fluid-fluid study between the surfactant and co-surfactant was at 10:3

The formulation selection for the polymer drive was 1000ppm Polyachralamide. The purpose of preparing the polymer was only to act as a mobility buffer to ensure that no loss of surfactant into channels inside the core. It is also to be as a sweeping agent to ensure that all the surfactant is being moved from the core inlet and flushed through up to the core outlet. The mobility ratio for the polymer drive and surfactant was calculated based on the viscosity of each liquid. Using a Viscometer, the surfactant/co-surfactant and the polymer viscosity were measure which gave the value of 0.7 cp and 6 cp respectively. Using the relative permeability of each phase, the mobility ratio between the displacing fluid and the displaced fluid can be calculated. The calculation gave the value for water/crude and chemical/polymer flood experiment of 0.928 and 1.09 respectively (**Table 5)**. The value of mobility ratio is considered preferable for a chemical flooding if it is less than or equal to one. And the value larger than one is considered unfavourable. For the polymer flood, the value is slightly above 1 but it still considered favourable since the measuring of the viscosity for the phase may had been inaccurate due to machine and human error.

Core Saturation and Preliminary Fluid Injection

Brine Flooding

Brine flood procedure was conducted using a total of 1000mL of synthetic brine containing 58000ppm NaCl. Brine was injected at the flow rate of 1.5 mL/min and the inlet pressure was set at 1000 psig and the confining pressure of 2000 psig. The brine was injected throughout the core and the pressure drop across the core was recorded directly in term of time versus the differential pressure between inlet and outlet. The flooding process was continued until the pressure difference or ΔP becoming constant. This procedure gave the average pressure drop of 3.104 psig (as shown in **Figure 11**). Using this data, flow rate data and core dimensions, the permeability of brine which represents the absolute permeability of the core can be calculated. Result showed the value of 21.3mD (**Table 3).** This is the basis for calculating relative permeability calculations for other liquid phase.

Crude Oil Flooding

The oil flood was conducted using a total of 500 mL of Dulang crude oil. The flooding experiment run by injecting a constant flow rate of the crude into the core at rate of 1.0 mL/min and the inlet pressure of 1000 psig and confining pressure of 2000 psig. The process was continued until no more water produced inside the glass tube. Data recorded including; the pressure drop, time elapsed and the flow rate which the experiment was conducted. From the results (Refer **Figure 12)**, calculation can be made in finding the average pressure drop. Assuming the pressure drop had become constant at the end of the injection procedure, the flow rate is assumed under a steady-state condition. The average pressure drop as the core was in the steady-state was at 9.531 psig (**Table 8)**. Using the data, permeability then can be calculated which gave the value of 17.4 mD (**Table 3)**.

Water Flooding

The water flood experiment had conducted by injecting the synthetic brine at a constant flow rate of 1.5 mL/min. The injection process was continued until no more oil was produced from the core. Data recorded for the water flood experiment to measure the pressure drop versus the pore volume of brine injected. **Figure 13** shows the pressure drop across the core versus the pore volume of synthetic brine injected. The brine injected continued until the pressure drop across the core almost constant which shows that the core is in steady-state condition. An average pressure drop of 24.6 psig was recorded. An end-point permeability of 9.7mD (**Table 3)** was calculated for the core, which corresponded to an end-point relative brine permeability of 0.46 (**Table 3)**

Surfactant/Co-surfactant/Polymer Flooding

Using the first method of injection; surfactant and co-surfactant mixed readily before flooded into the core. Surfactant and co-surfactant mixture was injected initially at 0.2 mL/min for 0.25 PV and was followed by polymer drive at the flow rate of 1.5 mL until no more oil is produced from the core. Pressure drop across the core was recorded starting from the injection of 0.25 PV of surfactant mixture and continued by the injection of polymer drive. Result of the flood experiment is as shown as in **Figure 14.** Average pressure drop during the surfactant flood was recorded as 3.1 psig and for the polymer drive was 20.3 psig.

Effluent Analysis

Effluent was collected in 10mL glass tube. The process repeated until no more oil is produced and the core flowed in steady-state under the polymer flood. The injection of first 0.25 PV of surfactant slug produced 2mL of oil in the glass tube. While for the next flood; polymer flood experiment the oil produced was in the lower quantity which mostly 0.2mL to 0.3mL per glass tube.

Oil Recovery

Figure 15 shows plot of cumulative oil recovery versus pore volumes injected. Based on the oil collected, the residual oil recovered can be calculated based on the residual oil saturation before chemical flood experiment. The chemical flood recovered about 50% of the residual oil during oil bank production and 39% recovered during microemulsion production.

Experiment 1:

Surfactant and branched alcohol mixed prior injecting to the core

Table 2: Dimensions of the core used in the chemical flood using the first method of injection

Core Name	ID-2	
Pore Volume	PV	7.715 ml
Porosity	Ø	17.247
Length	cm	3.9
Diameter	cm	3.8
Air Permeability	mD	51.11

Table 3: Permeability and relative permeability values of the barea Sandstone core used in the chemical flood experiment in the first method of injection

Absolute brine permeability	Kbrine	21.3 mD
End-point oil permeability	Ko	17.4 mD
End-point brine permeability	Kw	9.7 mD
End-point relative oil permeability	Kro	0.82
End-point relative brine permeability	Krw	0.46

Table 4: Saturation data calculated for core used on the chemical flood using the first method

Initial water saturation	Sw	0.226
Residual water saturation	Srw	0.48
Initial oil saturation	So	0.774
Residual oil saturation	Sro	0.52

Table 5: Viscosity of fluids used in the chemical flood. All viscosity values was measure at ambient temperature and pressure; 25 ^{o}C and 1 atm

Brine Viscosity	μ_w	3	cp
Crude oil viscosity	μ_o	5	cp
Surfactant slug viscosity	μ_s	0.7	cp
Polymer drive viscosity	μ_p	6	cp

Table 6: Chemical concentration used in the surfactant slugfor the chemical flood experiment

Dimethyloctadecyl Ammonio (Propane Sulfonate)	2.0	wt%
2-Methyl 1-Butanol	0.3	wt%
Polyacralamide	0.1	wt%
NaCl (optimal salinity)	5.8	wt%

Table 7: Flow rate, average pressure drop, injection volume data for the brine flood experiment

Flow rate	1.5	mL/min
Pressure drop (average)	3.104	Psi

Table 8: Flow rate, average pressure drop, injection volume data for oil flood experiment

Flow rate	1.0	mL/min
Pressure drop (average)	9.531	Psi

Table 9: Flow rate, average pressure drop, injection volume data for water flood experiment

Flow rate	1.5	mL/min
Pressure drop (average)	24.6	Psi

Table 10: Flow rate, average pressure drop, maximum pressure drop, and injection volume data for the chemical flood experiment

Flow rate	0.2	mL/min
Pressure drop (average)	3.102	Psi
Max pressure drop	5.72	Psi
Surfactant slug volume	0.25	PV
Polymer drive volume	*	PV

*Polymer drive was injected until no oil was produced from the core

Mobility and Mobility Ratio Calculation

Table 11: Mobility ratio for water flooding experiment

	Viscosity	Permeability	Mobility
Displacing Fluid (Brine)	3	9.7	3.23
Displaced Fluid (Crude)	5	17.4	3.48
Mobility Ratio			0.928

Table 12: Mobility ratio for chemical flooding experiment

	Viscosity	Permeability	Mobility
Displacing Fluid (Polymer)	6	17.73	2.96
Displaced Fluid (Surfactant)	0.2	1.89	0.95
Mobility Ratio			1.09

Core Data from PoroPerm

Measurement:

Core	Vp	Kair	Vgrain	porosity	Vbulk	Grain Density	Bulk density
syafiq	5.875915	4.9392	38.36818	13.28068	44.2441	2.66499471	2.311065
syafiq-ID1	5.967744	4.862592	38.27635	13.48823	44.2441	2.67138831	2.311065
syafiq-**ID2**	7.715374	51.1087	37.01971	17.24681	44.73508	2.60993421	2.159804
syafiq-ID3	7.990991	43.08901	35.9631	18.18031	43.95409	2.65828021	2.174997

Figure 6: PoroPerm test result

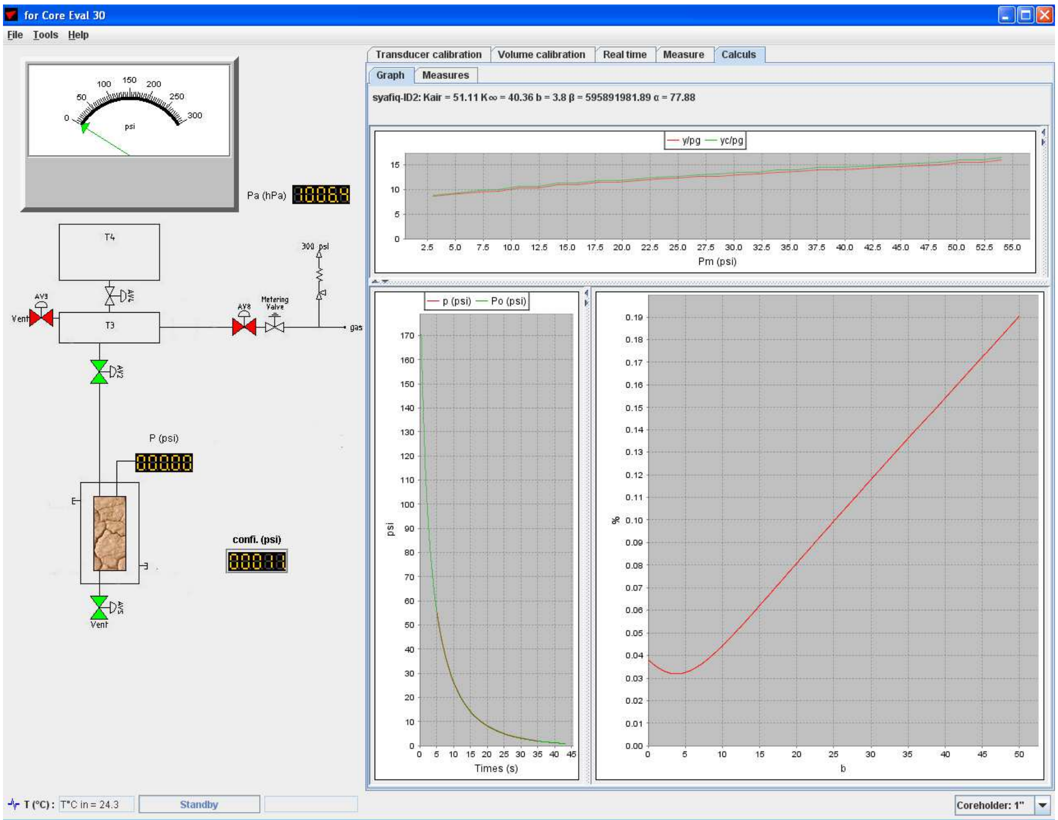


Figure 7: Collected brine during oil flood at 90^{o}C.

Figure 8: Collected oil during water flood at 90^{o}C.

Figure 9: Collected free oil during surfactant slug injection at 90^{o}C.

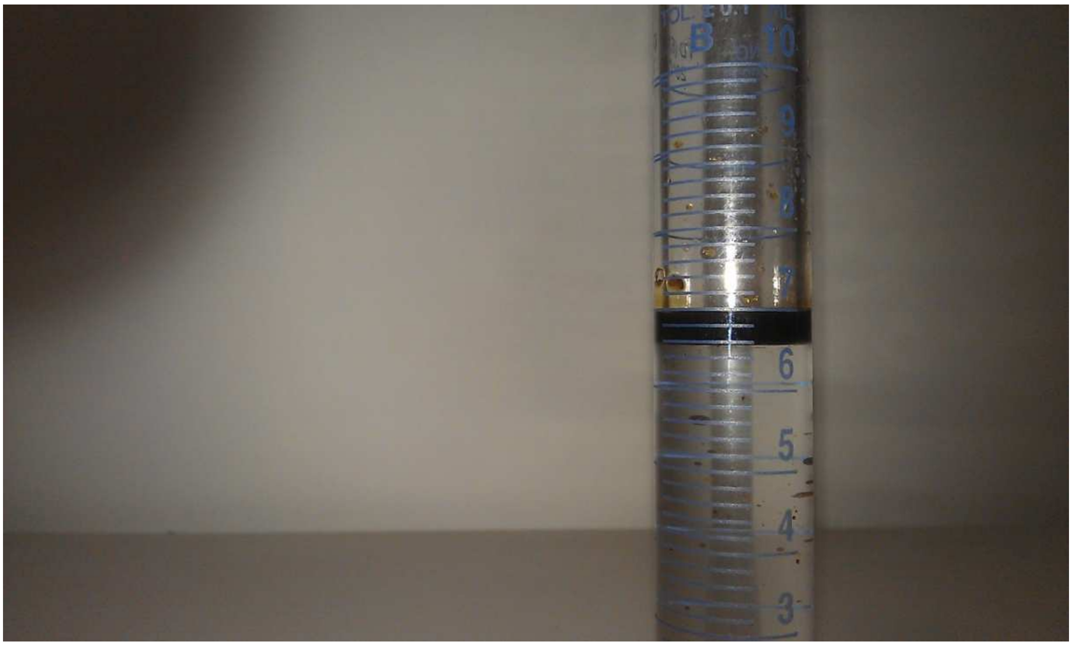


Figure 10: One of measuring tube which used to collect effluent during polymer flood at 90^{o}C.

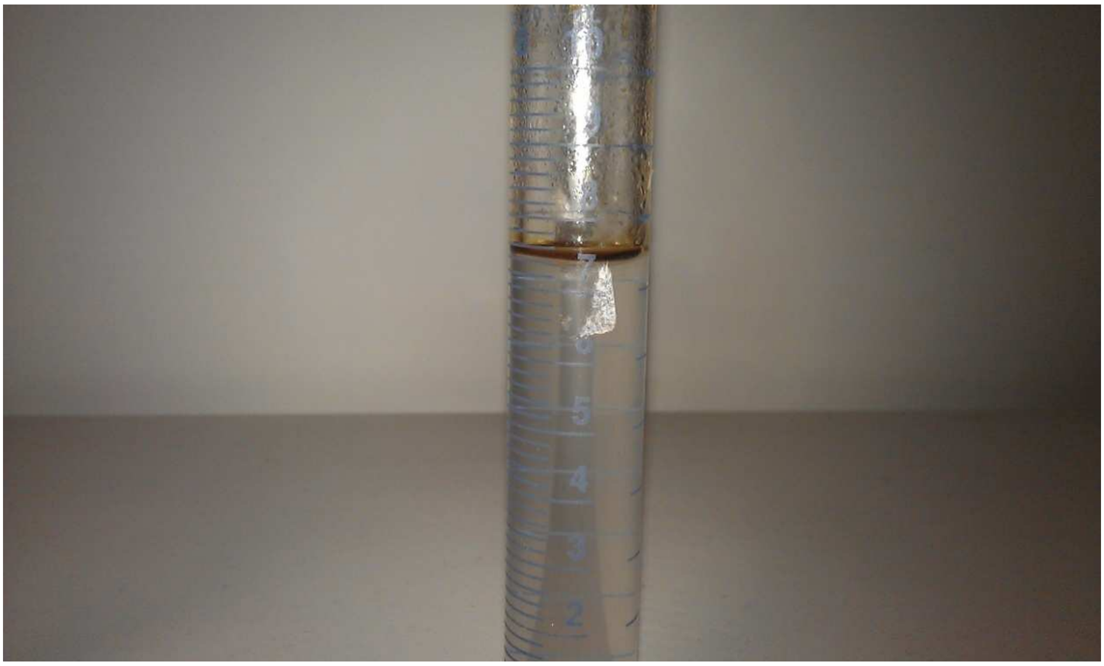


Figure 11: Pressure drop across the entire core versus pore volumes of injected synthetic formation brine during **brine flood experiment** at 90^{o}C

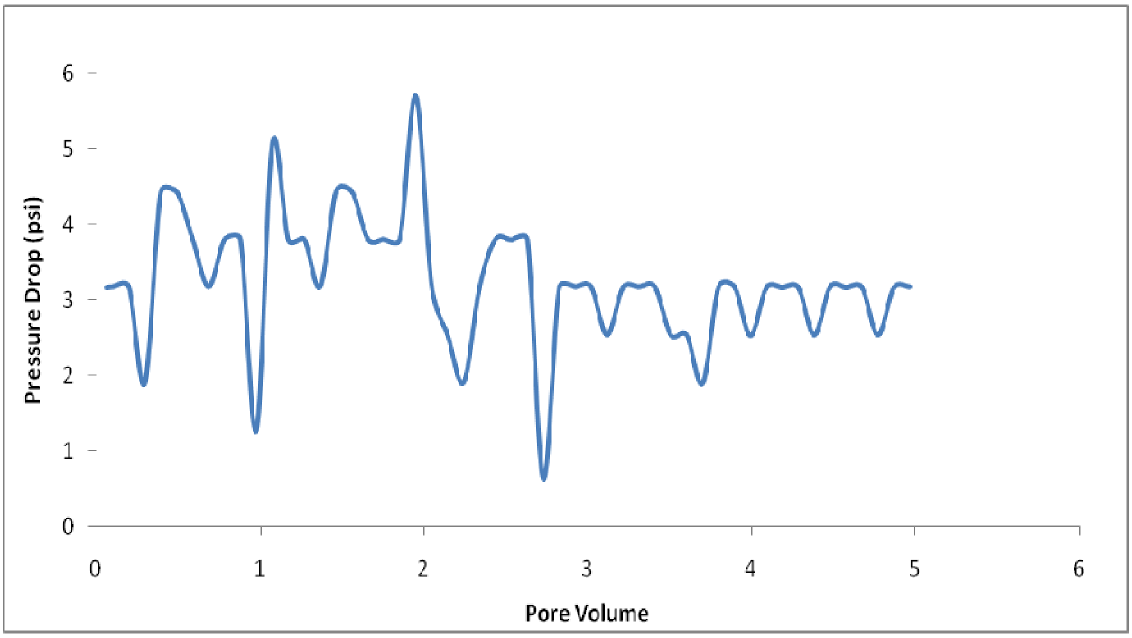


Figure 12: Pressure drop across the entire core versus pore volumes of Dulang crude injected during the **oil flood experiment** at 90^{o}C

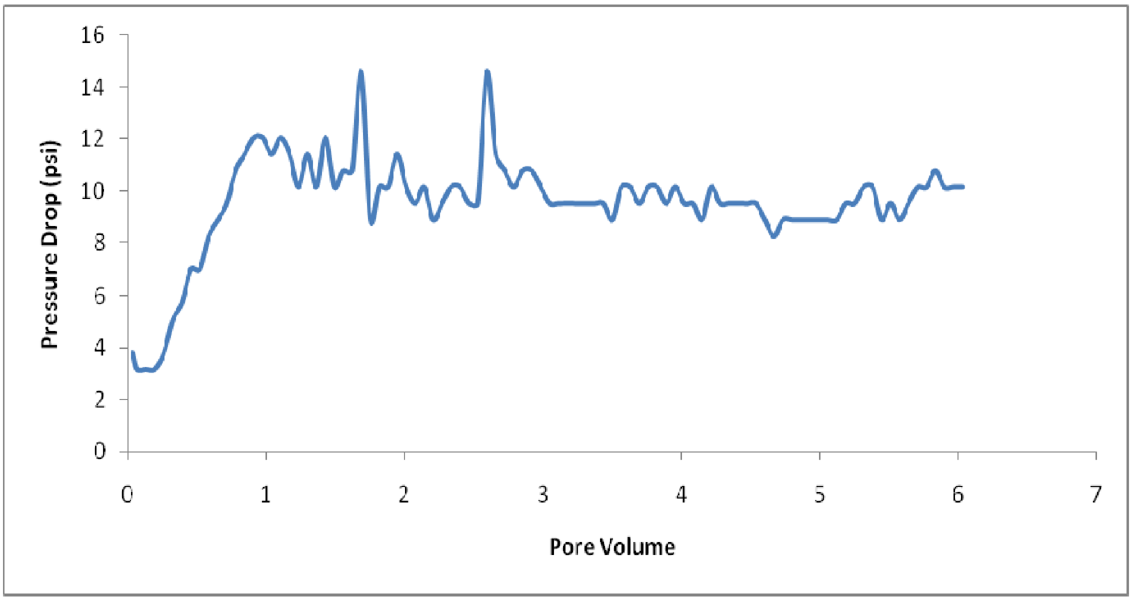


Figure 13: Pressure drop across the entire core versus pore volumes of synthetic formation brine injected during the **water flood experiment** at 90^{o}C

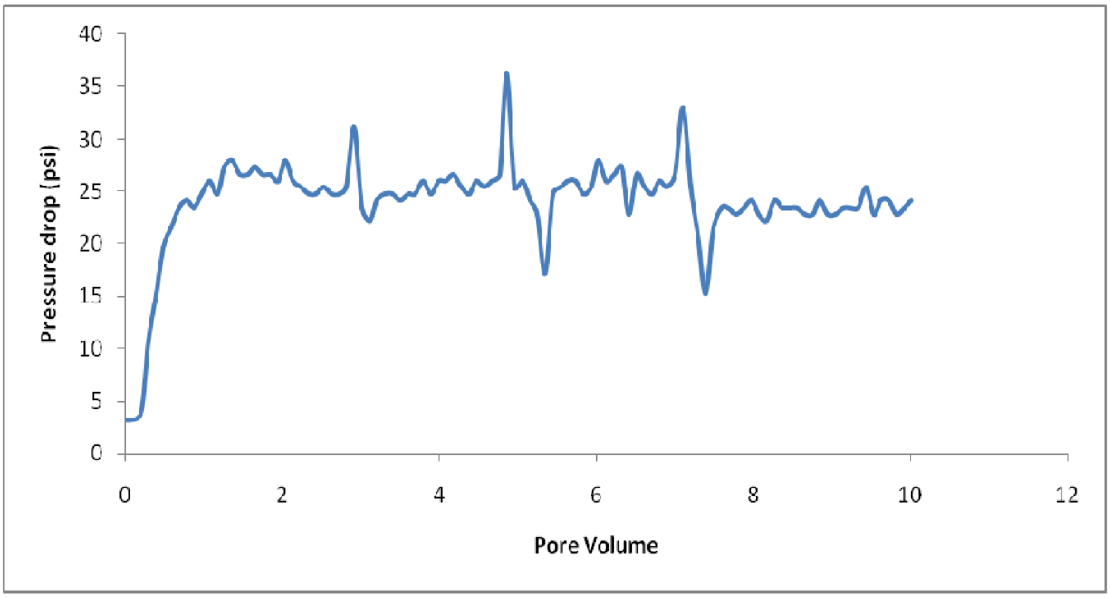


Figure 14: Pressure drop across the entire core versus pore volume injected. **Surfactant slug** was injected for the first 0.25 PV and **polymer drive** for the remaining until the no more oil is produced. The experiment was performed at 90^{o}C

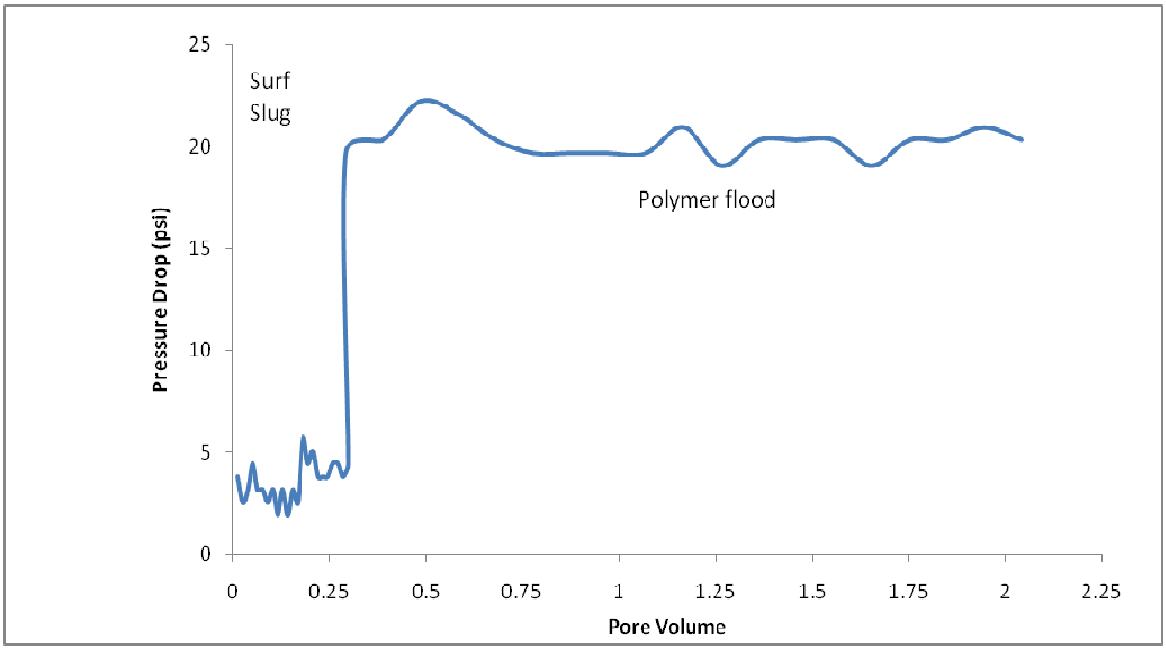


Figure 15: Cumulative residual oil recovery from original oil saturation during water flood data obtained from effluent analysis of the core flood with Dulang crude oil

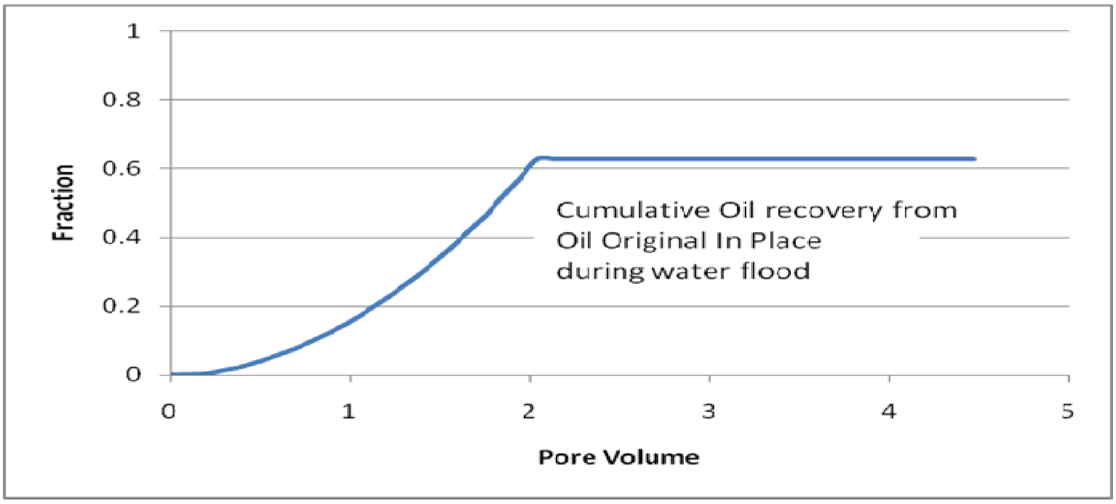
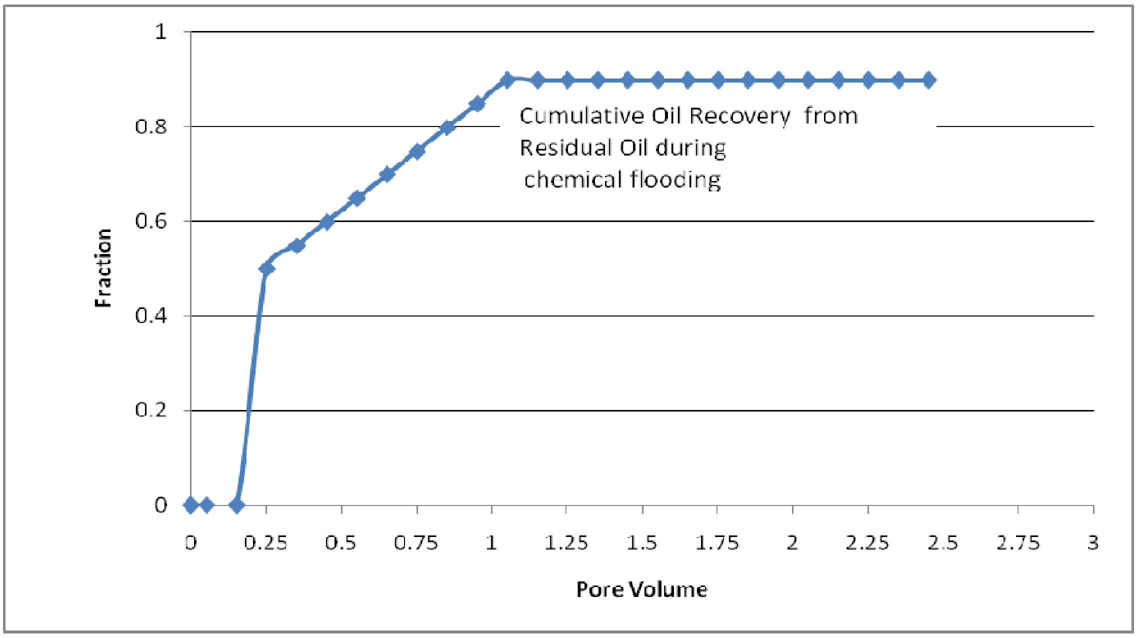


Figure 16: Cumulative oil recovery from residual oil during chemical flooding



Chapter 6

6.1 Key Milestone

Week	Project
1-2	Final Year Project Topic selection period
2-5	Performed research on the topic: Surfactant Co-surfactant Fluid-Rock study
6	Proposal submission: Initial objective was to investigate the effect of using branched alcohol on IFT, Adsorption, and Oil recovery
8-10	Proposal defence: Need to narrow the scope of work
11-13	Interim report preparation: Study on the effect of injection method on ASP flooding Project objective narrowed to find the optimum injection strategy for the formulated surfactant solution by Nik Mohd Qusyairi
14-16	Study on operating Relative Permeability Test System Assisting Nik Mohd Qusyairi in the fluid-fluid study
17-19	Start the preparation of cores to be used in core flooding experiments. 3 cores will be cleaned, measured and preflooding procedures will be conducted.
20-22	Chemical flooding will be conducted. Based on the formulations given by Nik Mohd Qusyairi
23-24	Final report and poster preparation

Chapter 7: Tools and Equipment

7.1 Tools and Equipment

1. Measuring tube
2. Relative Permeability Test System Equipment
3. PoroPerm Equipment
4. Hot plate
5. Mass balance
6. Rack

Chapter 8: Conclusion and Recommendation

8.1 Conclusion

Core flood experiment was conducted to investigate the difference capability of recovering residual oil using different method of injection. However, due to limitation of chemical stock (branched alcohol) the objective of the experiment failed to be achieved. Therefore, only the first method of injection which was put into test, it was tested that the method is able to recover the residual oil and this can be used as the benchmark of using branched alcohol as co-surfactant. This experiment was conducted as the continuation from phase behaviour study using the formulations.

The core flood experiment in this researched demonstrated that using a branched alcohol as co-surfactant with the suitable surfactant can recover trapped oil inside the pore spaces in the core. The result from the experiment was found as favourable as in term of oil recovered; the percentage was at 90% from the residual oil. Still to be included in the experiment was other hard ions such as Mg^{++} and Ca^{++} in the synthetic brine. The stated properties will vary the results of the flooding experiment as more reaction between the surfactant and co-surfactant will occurred.

This core floods shows very clearly that using branched alcohol as co-surfactant and mixing the co-surfactant and surfactant readily before injecting into the core have a preferable results in term of residual oil recovery.

8.2 Recommendation

1. The study should also cover on the adsorption of the chemicals using different injection strategies as this would play a great part in economic success of chemical flooding.

2. Field core should be use in the core flooding experiment as the properties are differed from Barea core.

3. Viscosity measurement for each liquid phase should be conducted at the reservoir temperature as in this case; 90^{o}C. As the viscosity was measured for the experiment was at room temperature, the value differs greatly compared to the in-situ viscosity value for the fluids used.

4. Core with larger diameter and length should be used as the core with smaller size is unable to store the crude inside the pore spaces efficiently which might affect the oil recovery process.

5. Core with higher air permeability needed to be chosen since permeability greatly influences the fluid flow inside the core. Range for a good permeability is between 200mD to 500mD.

References

1. E.C. Donaldson, G.V. Chilingarian and T.F. Yen, 1985. Enhanced Oil Recovery,1 Fundamentals and Analyses"(pg 47)

2. Sharma, M.K. Surfactants in Enhanced Petroleum Recovery Processes : An Overview in Particle Technology and Surface Production, Sharma, M.K.; Sharma, G.D. (Eds.), Plenum Press: New York, 1991

3. Don W. Green and G. Paul White: "Enhanced Oil Recovery" SPE textbook Series Vol. 6 by

4. Laurier L.Schramm: "Emulsions, Foams, and Suspensions. Fundamental Applications"(pg 272)

5. Salter, S.J: "Criteria for Surfactant Selection in Micellar Flooding," paper SPE 14106 presented at 1986 in SPE Intl. Meeting on Petroleum Engineering, Beijing, March 17-20, 1986

6. Trushenski, S. P,. Dauben, D. L. And Parrish, D. R.: "Micellar Flooding – Fluid Propagation, Interaction and Mobility," SPEJ (1974) 14 633

7. Ramesh Varadaraj, Jan Bock, Paul Valint, Jr., Stephen Zushma and Robert Thomas; Exxon Research and Engineering Company, Corporate Research Science Laboratories): "Fundamental Interfacial Properties of Alkyl-Branched Sulfate and Ethoxy Sulfate Surfactants Derived from Guerbet Alcohol. 1. Surface and Instantaneous Interfacial Tensions" in Clinton Township Annandale, New Jersey 08861 (Received: January 9, 1990; In Final Form: September 1I, 1990)

8. Troy R. French and Charles B. Josephson: "Alkaline Flooding Injection Strategy," IIT Research Institute, National Institute for Petroleum and Energy Research Bartlesville, Oklahama, March, 1992

9. "Fig 1. Glyceryl monostearate" in http://www.wasanlab.com/pharm/saa.html

10. Adam Knut Flaateen, B.S.: "Experimental Study of Microemulsion Characterization and Optimization in Enhanced Oil Recovery: A Design Approach for Reservoirs with

High Salinity and Hardness," Thesis presented to the Faculty of the Graduate School of The University of Texas at Austin

11. Salter, S. J: "The Influence of Type and Amount of Alcohol on Surfactant-Oil-Brine Phase Behavior and Properties," paper SPE 6843 presented at the 52nd Annual Fall Technology Conference and Exhibition of The Society of Petroleum Engineer of AIME, Denver, Colorado, Oct 9-12, 1977.

APPENDIX A

BRINE FLOOD EXPERIMENT DATA

Date	Time	Elapsed Time minutes	Inlet Pressure psi	Outlet Pressure psi	?P	Volume Inj	Pore Volun	Overburde Pressure psi	dP High psid	dP Low psid	Core Temperatu °C	Isco Pump Flow Rate ml/min	Isco Pump Flow Rate ml/min	Isco Pump Flow Rate ml/min	Actual Gas Flow Rate sccm	Separator Upper Volu ml	Separator Lower Volu ml	Liquid A Permeabili md	Liquid B Permeabili md	Gas Permeabili md	Log Mode
3/1/2012	########	0.31	1025.75	1022.58	3.17	0.465	0.060272	1919.95	-5.2	-0.07	89.34	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	0.52	1033.37	1030.19	3.18	0.78	0.101102	1930.74	-5.2	-0.07	89.34	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	1.02	1049.24	1046.06	3.18	1.53	0.198315	1956.13	-5.2	-0.07	89.34	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	1.52	1060.66	1058.76	1.9	2.28	0.295528	1983.42	-5.2	-0.07	89.66	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	2.02	1070.18	1065.74	4.44	3.03	0.392741	2007.55	-5.2	-0.07	89.66	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	2.52	1073.99	1069.55	4.44	3.78	0.489955	2031.03	-5.28	-0.07	89.98	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	3.02	1074.63	1070.82	3.81	4.53	0.587168	2055.79	-5.28	-0.07	89.98	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	3.52	1075.9	1072.72	3.18	5.28	0.684381	2076.74	-5.28	-0.07	89.98	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	4.02	1073.99	1070.18	3.81	6.03	0.781594	2081.82	-5.28	-0.07	90.61	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	4.52	1072.72	1068.91	3.81	6.78	0.878808	2079.28	-5.28	-0.07	90.61	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	5.02	1070.18	1068.91	1.27	7.53	0.976021	2078.64	-5.28	-0.07	90.61	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	5.52	1070.82	1065.74	5.08	8.28	1.073234	2078.64	-5.28	-0.07	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	6.02	1068.91	1065.11	3.8	9.03	1.170447	2078.64	-5.28	-0.07	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	6.52	1067.01	1063.2	3.81	9.78	1.26766	2078.64	-5.2	-0.07	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	7.02	1063.84	1060.66	3.18	10.53	1.364874	2078.64	-5.2	-0.07	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	7.52	1062.57	1058.12	4.45	11.28	1.462087	2079.28	-5.2	-0.07	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	8.02	1063.2	1058.76	4.44	12.03	1.5593	2079.28	-5.2	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	8.52	1058.76	1054.95	3.81	12.78	1.656513	2079.28	-5.28	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	9.02	1055.58	1051.77	3.81	13.53	1.753727	2079.28	-5.28	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	9.52	1054.95	1051.14	3.81	14.28	1.85094	2078.64	-5.28	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	10.02	1053.04	1047.33	5.71	15.03	1.948153	2078.64	-5.28	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	10.52	1049.24	1046.06	3.18	15.78	2.045366	2076.74	-5.28	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	11.02	1047.33	1044.79	2.54	16.53	2.142579	2076.1	-5.2	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	11.52	1042.89	1040.98	1.91	17.28	2.239793	2075.47	-5.2	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	12.02	1042.25	1039.08	3.17	18.03	2.337006	2073.56	-5.28	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	12.52	1039.08	1035.27	3.81	18.78	2.434219	2071.66	-5.28	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	13.02	1038.44	1034.64	3.8	19.53	2.531432	2070.39	-5.2	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	13.52	1036.54	1032.73	3.81	20.28	2.628645	2068.48	-5.28	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	14.02	1031.46	1030.83	0.63	21.03	2.725859	2067.22	-5.2	-0.07	91.88	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	14.52	1030.19	1027.02	3.17	21.78	2.823072	2065.95	-5.28	-0.07	91.88	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	15.02	1018.77	1015.59	3.18	22.53	2.920285	2058.33	-5.28	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	15.52	1022.58	1019.4	3.18	23.28	3.017498	2050.08	-5.28	-0.07	91.88	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	16.02	1023.21	1020.67	2.54	24.03	3.114712	2044.36	-5.28	-0.07	91.88	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	16.52	1020.67	1017.5	3.17	24.78	3.211925	2040.55	-5.28	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	17.02	1017.5	1014.32	3.18	25.53	3.309138	2038.02	-5.36	-0.06	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	17.52	1018.77	1015.59	3.18	26.28	3.406351	2035.48	-5.28	-0.06	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	18.02	1014.96	1012.42	2.54	27.03	3.503564	2034.21	-5.36	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	18.52	1014.96	1012.42	2.54	27.78	3.600778	2031.67	-5.28	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	19.02	1014.32	1012.42	1.9	28.53	3.697991	2031.03	-5.28	-0.06	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	19.52	1013.69	1010.51	3.18	29.28	3.795204	2030.4	-5.28	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	20.02	1012.42	1009.24	3.18	30.03	3.892417	2029.76	-5.28	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	20.52	1009.24	1006.71	2.53	30.78	3.989631	2028.49	-5.28	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	21.02	1009.88	1006.71	3.17	31.53	4.086844	2028.49	-5.28	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	21.52	1008.61	1005.44	3.17	32.28	4.184057	2027.86	-5.28	-0.06	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	22.02	1008.61	1005.44	3.17	33.03	4.28127	2027.86	-5.36	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	22.52	1007.34	1004.8	2.54	33.78	4.378483	2027.22	-5.28	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	23.02	1006.71	1003.53	3.18	34.53	4.475697	2026.59	-5.28	-0.06	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	23.52	1006.07	1002.9	3.17	35.28	4.57291	2025.95	-5.28	-0.06	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	24.02	1006.07	1002.9	3.17	36.03	4.670123	2025.32	-5.28	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	24.52	1002.9	1000.36	2.54	36.78	4.767336	2024.05	-5.36	-0.06	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	25.02	1003.53	1000.36	3.17	37.53	4.86455	2023.42	-5.36	-0.06	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	25.52	1001.63	998.45	3.18	38.28	4.961763	2022.78	-5.28	-0.06	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	26.02	1002.9	997.82	5.08	39.03	5.058976	2022.15	-5.28	-0.06	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	26.52	999.09	997.18	1.91	39.78	5.156189	2021.51	-5.28	-0.06	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	27.02	999.09	996.55	2.54	40.53	5.253402	2020.24	-5.28	-0.06	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	27.52	1000.36	994.65	5.71	41.28	5.350616	2018.97	-5.28	-0.06	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	28.02	998.45	996.55	1.9	42.03	5.447829	2018.97	-5.36	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	28.52	995.28	993.38	1.9	42.78	5.545042	2018.34	-5.36	-0.06	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	29.02	999.09	997.18	1.91	43.53	5.642255	2017.7	-5.36	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	29.52	998.45	996.55	1.9	44.28	5.739469	2016.43	-5.28	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	30.02	1004.8	1002.26	2.54	45.03	5.836682	2015.8	-5.36	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	30.52	1005.44	1002.26	3.18	45.78	5.933895	2015.16	-5.36	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	31.02	1009.24	1006.71	2.53	46.53	6.031108	2014.53	-5.28	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	31.52	1009.88	1007.34	2.54	47.28	6.128321	2013.26	-5.2	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	32.02	1013.69	1011.15	2.54	48.03	6.225535	2011.99	-5.28	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	32.52	1015.59	1013.69	1.9	48.78	6.322748	2011.36	-5.36	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	33.02	1018.13	1015.59	2.54	49.53	6.419961	2010.09	-5.2	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	33.52	1021.31	1018.13	3.18	50.28	6.517174	2009.45	-5.28	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	34.02	1024.48	1021.31	3.17	51.03	6.614388	2007.55	-5.2	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	34.52	1030.83	1027.65	3.18	51.78	6.711601	2006.91	-5.28	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	35.02	1032.73	1030.19	2.54	52.53	6.808814	2006.28	-5.28	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	35.52	1034	1031.46	2.54	53.28	6.906027	2004.37	-5.28	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	36.02	1036.54	1033.37	3.17	54.03	7.00324	2003.74	-5.2	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	36.52	1037.81	1035.27	2.54	54.78	7.100454	2003.1	-5.28	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	37.02	1039.71	1037.17	2.54	55.53	7.197667	2003.1	-5.2	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	37.52	1041.62	1039.08	2.54	56.28	7.29488	2001.83	-5.28	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	38.02	1047.33	1045.43	1.9	57.03	7.392093	2001.2	-5.28	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	38.52	1048.6	1046.06	2.54	57.78	7.489307	1999.93	-5.2	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	39.02	1049.87	1047.33	2.54	58.53	7.58652	1999.29	-5.28	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	39.52	1051.14	1049.24	1.9	59.28	7.683733	1998.66	-5.28	-0.08	91.57	0	0	0	0	0	0	0	0	0	Auto

APPENDIX B

OIL FLOOD EXPERIMENT DATA

Date	Time	Elapsed Time minutes	Inlet Pressure psi	Outlet Pressure psi	?P	Injected Fl	Pore Volun	Overburde Pressure psi	dP High psid	dP Low psid	Core Temperatu °C	Isco Pump Flow Rate A ml/min	Isco Pump Flow Rate B ml/min	Isco Pump Flow Rate A ml/min	Actual Gas Flow Rate sccm	Separator Upper Volu ml	Separator Lower Volu ml	Liquid A Permeabili md	Liquid B Permeabili md	Gas Permeabili md	Log Mode
3/1/2012	########	0.28	1082.88	1079.07	3.81	0.28	0.036293	1978.35	-5.2	-0.08	91.25	0.5	0.5	1	0	0	0	9.229	0	0	Auto
3/1/2012	########	0.51	1096.84	1093.67	3.17	0.51	0.066105	1975.81	-5.28	-0.08	91.25	0.89	0.118	1	0	0	0	9.091	0	0	Auto
3/1/2012	########	1.01	1119.06	1115.89	3.17	1.01	0.130914	1967.56	-5.28	-0.08	91.25	1	-60	1	0	0	0	9.091	0	0	Auto
3/1/2012	########	1.51	1141.91	1138.74	3.17	1.51	0.195723	1962.48	-5.36	-0.08	91.25	1	-60	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	2.01	1155.88	1152.07	3.81	2.01	0.260531	1958.03	-5.36	-0.09	90.93	1	-0.004	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	2.51	1158.42	1153.34	5.08	2.51	0.32534	1954.23	-5.36	-0.09	90.93	1	0.001	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	3.01	1157.15	1151.43	5.72	3.01	0.390149	1950.42	-5.36	-0.09	90.93	1	-0.004	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	3.51	1157.78	1150.8	6.98	3.51	0.454958	1947.24	-5.36	-0.09	90.93	1	0.011	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	4.01	1157.78	1150.8	6.98	4.01	0.519767	1946.61	-5.51	-0.09	90.93	1	-0.003	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	4.51	1158.42	1150.17	8.25	4.51	0.584576	1944.07	-5.36	-0.09	90.93	1	-0.003	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	5.01	1159.05	1150.17	8.88	5.01	0.649384	1943.43	-5.51	-0.09	90.93	1	0.01	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	5.51	1159.05	1149.53	9.52	5.51	0.714193	1942.16	-5.36	-0.09	90.93	1	0.013	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	6.01	1159.05	1148.26	10.79	6.01	0.779002	1941.53	-5.36	-0.09	90.93	1	0.013	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	6.51	1159.69	1148.26	11.43	6.51	0.843811	1940.9	-5.36	-0.09	90.93	1	0.002	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	7.01	1159.69	1147.63	12.06	7.01	0.90862	1939.63	-5.36	-0.09	90.93	1	-0.009	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	7.51	1159.05	1146.99	12.06	7.51	0.973428	1939.63	-5.51	-0.09	90.93	1	0.012	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	8.01	1158.42	1146.99	11.43	8.01	1.038237	1939.63	-5.51	-0.09	90.93	1	-0.008	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	8.51	1157.78	1145.72	12.06	8.51	1.103046	1939.63	-5.36	-0.09	90.93	1	0.001	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	9.01	1157.15	1145.72	11.43	9.01	1.167855	1940.9	-5.51	-0.09	90.93	1	-0.001	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	9.51	1155.88	1145.72	10.16	9.51	1.232664	1940.9	-5.36	-0.09	90.93	1	-0.003	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	10.01	1155.24	1143.82	11.42	10.01	1.297472	1940.9	-5.51	-0.09	90.93	1	0.009	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	10.51	1159.69	1149.53	10.16	10.51	1.362281	1941.53	-5.51	-0.09	90.93	1	0.018	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	11.01	1160.32	1148.26	12.06	11.01	1.42709	1942.16	-5.36	-0.09	90.93	1	0	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	11.51	1157.78	1147.63	10.15	11.51	1.491899	1942.16	-5.36	-0.09	90.93	1	0.019	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	12.01	1159.05	1148.26	10.79	12.01	1.556708	1942.8	-5.36	-0.09	90.93	1	-0.001	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	12.51	1157.78	1146.99	10.79	12.51	1.621517	1942.8	-5.36	-0.09	90.93	1	-0.001	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	13.01	1149.53	1134.93	14.6	13.01	1.686325	1943.43	-5.36	-0.09	90.93	1	-0.031	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	13.51	1150.8	1141.91	8.89	13.51	1.751134	1944.07	-5.36	-0.09	90.93	1	0.025	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	14.01	1157.15	1146.99	10.16	14.01	1.815943	1945.34	-5.51	-0.09	90.93	1	0.006	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	14.51	1157.15	1146.99	10.16	14.51	1.880752	1945.97	-5.51	-0.09	90.93	1	0.004	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	15.01	1155.24	1143.82	11.42	15.01	1.945561	1946.61	-5.51	-0.09	90.93	1	-0.02	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	15.51	1157.15	1146.99	10.16	15.51	2.010369	1947.24	-5.51	-0.09	90.93	1	0.008	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	16.01	1155.88	1146.36	9.52	16.01	2.075178	1949.15	-5.51	-0.09	90.93	1	0.008	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	16.51	1157.78	1147.63	10.15	16.51	2.139987	1949.15	-5.36	-0.09	90.93	1	-0.001	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	17.01	1154.61	1145.72	8.89	17.01	2.204796	1949.78	-5.51	-0.09	90.93	1	0.022	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	17.51	1155.88	1146.36	9.52	17.51	2.269605	1951.05	-5.51	-0.09	91.25	1	-0.014	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	18.01	1155.88	1145.72	10.16	18.01	2.334413	1951.69	-5.36	-0.09	91.25	1	-0.01	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	18.51	1155.88	1145.72	10.16	18.51	2.399222	1952.96	-5.51	-0.09	91.25	1	-0.005	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	19.01	1155.88	1146.36	9.52	19.01	2.464031	1953.59	-5.36	-0.09	91.25	1	0.01	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	19.51	1155.24	1145.72	9.52	19.51	2.52884	1954.23	-5.51	-0.09	91.25	1	-0.008	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	20.01	1134.3	1119.7	14.6	20.01	2.593649	1954.86	-5.51	-0.09	91.25	1	-0.014	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	20.51	1125.41	1113.98	11.43	20.51	2.658458	1955.49	-5.59	-0.09	91.25	1	0.019	1	0	0	0	8.575	0	0	Auto
3/1/2012	########	21.01	1122.87	1112.08	10.79	21.01	2.723266	1957.4	-5.51	-0.08	91.25	1	-0.005	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	21.51	1123.5	1113.35	10.15	21.51	2.788075	1958.03	-5.51	-0.09	91.25	1	0.008	1	0	0	0	8.575	0	0	Auto
3/1/2012	########	22.01	1125.41	1114.62	10.79	22.01	2.852884	1958.67	-5.51	-0.09	91.25	1	0.023	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	22.51	1126.68	1115.89	10.79	22.51	2.917693	1959.94	-5.51	-0.09	91.25	1	-0.006	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	23.01	1127.95	1117.79	10.16	23.01	2.982502	1961.21	-5.51	-0.09	91.25	1	0.006	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	23.51	1130.49	1120.97	9.52	23.51	3.04731	1961.84	-5.36	-0.09	91.25	1	-0.019	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	24.01	1133.66	1124.14	9.52	24.01	3.112119	1963.11	-5.51	-0.09	91.25	1	-0.003	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	24.51	1135.57	1126.04	9.53	24.51	3.176928	1963.75	-5.51	-0.09	91.25	1	0.009	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	25.01	1137.47	1127.95	9.52	25.01	3.241737	1965.02	-5.51	-0.09	91.25	1	-0.004	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	25.51	1137.47	1127.95	9.52	25.51	3.306546	1965.65	-5.51	-0.09	91.25	1	-0.001	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	26.01	1138.74	1129.22	9.52	26.01	3.371355	1966.29	-5.51	-0.08	91.25	1	-0.002	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	26.51	1138.74	1129.22	9.52	26.51	3.436163	1967.56	-5.51	-0.09	91.25	1	0.016	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	27.01	1138.1	1129.22	8.88	27.01	3.500972	1968.19	-5.36	-0.09	91.25	1	0.001	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	27.51	1138.1	1127.95	10.15	27.51	3.565781	1969.46	-5.51	-0.09	91.25	1	-0.013	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	28.01	1138.1	1127.95	10.15	28.01	3.63059	1970.73	-5.36	-0.09	91.25	1	0.012	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	28.51	1137.47	1127.95	9.52	28.51	3.695399	1972	-5.51	-0.09	91.25	1	-0.005	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	29.01	1137.47	1127.31	10.16	29.01	3.760207	1973.27	-5.51	-0.09	91.25	1	-0.01	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	29.51	1138.1	1127.95	10.15	29.51	3.825016	1974.54	-5.36	-0.09	91.25	1	-0.012	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	30.01	1137.47	1127.95	9.52	30.01	3.889825	1975.17	-5.36	-0.09	91.25	1	-0.008	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	30.51	1137.47	1127.31	10.16	30.51	3.954634	1975.81	-5.36	-0.09	91.25	1	0.006	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	31.01	1136.2	1126.68	9.52	31.01	4.019443	1977.08	-5.51	-0.09	91.25	1	-0.008	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	31.51	1136.2	1126.68	9.52	31.51	4.084251	1978.35	-5.51	-0.09	91.25	1	-0.004	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	32.01	1136.2	1127.31	8.89	32.01	4.14906	1978.98	-5.36	-0.09	91.25	1	-0.001	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	32.51	1137.47	1127.31	10.16	32.51	4.213869	1979.62	-5.51	-0.09	91.25	1	0.014	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	33.01	1136.2	1126.68	9.52	33.01	4.278678	1981.52	-5.51	-0.09	91.25	1	-0.014	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	33.51	1135.57	1126.04	9.53	33.51	4.343487	1982.16	-5.51	-0.09	91.25	1	0.01	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	34.01	1135.57	1126.04	9.53	34.01	4.408296	1982.79	-5.51	-0.08	91.25	1	-0.016	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	34.51	1136.2	1126.68	9.52	34.51	4.473104	1983.42	-5.36	-0.09	91.25	1	-0.003	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	35.01	1136.2	1126.68	9.52	35.01	4.537913	1984.06	-5.36	-0.09	91.25	1	-0.005	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	35.51	1134.93	1126.04	8.89	35.51	4.602722	1985.96	-5.51	-0.08	91.25	1	0.005	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	36.01	1134.93	1126.68	8.25	36.01	4.667531	1986.6	-5.51	-0.09	91.25	1	0.004	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	36.51	1135.57	1126.68	8.89	36.51	4.73234	1987.23	-5.36	-0.09	91.25	1	-0.022	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	37.01	1134.3	1125.41	8.89	37.01	4.797148	1987.87	-5.51	-0.09	91.25	1	0.009	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	37.51	1134.3	1125.41	8.89	37.51	4.861957	1989.77	-5.36	-0.09	91.25	1	0.001	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	38.01	1134.3	1125.41	8.89	38.01	4.926766	1990.41	-5.36	-0.09	91.57	1	-0.007	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	38.51	1134.3	1125.41	8.89	38.51	4.991575	1991.04	-5.36	-0.09	91.25	1	0.002	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	39.01	1134.3	1125.41	8.89	39.01	5.056384	1991.68	-5.51	-0.09	91.57	1	-0.015	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	39.51	1134.3	1125.41	8.89	39.51	5.121192	1992.31	-5.51	-0.09	91.57	1	-0.001	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	40.01	1133.66	1124.14	9.52	40.01	5.186001	1993.58	-5.36	-0.09	91.57	1	-0.018	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	40.51	1133.66	1124.14	9.52	40.51	5.25081	1994.22	-5.51	-0.09	91.57	1	-0.006	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	41.01	1133.03	1122.87	10.16	41.01	5.315619	1994.85	-5.36	-0.09	91.57	1	-0.004	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	41.51	1133.03	1122.87	10.16	41.51	5.380428	1996.12	-5.51	-0.09	91.57	1	-0.005	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	42.01	1131.76	1122.87	8.89	42.01	5.445237	1997.39	-5.51	-0.09	91.57	1	0.008	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	42.51	1133.03	1123.5	9.53	42.51	5.510045	1998.02	-5.51	-0.09	91.57	1	0.008	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	43.01	1131.76	1122.87	8.89	43.01	5.574854	1998.66	-5.51	-0.09	91.57	1	-0.009	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	43.51	1130.49	1120.97	9.52	43.51	5.639663	1999.29	-5.51	-0.09	91.57	1	0.011	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	44.01	1129.85	1119.7	10.15	44.01	5.704472	1999.93	-5.36	-0.09	91.57	1	-0.006	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	44.51	1129.85	1119.7	10.15	44.51	5.769281	2001.2	-5.51	-0.08	91.57	1	-0.004	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	45.01	1129.85	1119.06	10.79	45.01	5.834089	2001.83	-5.36	-0.09	91.57	1	-0.006	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	45.51	1129.85	1119.7	10.15	45.51	5.898898	2002.47	-5.51	-0.09	91.57	1	0	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	46.01	1129.22	1119.06	10.16	46.01	5.963707	2003.1	-5.51	-0.09	91.57	1	-0.001	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	46.51	1129.22	1119.06	10.16	46.51	6.028516	2003.74	-5.36	-0.08	91.57	1	-0.003	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	47.01	1131.12	1122.87	8.25	47.01	6.093325	2004.37	-5.36	-0.09	91.57	1	0.009	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	47.51	1131.76	1122.87	8.89	47.51	6.158134	2005.64	-5.51	-0.09	91.57	1	-0.012	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	48.01	1129.22	1118.43	10.79	48.01	6.222942	2006.28	-5.36	-0.09	91.57	1	-0.009	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	48.51	1127.31	1117.79	9.52	48.51	6.287751	2006.91	-5.51	-0.09	91.57	1	-0.009	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	49.01	1126.04	1115.89	10.15	49.01	6.35256	2007.55	-5.36	-0.09	91.57	1	0.001	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	49.51	1126.04	1117.16	8.88	49.51	6.417369	2008.18	-5.51	-0.09	91.57	1	0.006	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	50.01	1126.68	1117.79	8.89	50.01	6.482178	2009.45	-5.51	-0.08	91.57	1	0.004	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	50.51	1127.31	1117.79	9.52	50.51	6.546986	2010.09	-5.36	-0.09	91.57	1	-0.004	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	51.01	1127.31	1117.79	9.52	51.01	6.611795	2010.72	-5.51	-0.09	91.57	1	-0.012	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	51.51	1133.03	1123.5	9.53	51.51	6.676604	2011.36	-5.51	-0.09	91.57	1	0.005	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	52.01	1131.76	1123.5	8.26	52.01	6.741413	2011.99	-5.36	-0.09	91.57	1	0.001	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	52.51	1131.76	1123.5	8.26	52.51	6.806222	2013.26	-5.51	-0.09	91.57	1	0.005	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	53.01	1131.76	1122.87	8.89	53.01	6.87103	2013.26	-5.36	-0.09	91.57	1	-0.003	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	53.51	1131.12	1122.87	8.25	53.51	6.935839	2013.89	-5.51	-0.09	91.57	1	0.003	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	54.01	1131.76	1122.87	8.89	54.01	7.000648	2014.53	-5.51	-0.09	91.57	1	-0.014	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	54.51	1131.12	1122.87	8.25	54.51	7.065457	2015.16	-5.36	-0.09	91.57	1	-0.007	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	55.01	1131.12	1122.87	8.25	55.01	7.130266	2015.8	-5.36	-0.09	91.57	1	-0.01	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	55.51	1131.12	1122.87	8.25	55.51	7.195075	2016.43	-5.36	-0.09	91.57	1	0.001	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	56.01	1130.49	1121.6	8.89	56.01	7.259883	2017.7	-5.36	-0.09	91.57	1	0.011	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	56.51	1130.49	1120.97	9.52	56.51	7.324692	2017.7	-5.51	-0.08	91.57	1	-0.012	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	57.01	1130.49	1120.97	9.52	57.01	7.389501	2018.34	-5.51	-0.09	91.57	1	0.003	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	57.51	1129.85	1120.97	8.88	57.51	7.45431	2018.97	-5.51	-0.09	91.57	1	-0.004	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	58.01	1129.85	1120.97	8.88	58.01	7.519119	2019.61	-5.51	-0.09	91.57	1	-0.005	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	58.51	1129.22	1119.7	9.52	58.51	7.583927	2020.24	-5.51	-0.08	91.57	1	0.002	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	59.01	1129.22	1120.97	8.25	59.01	7.648736	2020.24	-5.59	-0.09	91.88	1	0.008	1	0	0	0	8.575	0	0	Auto
3/1/2012	########	59.51	1129.22	1120.97	8.25	59.51	7.713545	2021.51	-5.36	-0.09	91.57	1	0.017	1	0	0	0	8.575	0	0	Auto
3/1/2012	########	60.01	1129.22	1119.7	9.52	60.01	7.778354	2022.15	-5.51	-0.09	91.57	1	-0.011	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	60.51	1129.22	1119.7	9.52	60.51	7.843163	2022.15	-5.36	-0.09	91.57	1	-0.005	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	61.01	1127.95	1118.43	9.52	61.01	7.907971	2022.78	-5.36	-0.08	91.88	1	-0.001	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	61.51	1127.95	1119.06	8.89	61.51	7.97278	2023.42	-5.51	-0.08	91.57	1	-0.007	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	62.01	1127.95	1118.43	9.52	62.01	8.037589	2024.05	-5.36	-0.09	91.57	1	-0.018	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	62.51	1127.95	1119.06	8.89	62.51	8.102398	2025.32	-5.51	-0.08	91.57	1	-0.008	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	63.01	1127.95	1118.43	9.52	63.01	8.167207	2025.32	-5.51	-0.08	91.57	1	-0.005	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	63.51	1127.95	1119.06	8.89	63.51	8.232016	2025.95	-5.51	-0.09	91.88	1	0.006	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	64.01	1127.95	1119.06	8.89	64.01	8.296824	2026.59	-5.36	-0.08	91.57	1	0.003	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	64.51	1127.95	1118.43	9.52	64.51	8.361633	2026.59	-5.51	-0.08	91.88	1	0.02	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	65.01	1127.31	1118.43	8.88	65.01	8.426442	2027.22	-5.51	-0.08	91.88	1	0.001	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	65.51	1127.31	1118.43	8.88	65.51	8.491251	2027.86	-5.51	-0.08	91.88	1	0.015	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	66.01	1126.68	1117.79	8.89	66.01	8.55606	2027.86	-5.51	-0.09	91.88	1	0.005	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	66.51	1126.68	1117.79	8.89	66.51	8.620868	2028.49	-5.36	-0.09	91.88	1	0.006	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	67.01	1108.9	1094.3	14.6	67.01	8.685677	2028.49	-5.51	-0.08	91.88	1	-0.039	1	0	0	0	8.956	0	0	Auto
3/1/2012	########	67.51	1084.78	1074.63	10.15	67.51	8.750486	2028.49	-5.51	-0.08	91.57	1	0.001	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	68.01	1079.07	1070.18	8.89	68.01	8.815295	2029.76	-5.51	-0.08	91.88	1	-0.01	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	68.51	1079.07	1070.82	8.25	68.51	8.880104	2030.4	-5.51	-0.08	91.88	1	-0.003	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	69.01	1089.23	1082.24	6.99	69.01	8.944913	2030.4	-5.51	-0.08	91.88	1	0.014	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	69.51	1099.38	1091.77	7.61	69.51	9.009721	2031.03	-5.51	-0.08	91.88	1	0	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	70.01	1105.73	1098.11	7.62	70.01	9.07453	2031.67	-5.51	-0.08	91.88	1	0.018	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	70.51	1108.9	1101.29	7.61	70.51	9.139339	2031.67	-5.51	-0.08	91.88	1	-0.003	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	71.01	1111.44	1103.19	8.25	71.01	9.204148	2033.57	-5.51	-0.08	91.88	1	-0.003	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	71.51	1110.81	1102.56	8.25	71.51	9.268957	2033.57	-5.36	-0.08	91.88	1	-0.005	1	0	0	0	8.575	0	0	Auto
3/1/2012	########	72.01	1110.81	1103.19	7.62	72.01	9.333765	2034.21	-5.51	-0.08	91.88	1	-0.016	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	72.51	1111.44	1103.19	8.25	72.51	9.398574	2034.84	-5.51	-0.09	91.88	1	-0.013	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	73.01	1111.44	1103.19	8.25	73.01	9.463383	2034.84	-5.36	-0.09	91.88	1	0.007	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	73.51	1110.81	1103.19	7.62	73.51	9.528192	2035.48	-5.51	-0.08	91.88	1	-0.007	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	74.01	1110.81	1102.56	8.25	74.01	9.593001	2035.48	-5.51	-0.08	91.88	1	-0.013	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	74.51	1110.81	1103.19	7.62	74.51	9.657809	2036.11	-5.51	-0.09	91.88	1	-0.001	1	0	0	0	8.698	0	0	Auto
3/1/2012	########	75.01	1111.44	1103.19	8.25	75.01	9.722618	2036.11	-5.51	-0.08	91.88	1	-0.006	1	0	0	0	8.698	0	0	Auto

APPENDIX C

WATER FLOOD EXPERIMENT DATA

Date	Time	Elapsed Time minutes	Inlet Pressure psi	Outlet Pressure psi	?P	Volume	Pore Volun	Overburde Pressure psi	dP High psid	dP Low psid	Core Temperatu °C	Isco Pump Flow Rate / ml/min	Isco Pump Flow Rate I ml/min	Isco Pump Flow Rate / ml/min	Actual Gas Flow Rate sccm	Separator Upper Volu ml	Separator Lower Volu ml	Liquid A Permeabili md	Liquid B Permeabili md	Gas Permeabili md	Log Mode
3/1/2012	12:08:01 PM	0.32	968.62	965.45	3.17	0	0	2029.76	-5.51	-0.07	91.88	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	12:08:11 PM	0.5	961.64	958.46	3.18	0	0	2028.49	-5.51	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	12:08:41 PM	1	1093.04	1089.23	3.81	1.5	0.194426	2019.61	-5.51	-0.08	91.88	0.75	0.75	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:09:12 PM	1.5	1119.7	1108.9	10.8	2.25	0.29164	2013.26	-5.36	-0.08	91.88	-60	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:09:41 PM	2	1125.41	1110.17	15.24	3	0.388853	2006.91	-5.51	-0.08	91.57	-59.97	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:10:11 PM	2.5	1129.22	1109.54	19.68	3.75	0.486066	2001.83	-5.59	-0.08	91.57	-60	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	12:10:41 PM	3	1131.76	1110.17	21.59	4.5	0.583279	1997.39	-5.51	-0.08	91.25	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:11:11 PM	3.5	1133.03	1109.54	23.49	5.25	0.680493	1993.58	-5.59	-0.08	91.57	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	12:11:41 PM	4	1133.66	1109.54	24.12	6	0.777706	1990.41	-5.51	-0.09	91.25	-0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:12:11 PM	4.5	1133.66	1110.17	23.49	6.75	0.874919	1987.23	-5.51	-0.09	91.25	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:12:41 PM	5	1134.3	1109.54	24.76	7.5	0.972132	1985.33	-5.59	-0.08	91.25	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	12:13:11 PM	5.5	1133.66	1107.64	26.02	8.25	1.069345	1982.79	-5.51	-0.08	91.25	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:13:41 PM	6	1131.76	1107	24.76	9	1.166559	1981.52	-5.51	-0.08	91.25	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:14:11 PM	6.5	1133.66	1106.37	27.29	9.75	1.263772	1979.62	-5.59	-0.08	91.25	-0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	12:14:41 PM	7	1134.93	1107	27.93	10.5	1.360985	1978.98	-5.51	-0.08	91.25	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:15:11 PM	7.5	1133.66	1107	26.66	11.25	1.458198	1977.71	-5.51	-0.08	91.25	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:15:42 PM	8	1133.66	1107	26.66	12	1.555412	1977.71	-5.51	-0.09	91.25	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:16:11 PM	8.5	1134.3	1107	27.3	12.75	1.652625	1975.81	-5.59	-0.08	91.25	0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	12:16:41 PM	9	1133.66	1107	26.66	13.5	1.749838	1975.81	-5.51	-0.08	91.25	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:17:11 PM	9.5	1133.66	1107	26.66	14.25	1.847051	1975.17	-5.51	-0.08	91.25	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:17:41 PM	10	1133.03	1107	26.03	15	1.944264	1970.73	-5.51	-0.08	91.25	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:18:11 PM	10.5	1137.47	1109.54	27.93	15.75	2.041478	1969.46	-5.51	-0.08	91.25	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:18:41 PM	11	1138.1	1112.08	26.02	16.5	2.138691	1967.56	-5.51	-0.08	91.25	0.02	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:19:11 PM	11.5	1142.55	1117.16	25.39	17.25	2.235904	1966.29	-5.51	-0.08	91.25	-0.03	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:19:41 PM	12	1148.26	1123.5	24.76	18	2.333117	1965.65	-5.59	-0.09	91.25	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:20:11 PM	12.5	1155.24	1130.49	24.75	18.75	2.430331	1963.75	-5.51	-0.09	91.25	0.03	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:20:41 PM	13	1169.21	1143.82	25.39	19.5	2.527544	1963.11	-5.51	-0.09	91.25	-0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:21:11 PM	13.5	1174.29	1149.53	24.76	20.25	2.624757	1963.11	-5.51	-0.09	91.25	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:21:41 PM	14	1179.36	1154.61	24.75	21	2.72197	1962.48	-5.51	-0.09	91.25	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:22:11 PM	14.5	1184.44	1159.05	25.39	21.75	2.819183	1962.48	-5.51	-0.09	91.25	0.02	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:22:41 PM	15	1176.19	1145.09	31.1	22.5	2.916397	1961.84	-5.51	-0.09	91.25	-0.03	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:23:11 PM	15.5	1167.3	1143.82	23.48	23.25	3.01361	1961.84	-5.51	-0.09	91.25	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:23:41 PM	16	1175.56	1153.34	22.22	24	3.110823	1961.84	-5.51	-0.09	91.25	0.03	1.5	1.5	0	0	0	13.434	0	0	Auto
3/1/2012	12:24:11 PM	16.5	1188.25	1164.13	24.12	24.75	3.208036	1961.84	-5.36	-0.09	91.25	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:24:41 PM	17	1200.31	1175.56	24.75	25.5	3.30525	1961.84	-5.36	-0.1	91.25	-0.01	1.5	1.5	0	0	0	13.434	0	0	Auto
3/1/2012	12:25:11 PM	17.5	1204.12	1179.36	24.76	26.25	3.402463	1961.84	-5.51	-0.1	91.25	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:25:41 PM	18	1208.56	1184.44	24.12	27	3.499676	1961.84	-5.51	-0.1	91.25	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:26:11 PM	18.5	1210.47	1185.71	24.76	27.75	3.596889	1961.84	-5.51	-0.1	91.25	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:26:41 PM	19	1215.55	1190.79	24.76	28.5	3.694102	1962.48	-5.51	-0.1	91.25	-0.02	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:27:11 PM	19.5	1217.45	1191.43	26.02	29.25	3.791316	1962.48	-5.36	-0.1	91.25	-0.01	1.5	1.5	0	0	0	13.434	0	0	Auto
3/1/2012	12:27:41 PM	20	1216.18	1191.43	24.75	30	3.888529	1962.48	-5.51	-0.1	91.25	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:28:11 PM	20.5	1217.45	1191.43	26.02	30.75	3.985742	1962.48	-5.59	-0.1	91.25	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:28:41 PM	21	1218.09	1192.06	26.03	31.5	4.082955	1962.48	-5.51	-0.1	91.25	-0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:29:11 PM	21.5	1217.45	1190.79	26.66	32.25	4.180169	1963.11	-5.36	-0.1	91.25	-0.01	1.5	1.5	0	0	0	13.434	0	0	Auto
3/1/2012	12:29:41 PM	22	1215.55	1190.16	25.39	33	4.277382	1963.11	-5.36	-0.1	91.25	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:30:11 PM	22.5	1214.91	1190.16	24.75	33.75	4.374595	1963.11	-5.51	-0.1	91.25	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:30:41 PM	23	1215.55	1189.52	26.03	34.5	4.471808	1963.75	-5.51	-0.1	91.25	-0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:31:11 PM	23.5	1214.91	1189.52	25.39	35.25	4.569021	1965.02	-5.51	-0.1	91.25	-0.01	1.5	1.5	0	0	0	13.434	0	0	Auto
3/1/2012	12:31:41 PM	24	1214.28	1188.25	26.03	36	4.666235	1965.02	-5.51	-0.1	91.25	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:32:11 PM	24.5	1213.64	1186.98	26.66	36.75	4.763448	1965.65	-5.36	-0.1	91.25	-0.01	1.5	1.5	0	0	0	13.434	0	0	Auto
3/1/2012	12:32:41 PM	25	1199.04	1162.86	36.18	37.5	4.860661	1965.65	-5.51	-0.1	91.25	-0.04	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:33:11 PM	25.5	1179.36	1153.97	25.39	38.25	4.957874	1965.65	-5.36	-0.1	91.25	0.01	1.5	1.5	0	0	0	13.434	0	0	Auto
3/1/2012	12:33:41 PM	26	1178.1	1152.07	26.03	39	5.055087	1966.29	-5.51	-0.1	91.25	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:34:11 PM	26.5	1174.29	1150.17	24.12	39.75	5.152301	1965.65	-5.51	-0.1	91.25	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:34:41 PM	27	1180	1157.15	22.85	40.5	5.249514	1962.48	-5.51	-0.1	91.57	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:35:11 PM	27.5	1190.79	1173.65	17.14	41.25	5.346727	1961.84	-5.59	-0.1	91.25	0.03	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	12:35:41 PM	28	1195.23	1170.48	24.75	42	5.44394	1959.94	-5.59	-0.1	91.25	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:36:11 PM	28.5	1196.5	1171.11	25.39	42.75	5.541154	1959.3	-5.36	-0.1	91.25	0	1.5	1.5	0	0	0	13.434	0	0	Auto
3/1/2012	12:36:41 PM	29	1198.41	1172.38	26.03	43.5	5.638367	1958.67	-5.51	-0.1	91.25	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:37:11 PM	29.5	1197.77	1171.75	26.02	44.25	5.73558	1958.67	-5.51	-0.1	91.25	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:37:41 PM	30	1195.87	1171.11	24.76	45	5.832793	1958.67	-5.51	-0.1	91.25	-0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:38:11 PM	30.5	1196.5	1171.11	25.39	45.75	5.930006	1958.03	-5.51	-0.1	91.25	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:38:41 PM	31	1186.35	1158.42	27.93	46.5	6.02722	1958.03	-5.51	-0.09	91.25	-0.02	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:39:11 PM	31.5	1189.52	1163.5	26.02	47.25	6.124433	1958.03	-5.51	-0.1	91.25	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:39:41 PM	32	1188.25	1161.59	26.66	48	6.221646	1958.03	-5.51	-0.1	91.25	-0.02	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:40:11 PM	32.5	1186.98	1159.69	27.29	48.75	6.318859	1958.03	-5.51	-0.1	91.25	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:40:41 PM	33	1195.23	1172.38	22.85	49.5	6.416073	1958.67	-5.51	-0.1	91.25	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:41:11 PM	33.5	1199.04	1172.38	26.66	50.25	6.513286	1958.67	-5.59	-0.1	91.25	-0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	12:41:41 PM	34	1196.5	1171.11	25.39	51	6.610499	1959.3	-5.51	-0.09	91.25	-0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:42:11 PM	34.5	1195.23	1170.48	24.75	51.75	6.707712	1959.3	-5.59	-0.09	91.25	0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	12:42:41 PM	35	1195.87	1169.84	26.03	52.5	6.804925	1959.3	-5.51	-0.1	91.25	-0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:43:11 PM	35.5	1194.6	1169.21	25.39	53.25	6.902139	1959.3	-5.51	-0.09	91.25	-0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:43:41 PM	36	1194.6	1167.94	26.66	54	6.999352	1959.94	-5.59	-0.1	91.25	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	12:44:11 PM	36.5	1145.09	1112.08	33.01	54.75	7.096565	1959.3	-5.59	-0.1	91.25	-0.04	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	12:44:41 PM	37	1115.25	1089.86	25.39	55.5	7.193778	1959.94	-5.59	-0.09	91.25	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:45:11 PM	37.5	1107.64	1086.69	20.95	56.25	7.290992	1959.94	-5.51	-0.09	91.57	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:45:41 PM	38	1134.93	1119.7	15.23	57	7.388205	1961.21	-5.59	-0.1	91.25	0.02	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	12:46:11 PM	38.5	1161.59	1140.01	21.58	57.75	7.485418	1961.84	-5.59	-0.09	91.57	0.02	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	12:46:41 PM	39	1169.21	1145.72	23.49	58.5	7.582631	1961.84	-5.51	-0.1	91.25	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:47:11 PM	39.5	1169.21	1145.72	23.49	59.25	7.679844	1962.48	-5.51	-0.1	91.25	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:47:41 PM	40	1174.29	1151.43	22.86	60	7.777058	1963.11	-5.51	-0.1	91.25	0.03	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:48:11 PM	40.5	1174.29	1150.8	23.49	60.75	7.874271	1963.11	-5.51	-0.09	91.57	-0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:48:41 PM	41	1174.29	1150.17	24.12	61.5	7.971484	1963.75	-5.59	-0.09	91.25	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:49:11 PM	41.5	1172.38	1149.53	22.85	62.25	8.068697	1963.75	-5.51	-0.1	91.57	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:49:41 PM	42	1171.75	1149.53	22.22	63	8.165911	1965.02	-5.51	-0.1	91.57	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:50:11 PM	42.5	1172.38	1148.26	24.12	63.75	8.263124	1965.65	-5.51	-0.1	91.57	0.02	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:50:41 PM	43	1171.75	1148.26	23.49	64.5	8.360337	1965.65	-5.59	-0.09	91.25	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:51:11 PM	43.5	1171.11	1147.63	23.48	65.25	8.45755	1966.29	-5.59	-0.1	91.57	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	12:51:41 PM	44	1169.21	1145.72	23.49	66	8.554763	1966.92	-5.51	-0.09	91.57	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:52:11 PM	44.5	1167.94	1145.09	22.85	66.75	8.651977	1967.56	-5.51	-0.1	91.57	-0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:52:41 PM	45	1167.94	1145.09	22.85	67.5	8.74919	1967.56	-5.51	-0.09	91.57	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:53:11 PM	45.5	1169.21	1145.09	24.12	68.25	8.846403	1968.19	-5.51	-0.1	91.57	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:53:41 PM	46	1167.94	1145.09	22.85	69	8.943616	1969.46	-5.51	-0.09	91.57	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:54:11 PM	46.5	1167.94	1145.09	22.85	69.75	9.04083	1970.09	-5.51	-0.09	91.57	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:54:41 PM	47	1167.3	1143.82	23.48	70.5	9.138043	1970.73	-5.51	-0.1	91.57	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:55:11 PM	47.5	1166.67	1143.18	23.49	71.25	9.235256	1970.73	-5.59	-0.1	91.57	0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	12:55:41 PM	48	1169.21	1145.72	23.49	72	9.332469	1972	-5.59	-0.1	91.57	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	12:56:11 PM	48.5	1169.21	1143.82	25.39	72.75	9.429682	1973.27	-5.51	-0.09	91.57	-0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:56:41 PM	49	1166.67	1143.82	22.85	73.5	9.526896	1973.27	-5.51	-0.09	91.57	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:57:11 PM	49.5	1167.94	1143.82	24.12	74.25	9.624109	1973.9	-5.51	-0.09	91.57	-0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:57:41 PM	50	1167.3	1143.18	24.12	75	9.721322	1974.54	-5.59	-0.09	91.57	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:58:11 PM	50.5	1166.03	1143.18	22.85	75.75	9.818535	1974.54	-5.51	-0.09	91.57	-0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:58:41 PM	51	1166.03	1142.55	23.48	76.5	9.915749	1975.17	-5.51	-0.09	91.57	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	12:59:11 PM	51.5	1166.03	1141.91	24.12	77.25	10.01296	1975.17	-5.59	-0.09	91.57	0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	12:59:41 PM	52	1165.4	1141.91	23.49	78	10.11017	1975.81	-5.51	-0.09	91.57	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	1:00:11 PM	52.5	1164.13	1140.01	24.12	78.75	10.20739	1977.08	-5.51	-0.1	91.57	1.5	-60	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	1:00:41 PM	53	1164.13	1140.01	24.12	79.5	10.3046	1977.08	-5.59	-0.09	91.57	1.5	-60	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	1:01:11 PM	53.5	1162.86	1139.37	23.49	80.25	10.40181	1977.71	-5.51	-0.09	91.57	1.5	-60	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	1:01:41 PM	54	1162.86	1139.37	23.49	81	10.49903	1977.71	-5.51	-0.09	91.57	1.5	0.009	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	1:02:11 PM	54.5	1163.5	1139.37	24.13	81.75	10.59624	1978.35	-5.59	-0.09	91.57	1.5	0.003	1.5	0	0	0	13.047	0	0	Auto

APPENDIX D

SURFACTANT/BRANCHED ALCOHOL FLOOD EXPERIMENT DATA

Date	Time	Elapsed Time minutes		Inlet Pressure psi	Outlet Pressure psi	?P	Volume Inj	Pore Volun	Overburde Pressure psi	dP High psid	dP Low psid	Core Temperatu °C	Isco Pump Flow Rate A ml/min	Isco Pump Flow Rate B ml/min	Isco Pump Flow Rate AB ml/min	Actual Gas Flow Rate sccm	Separator Upper Volu ml	Separator Lower Volu ml	Liquid A Permeabili md	Liquid B Permeabili md	Gas Permeabili md	Log Mode
3/1/2012	########	0.2		1082.88	1079.07	3.81	0	0	1969.46	-5.59	-0.08	91.88	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	0.5		1077.8	1073.99	3.81	0	0	1967.56	-5.59	-0.08	91.88	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	1		1066.37	1062.57	3.8	0	0	1961.84	-5.67	-0.08	91.88	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	1.5		1027.65	1025.11	2.54	0	0	1954.23	-5.59	-0.08	91.88	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	2		973.7	970.52	3.18	0	0	1945.34	-5.59	-0.07	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	2.5	0.5	881.02	877.21	3.81	0.1	0.012962	1928.83	-5.59	-0.06	91.57	0.1	0.1	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	3	1	957.19	954.65	2.54	0.2	0.025924	1915.5	-5.59	-0.07	91.57	0.2	0.019	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	3.5	1.5	991.47	988.3	3.17	0.3	0.038885	1905.35	-5.59	-0.07	91.25	0.2	0.018	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	4	2	1001.63	997.18	4.45	0.4	0.051847	1895.19	-5.51	-0.07	91.25	0.2	0.006	0.2	0	0	0	1.74	0	0	Auto
3/1/2012	########	4.5	2.5	997.18	994.01	3.17	0.5	0.064809	1887.57	-5.51	-0.07	90.93	0.2	0.019	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	5	3	988.3	985.12	3.18	0.6	0.077771	1881.86	-5.51	-0.07	90.93	0.2	0.019	0.2	0	0	0	1.74	0	0	Auto
3/1/2012	########	5.5	3.5	976.24	973.7	2.54	0.7	0.090732	1876.78	-5.51	-0.07	90.93	0.2	0.021	0.2	0	0	0	1.74	0	0	Auto
3/1/2012	########	6	4	965.45	962.27	3.18	0.8	0.103694	1871.7	-5.59	-0.07	90.93	0.2	0.017	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	6.5	4.5	955.29	953.38	1.91	0.9	0.116656	1868.53	-5.59	-0.07	90.93	0.2	0.016	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	7	5	948.31	945.13	3.18	1	0.129618	1865.36	-5.59	-0.06	90.93	0.2	0.015	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	7.5	5.5	938.78	936.88	1.9	1.1	0.142579	1862.18	-5.51	-0.07	90.93	0.2	0.013	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	8	6	933.07	929.9	3.17	1.2	0.155541	1859.64	-5.51	-0.07	90.93	0.2	0.014	0.2	0	0	0	1.74	0	0	Auto
3/1/2012	########	8.5	6.5	929.26	926.72	2.54	1.3	0.168503	1858.37	-5.59	-0.07	90.93	0.2	0.017	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	9		926.09	924.18	1.91	0	0	1857.1	-5.67	-0.06	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	9.5		925.45	922.28	3.17	0	0	1855.2	-5.59	-0.06	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	10		929.26	927.99	1.27	0	0	1854.57	-5.67	-0.07	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	10.5		932.44	929.26	3.18	0	0	1853.93	-5.59	-0.07	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	11		932.44	929.9	2.54	0	0	1853.3	-5.51	-0.07	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	11.5		932.44	929.9	2.54	0	0	1852.66	-5.51	-0.07	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	12		932.44	929.26	3.18	0	0	1852.66	-5.51	-0.07	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	12.5		930.53	928.63	1.9	0	0	1851.39	-5.51	-0.07	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	13		929.9	927.99	1.91	0	0	1851.39	-5.67	-0.07	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	13.5		929.26	926.72	2.54	0	0	1851.39	-5.59	-0.06	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	14		929.26	926.72	2.54	0	0	1850.76	-5.51	-0.07	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	14.5		929.26	926.09	3.17	0	0	1851.39	-5.51	-0.07	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	15		928.63	926.09	2.54	0	0	1850.76	-5.59	-0.07	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	15.5		928.63	925.45	3.18	0	0	1851.39	-5.59	-0.06	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	16		928.63	925.45	3.18	0	0	1851.39	-5.51	-0.07	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	16.5		927.99	925.45	2.54	0	0	1851.39	-5.59	-0.07	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	17		928.63	925.45	3.18	0	0	1852.66	-5.59	-0.06	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	17.5		927.99	925.45	2.54	0	0	1852.66	-5.59	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	18		927.99	925.45	2.54	0	0	1853.3	-5.51	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	18.5		927.99	925.45	2.54	0	0	1853.3	-5.59	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	19		928.63	925.45	3.18	0	0	1853.93	-5.59	-0.06	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	19.5		928.63	926.09	2.54	0	0	1853.93	-5.59	-0.06	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	20		928.63	925.45	3.18	0	0	1854.57	-5.59	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	20.5		927.99	925.45	2.54	0	0	1855.2	-5.59	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	21		927.99	924.82	3.17	0	0	1855.2	-5.59	-0.06	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	21.5		927.99	924.82	3.17	0	0	1856.47	-5.59	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	22		927.99	924.82	3.17	0	0	1857.1	-5.59	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	22.5		926.72	924.82	1.9	0	0	1857.74	-5.59	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	23		926.72	924.82	1.9	0	0	1857.74	-5.59	-0.06	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	23.5		926.72	924.82	1.9	0	0	1859.01	-5.59	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	24		926.09	924.18	1.91	0	0	1859.64	-5.59	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	24.5		926.09	924.18	1.91	0	0	1860.91	-5.59	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	25		926.09	922.92	3.17	0	0	1861.55	-5.59	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	25.5		925.45	922.92	2.53	0	0	1862.18	-5.59	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	26		925.45	922.92	2.53	0	0	1862.82	-5.59	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	26.5		924.82	922.28	2.54	0	0	1863.45	-5.59	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	27		924.82	922.28	2.54	0	0	1864.72	-5.59	-0.06	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	27.5		924.82	921.65	3.17	0	0	1865.36	-5.59	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	28		924.82	921.65	3.17	0	0	1866.63	-5.59	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	28.5		924.82	921.65	3.17	0	0	1867.26	-5.59	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	29		924.18	921.01	3.17	0	0	1867.26	-5.59	-0.06	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	29.5		1034.64	1030.83	3.81	0	0	1864.72	-5.59	-0.08	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	30	7	1049.24	1043.52	5.72	1.4	0.181465	1860.91	-5.59	-0.08	91.25	0.1	0.1	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	30.5	7.5	1038.44	1034	4.44	1.5	0.194426	1857.74	-5.67	-0.08	91.25	0.1	0.1	0.2	0	0	0	1.691	0	0	Auto
3/1/2012	########	31	8	1032.73	1027.65	5.08	1.6	0.207388	1855.2	-5.59	-0.08	91.25	0.1	0.1	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	31.5	8.5	1028.92	1025.11	3.81	1.7	0.22035	1852.66	-5.59	-0.08	91.25	0.1	0.1	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	32	9	1038.44	1034.64	3.8	1.8	0.233312	1850.76	-5.67	-0.08	90.93	-27.34	0.2	0.2	0	0	0	1.691	0	0	Auto
3/1/2012	########	32.5	9.5	1044.79	1040.98	3.81	1.9	0.246273	1849.49	-5.59	-0.08	91.25	0	0.2	0.2	0	0	0	1.691	0	0	Auto
3/1/2012	########	33	10	1047.33	1042.89	4.44	2	0.259235	1847.58	-5.67	-0.08	90.93	-0.01	0.2	0.2	0	0	0	1.691	0	0	Auto
3/1/2012	########	33.5	10.5	1046.7	1042.25	4.45	2.1	0.272197	1846.95	-5.59	-0.08	91.25	0	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	34	11	1049.87	1046.06	3.81	2.2	0.285159	1846.31	-5.59	-0.08	90.93	-0.01	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	34.5	11.5	1053.68	1049.24	4.44	2.3	0.298121	1846.31	-5.59	-0.08	91.25	0.01	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	35		1051.77	1047.33	4.44	7	0.907323	1846.31	-5.59	-0.08	90.93	-0.01	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	35.5		1049.87	1045.43	4.44	7.1	0.920285	1845.68	-5.59	-0.08	91.25	0	0.2	0.2	0	0	0	1.691	0	0	Auto
3/1/2012	########	36		1047.33	1042.89	4.44	7.2	0.933247	1845.68	-5.59	-0.08	90.93	0	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	36.5		1046.06	1041.62	4.44	7.3	0.946209	1845.68	-5.59	-0.08	90.93	0	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	37		1044.79	1039.71	5.08	7.4	0.95917	1846.31	-5.59	-0.08	91.25	0	0.2	0.2	0	0	0	1.691	0	0	Auto
3/1/2012	########	37.5		1056.85	1053.04	3.81	7.5	0.972132	1846.31	-5.59	-0.08	91.25	0.03	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	38		1067.01	1063.2	3.81	7.6	0.985094	1846.95	-5.59	-0.08	91.25	-0.01	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	38.5		1067.64	1063.2	4.44	7.7	0.998056	1846.95	-5.59	-0.08	91.25	-0.01	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	39		1065.11	1059.39	5.72	7.8	1.011017	1847.58	-5.59	-0.08	91.25	0	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	39.5		1061.93	1057.49	4.44	7.9	1.023979	1847.58	-5.59	-0.08	91.25	-0.01	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	40		1057.49	1053.04	4.45	8	1.036941	1848.85	-5.59	-0.08	91.25	0	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	40.5		1054.31	1049.24	5.07	8.1	1.049903	1848.85	-5.59	-0.08	91.25	0.01	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	41		1051.14	1046.7	4.44	8.2	1.062865	1849.49	-5.59	-0.08	91.25	-0.01	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	41.5		1049.87	1045.43	4.44	8.3	1.075826	1850.76	-5.59	-0.08	91.25	0	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	42		1049.24	1045.43	3.81	8.4	1.088788	1851.39	-5.59	-0.08	91.25	0	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	42.5		1048.6	1044.79	3.81	8.5	1.10175	1852.66	-5.67	-0.08	91.25	0.01	0.2	0.2	0	0	0	1.691	0	0	Auto
3/1/2012	########	43		1053.04	1049.24	3.8	8.6	1.114712	1853.3	-5.59	-0.08	91.25	0.03	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	43.5		1068.91	1063.84	5.07	8.7	1.127673	1853.93	-5.51	-0.08	91.25	0.02	0.2	0.2	0	0	0	1.74	0	0	Auto
3/1/2012	########	44		1083.51	1079.7	3.81	8.8	1.140635	1854.57	-5.59	-0.08	91.25	0	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	44.5		1094.94	1091.13	3.81	8.9	1.153597	1856.47	-5.59	-0.09	91.25	0	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	45		1102.56	1097.48	5.08	9	1.166559	1857.1	-5.59	-0.08	91.25	0.01	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	45.5		1099.38	1094.94	4.44	9.1	1.17952	1857.74	-5.59	-0.09	91.25	-0.01	0.2	0.2	0	0	0	1.74	0	0	Auto
3/1/2012	########	46		1097.48	1093.04	4.44	9.2	1.192482	1858.37	-5.59	-0.09	91.25	0	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	46.5		1095.57	1091.13	4.44	9.3	1.205444	1859.01	-5.59	-0.08	91.25	0	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	47		1095.57	1090.5	5.07	9.4	1.218406	1859.64	-5.59	-0.08	91.25	0	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	47.5		1094.94	1089.86	5.08	9.5	1.231367	1860.91	-5.51	-0.08	91.25	-0.01	0.2	0.2	0	0	0	1.74	0	0	Auto
3/1/2012	########	48		1094.94	1089.86	5.08	9.6	1.244329	1861.55	-5.59	-0.09	91.25	-0.01	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	48.5		1094.3	1089.86	4.44	9.7	1.257291	1862.18	-5.59	-0.08	91.25	-0.01	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	49		1094.3	1089.86	4.44	9.8	1.270253	1862.82	-5.59	-0.08	91.25	0	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	49.5		1094.3	1089.86	4.44	9.9	1.283215	1863.45	-5.59	-0.09	91.25	0	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	50		1094.3	1089.23	5.07	10	1.296176	1865.36	-5.59	-0.08	91.25	-0.01	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	50.5		1094.3	1089.23	5.07	10.1	1.309138	1865.99	-5.59	-0.08	91.25	0.01	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	51		1093.67	1089.23	4.44	10.2	1.3221	1866.63	-5.59	-0.09	91.25	0.01	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	51.5		1093.67	1087.96	5.71	10.3	1.335062	1867.26	-5.59	-0.09	91.25	0	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	52		1093.04	1087.32	5.72	10.4	1.348023	1868.53	-5.59	-0.08	91.57	0.01	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	52.5		1093.04	1087.32	5.72	10.5	1.360985	1869.17	-5.51	-0.08	91.25	0	0.2	0.2	0	0	0	1.74	0	0	Auto
3/1/2012	########	53		1093.04	1087.32	5.72	10.6	1.373947	1870.43	-5.59	-0.08	91.57	0.01	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	53.5		1093.04	1087.96	5.08	10.7	1.386909	1871.07	-5.59	-0.09	91.25	0	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	54		1093.67	1087.96	5.71	10.8	1.39987	1871.7	-5.59	-0.08	91.57	0.01	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	54.5		1094.3	1089.23	5.07	10.9	1.412832	1872.97	-5.51	-0.09	91.57	0	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	55		1094.94	1089.86	5.08	11	1.425794	1873.61	-5.59	-0.09	91.57	0.01	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	55.5		1094.94	1090.5	4.44	11.1	1.438756	1874.88	-5.59	-0.09	91.57	0.01	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	56		1095.57	1091.13	4.44	11.2	1.451717	1875.51	-5.59	-0.08	91.57	0	0.2	0.2	0	0	0	1.715	0	0	Auto
3/1/2012	########	56.5		1089.23	1084.78	4.45	0	0	1876.78	-5.59	-0.09	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	57		1071.45	1066.37	5.08	0	0	1877.42	-5.59	-0.09	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	57.5		1057.49	1053.68	3.81	0	0	1878.05	-5.67	-0.08	91.57	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	58		1030.19	1026.38	3.81	0	0	1874.88	-5.59	-0.08	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	58.5		966.08	962.91	3.17	0	0	1864.72	-5.67	-0.07	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	59		1013.05	1009.88	3.17	0	0	1855.2	-5.51	-0.08	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	59.5		1042.25	1039.08	3.17	0	0	1847.58	-5.67	-0.08	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	60		1049.87	1046.06	3.81	0	0	1841.87	-5.59	-0.08	91.25	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	60.5		933.71	930.53	3.18	0	0	1828.54	-5.67	-0.07	90.93	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	61		846.11	844.2	1.91	0	0	1812.67	-5.67	-0.06	90.61	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	61.5		784.53	782	2.53	0	0	1793.63	-5.59	-0.05	89.98	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	62		740.73	738.2	2.53	0	0	1772.68	-5.51	-0.05	89.98	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	62.5		705.82	703.92	1.9	0	0	1752.37	-5.28	-0.04	89.66	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	63		677.89	676.62	1.27	0	0	1730.15	-5.36	-0.04	89.66	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	63.5		656.94	655.04	1.9	0	0	1706.66	-5.36	-0.03	89.34	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	64		640.44	638.54	1.9	0	0	1684.45	-5.28	-0.03	89.03	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	64.5		624.57	622.67	1.9	0	0	1660.32	-5.2	-0.03	89.03	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	65		612.51	611.24	1.27	0	0	1636.84	-5.12	-0.03	88.71	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	65.5		604.26	602.99	1.27	0	0	1613.99	-5.12	-0.03	88.08	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	66		596.01	594.74	1.27	0	0	1589.23	-5.12	-0.03	88.08	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	66.5		586.48	584.58	1.9	0	0	1565.74	-5.12	-0.03	87.44	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	67		578.23	576.33	1.9	0	0	1542.89	-5.04	-0.02	87.44	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	67.5		568.71	567.44	1.27	0	0	1518.77	-5.04	-0.03	87.44	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	68		563	560.46	2.54	0	0	1495.92	-4.88	-0.02	87.12	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	68.5		556.02	554.75	1.27	0	0	1472.43	-4.88	-0.02	86.81	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	69		547.76	546.49	1.27	0	0	1448.94	-4.88	-0.02	86.17	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	69.5		539.51	538.24	1.27	0	0	1426.73	-4.88	-0.02	86.17	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	70		531.26	529.99	1.27	0	0	1403.88	-4.8	-0.02	85.85	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	70.5		523.64	521.1	2.54	0	0	1381.02	-4.8	-0.02	85.85	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	71		514.75	512.85	1.9	0	0	1359.44	-4.8	-0.02	85.54	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	71.5		507.77	506.5	1.27	0	0	1338.49	-4.72	-0.02	85.22	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	72		502.06	500.16	1.9	0	0	1316.28	-4.72	-0.01	85.22	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	72.5		495.08	493.81	1.27	0	0	1294.69	-4.72	-0.01	84.9	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	73		488.09	486.82	1.27	0	0	1274.38	-4.72	-0.02	84.58	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	73.5		482.38	480.48	1.9	0	0	1253.43	-4.64	-0.01	84.58	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	74		475.4	474.76	0.64	0	0	1231.85	-4.64	-0.01	83.95	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	74.5		469.69	467.78	1.91	0	0	1212.17	-4.56	-0.01	83.95	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	75		463.97	462.7	1.27	0	0	1198.84	-4.64	-0.02	83.63	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	75.5		459.53	458.26	1.27	0	0	1195.67	-4.56	-0.01	83.63	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	76		455.09	452.55	2.54	0	0	1195.67	-4.64	-0.01	83.31	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	76.5		451.28	450.01	1.27	0	0	1195.03	-4.48	-0.01	83	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	77		448.1	446.83	1.27	0	0	1193.76	-4.56	-0.01	83	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	77.5		443.66	443.03	0.63	0	0	1189.96	-4.32	-0.01	82.68	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	78		439.85	438.58	1.27	0	0	1185.51	-4.32	-0.01	82.68	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	78.5		435.41	433.5	1.91	0	0	1174.09	-4.32	-0.01	82.04	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	79		430.33	428.43	1.9	0	0	1161.39	-4.32	-0.01	81.73	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	79.5		427.16	425.89	1.27	0	0	1149.33	-4.32	-0.01	81.73	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	80		423.35	422.08	1.27	0	0	1137.27	-4.32	-0.01	81.41	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	80.5		417.63	416.36	1.27	0	0	1127.11	-4.25	-0.01	81.41	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	81		412.56	411.29	1.27	0	0	1119.5	-4.25	-0.01	81.09	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	81.5		409.38	407.48	1.9	0	0	1115.05	-4.25	-0.01	81.09	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	82		405.57	403.67	1.9	0	0	1111.88	-4.17	-0.01	80.78	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	82.5		401.76	399.86	1.9	0	0	1109.97	-4.17	-0.01	80.14	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	83		397.96	397.32	0.64	0	0	1108.7	-4.17	-0.01	80.14	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	83.5		425.89	423.98	1.91	0	0	1108.7	-4.17	-0.01	80.14	0	0	0	0	0	0	0	0	0	Auto

APPENDIX E

POLYMERFLOOD EXPERIMENT DATA

Date	Time	Elapsed Time minutes		Inlet Pressure psi	Outlet Pressure psi	?P	Volume Injectec	Pore Volun	Overburde Pressure psi	dP High psid	dP Low psid	Core Temperatu °C	Isco Pump Flow Rate A ml/min	Isco Pump Flow Rate B ml/min	Isco Pump Flow Rate A ml/min	Actual Gas Flow Rate sccm	Separator Upper Volu ml	Separator Lower Volu ml	Liquid A Permeabili md	Liquid B Permeabili md	Gas Permeabili md	Log Mode
3/1/2012	########	0.28		467.78	466.51	1.27			1106.8	-4.25	-0.01	80.14	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	0.51		488.73	486.82	1.91			1106.17	-4.25	-0.01	79.82	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	1.01		528.72	526.18	2.54			1104.9	-4.32	-0.01	79.82	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	1.51		309.72	317.34	-7.62			1099.18	-4.17	-0.01	79.82	0.75	0.758	1.5	0	0	0	17.272	0	0	Auto
3/1/2012	########	2.01		276.71	275.44	1.27			1097.91	-3.05	0	79.51	1.5	-57.678	1.5	0	0	0	23.553	0	0	Auto
3/1/2012	########	2.51		300.84	298.3	2.54			1097.91	-3.13	0	79.51	11.5	-0.004	11.5	0	0	0	176.002	0	0	Auto
3/1/2012	########	3.01		318.61	317.97	0.64			1098.55	-3.13	0	79.51	11.5	0.018	11.5	0	0	0	171.656	0	0	Auto
3/1/2012	########	3.51		331.3	330.67	0.63			1095.37	-3.05	0	79.51	11.5	0.039	11.5	0	0	0	171.656	0	0	Auto
3/1/2012	########	4.01		341.46	340.19	1.27			1086.49	-3.21	0	79.51	11.5	0.29	11.5	0	0	0	171.656	0	0	Auto
3/1/2012	########	4.51	0	557.28	554.75	2.53			1081.41	-4.17	-0.01	79.19	0	0	0	0	0	0	0	0	0	Auto
3/1/2012	########	5.01	0	870.86	867.69	3.17	0	0	1082.04	-4.88	-0.05	79.19	0.75	0.75	1.5	0	0	0	14.745	0	0	Auto
3/1/2012	########	5.51	0.5	991.47	983.22	8.25	0.75	0.097213	1709.84	-5.2	-0.06	79.19	0.75	0.75	1.5	0	0	0	13.844	0	0	Auto
3/1/2012	########	6.01	1	1109.54	1093.67	15.87	1.5	0.194426	1712.38	-5.36	-0.08	79.19	0.75	0.75	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	6.51	1.5	1111.44	1091.77	19.67	2.25	0.29164	1708.57	-5.51	-0.08	79.19	-22.5	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	7.01	2	1113.35	1093.04	20.31	3	0.388853	1705.39	-5.51	-0.08	79.19	-0.65	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	7.51	2.5	1115.25	1093.04	22.21	3.75	0.486066	1702.85	-5.51	-0.08	79.19	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	8.01	3	1113.35	1091.77	21.58	4.5	0.583279	1701.58	-5.51	-0.08	79.19	-0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	8.51	3.5	1112.08	1091.77	20.31	5.25	0.680493	1701.58	-5.51	-0.08	79.51	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	9.01	4	1111.44	1091.77	19.67	6	0.777706	1700.32	-5.51	-0.08	79.51	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	9.51	4.5	1110.81	1091.13	19.68	6.75	0.874919	1700.32	-5.59	-0.08	79.51	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	10.01	5	1111.44	1091.77	19.67	7.5	0.972132	1700.32	-5.51	-0.08	79.51	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	10.51	5.5	1111.44	1091.77	19.67	8.25	1.069345	1700.32	-5.51	-0.08	79.51	0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	11.01	6	1112.08	1091.13	20.95	9	1.166559	1700.95	-5.59	-0.08	79.82	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	11.51	6.5	1112.08	1093.04	19.04	9.75	1.263772	1701.58	-5.59	-0.08	79.82	0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	12.01	7	1113.35	1093.04	20.31	10.5	1.360985	1702.85	-5.59	-0.08	79.82	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	12.51	7.5	1112.08	1091.77	20.31	11.25	1.458198	1704.76	-5.59	-0.08	79.82	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	13.01	8	1112.08	1091.77	20.31	12	1.555412	1706.66	-5.59	-0.08	79.82	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	13.51	8.5	1112.08	1093.04	19.04	12.75	1.652625	1708.57	-5.59	-0.09	80.14	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	14.01	9	1112.08	1091.77	20.31	13.5	1.749838	1711.74	-5.51	-0.08	80.14	-0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	14.51	9.5	1113.35	1093.04	20.31	14.25	1.847051	1713.65	-5.59	-0.08	80.14	0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	15.01	10	1113.98	1093.04	20.94	15	1.944264	1717.45	-5.51	-0.08	80.14	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	15.51	10.5	1114.62	1094.3	20.32	15.75	2.041478	1720.63	-5.59	-0.08	80.78	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	16.01	11	1114.62	1093.04	21.58	16.5	2.138691	1724.44	-5.59	-0.08	80.78	0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	16.51	11.5	1117.16	1094.94	22.22	17.25	2.235904	1729.51	-5.59	-0.08	80.78	-0.03	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	17.01	12	1114.62	1093.67	20.95	18	2.333117	1733.32	-5.51	-0.08	80.78	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	17.51	12.5	1117.16	1094.94	22.22	18.75	2.430331	1737.77	-5.59	-0.08	81.09	0.02	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	18.01	13	1119.06	1098.11	20.95	19.5	2.527544	1742.85	-5.59	-0.09	81.09	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	18.51	13.5	1118.43	1094.94	23.49	20.25	2.624757	1748.56	-5.67	-0.09	81.09	0	1.5	1.5	0	0	0	12.682	0	0	Auto
3/1/2012	########	19.01	14	1122.87	1100.02	22.85	21	2.72197	1753.64	-5.59	-0.09	81.41	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	19.51	14.5	1126.04	1102.56	23.48	21.75	2.819183	1758.71	-5.59	-0.08	81.41	-0.02	1.5	1.5	0	0	0	12.682	0	0	Auto
3/1/2012	########	20.01	15	1129.22	1106.37	22.85	22.5	2.916397	1765.06	-5.51	-0.09	81.41	-0.02	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	20.51	15.5	1133.03	1109.54	23.49	23.25	3.01361	1770.78	-5.59	-0.09	81.41	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	21.01	16	1136.2	1113.35	22.85	24	3.110823	1777.12	-5.59	-0.09	81.41	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	21.51	16.5	1140.01	1115.25	24.76	24.75	3.208036	1782.84	-5.51	-0.09	81.73	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	22.01	17	1141.91	1117.79	24.12	25.5	3.30525	1790.45	-5.51	-0.09	81.73	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	22.51	17.5	1146.36	1122.87	23.49	26.25	3.402463	1796.8	-5.59	-0.09	81.73	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	23.01	18	1150.17	1126.68	23.49	27	3.499676	1803.15	-5.51	-0.09	81.73	0.03	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	23.51	18.5	1153.97	1127.95	26.02	27.75	3.596889	1810.13	-5.51	-0.09	82.04	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	24.01	19	1157.15	1133.66	23.49	28.5	3.694102	1817.11	-5.67	-0.09	82.04	0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	24.51	19.5	1159.05	1134.93	24.12	29.25	3.791316	1824.73	-5.51	-0.09	82.04	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	25.01	20	1162.86	1138.1	24.76	30	3.888529	1832.35	-5.59	-0.09	82.04	0.03	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	25.51	20.5	1166.03	1141.91	24.12	30.75	3.985742	1838.7	-5.67	-0.09	82.04	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	26.01	21	1147.63	1121.6	26.03	31.5	4.082955	1845.68	-5.59	-0.09	82.68	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	26.51	21.5	1159.05	1134.93	24.12	32.25	4.180169	1854.57	-5.59	-0.09	82.68	0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	27.01	22	1167.3	1142.55	24.75	33	4.277382	1861.55	-5.59	-0.09	82.68	0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	27.51	22.5	1171.75	1146.36	25.39	33.75	4.374595	1869.17	-5.59	-0.09	82.68	-0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	28.01	23	1178.1	1151.43	26.67	34.5	4.471808	1877.42	-5.59	-0.09	82.68	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	28.51	23.5	1173.65	1149.53	24.12	35.25	4.569021	1885.03	-5.67	-0.1	83	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	29.01	24	1181.9	1155.24	26.66	36	4.666235	1892.65	-5.67	-0.1	83	0.01	1.5	1.5	0	0	0	12.682	0	0	Auto
3/1/2012	########	29.51	24.5	1183.81	1157.78	26.03	36.75	4.763448	1899.63	-5.51	-0.09	83	0.02	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	30.01	25	1186.35	1159.05	27.3	37.5	4.860661	1907.89	-5.51	-0.1	83	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	30.51	25.5	1187.62	1160.32	27.3	38.25	4.957874	1916.77	-5.51	-0.1	83	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	31.01	26	1189.52	1160.32	29.2	39	5.055087	1923.76	-5.51	-0.1	83.31	-0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	31.51	26.5	1191.43	1162.86	28.57	39.75	5.152301	1932.01	-5.51	-0.1	83.31	0.02	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	32.01	27	1193.33	1164.13	29.2	40.5	5.249514	1939.63	-5.59	-0.1	83.31	-0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	32.51	27.5	1195.23	1166.67	28.56	41.25	5.346727	1947.88	-5.59	-0.1	83.31	0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	33.01	28	1196.5	1167.94	28.56	42	5.44394	1955.49	-5.59	-0.1	83.31	0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	33.51	28.5	1199.68	1170.48	29.2	42.75	5.541154	1963.75	-5.59	-0.1	83.31	0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	34.01	29	1201.58	1173.65	27.93	43.5	5.638367	1972	-5.59	-0.1	83.63	-0.02	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	34.51	29.5	1202.85	1174.29	28.56	44.25	5.73558	1980.25	-5.51	-0.1	83.63	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	35.01	30	1205.39	1175.56	29.83	45	5.832793	1987.87	-5.59	-0.1	83.63	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	35.51	30.5	1203.49	1174.92	28.57	45.75	5.930006	1997.39	-5.59	-0.1	83.63	0.02	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	36.01	31	1206.66	1177.46	29.2	46.5	6.02722	2004.37	-5.59	-0.1	83.63	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	36.51	31.5	1208.56	1176.19	32.37	47.25	6.124433	2011.99	-5.59	-0.1	83.95	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	37.01	32	1208.56	1178.73	29.83	48	6.221646	2021.51	-5.51	-0.1	83.95	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	37.51	32.5	1209.83	1179.36	30.47	48.75	6.318859	2028.49	-5.51	-0.1	83.95	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	38.01	33	1211.1	1181.27	29.83	49.5	6.416073	2038.02	-5.59	-0.1	83.95	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	38.51	33.5	1212.37	1183.17	29.2	50.25	6.513286	2046.27	-5.59	-0.1	83.95	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	39.01	34	1213.64	1183.81	29.83	51	6.610499	2053.88	-5.51	-0.1	84.58	0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	39.51	34.5	1214.91	1184.44	30.47	51.75	6.707712	2062.14	-5.51	-0.11	84.58	-0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	40.01	35	1215.55	1186.35	29.2	52.5	6.804925	2069.75	-5.59	-0.1	84.58	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	40.51	35.5	1217.45	1186.98	30.47	53.25	6.902139	2078.01	-5.51	-0.1	84.58	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	41.01	36	1218.09	1187.62	30.47	54	6.999352	2085.62	-5.59	-0.1	84.58	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	41.51	36.5	1219.36	1189.52	29.84	54.75	7.096565	2094.51	-5.51	-0.11	84.58	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	42.01	37	1219.36	1189.52	29.84	55.5	7.193778	2102.13	-5.51	-0.11	84.9	-0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	42.51	37.5	1220.63	1190.79	29.84	56.25	7.290992	2108.48	-5.59	-0.1	84.9	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	43.01	38	1221.89	1191.43	30.46	57	7.388205	2115.46	-5.59	-0.11	84.9	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	43.51	38.5	1222.53	1192.06	30.47	57.75	7.485418	2123.08	-5.51	-0.11	84.9	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	44.01	39	1223.8	1193.96	29.84	58.5	7.582631	2130.69	-5.59	-0.11	84.9	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	44.51	39.5	1225.7	1194.6	31.1	59.25	7.679844	2138.94	-5.51	-0.1	84.9	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	45.01	40	1223.8	1192.06	31.74	60	7.777058	2146.56	-5.51	-0.11	84.9	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	45.51	40.5	1223.8	1193.96	29.84	60.75	7.874271	2155.45	-5.51	-0.11	85.22	-0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	46.01	41	1225.7	1194.6	31.1	61.5	7.971484	2163.07	-5.59	-0.11	85.22	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	46.51	41.5	1226.34	1195.23	31.11	62.25	8.068697	2170.68	-5.51	-0.11	85.22	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	47.01	42	1227.61	1197.77	29.84	63	8.165911	2178.94	-5.51	-0.1	85.22	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	47.51	42.5	1226.97	1195.87	31.1	63.75	8.263124	2186.55	-5.59	-0.1	85.22	-0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	48.01	43	1227.61	1196.5	31.11	64.5	8.360337	2194.17	-5.51	-0.11	85.22	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	48.51	43.5	1228.24	1196.5	31.74	65.25	8.45755	2201.15	-5.51	-0.11	85.54	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	49.01	44	1228.24	1196.5	31.74	66	8.554763	2208.77	-5.51	-0.11	85.54	-0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	49.51	44.5	1227.61	1195.87	31.74	66.75	8.651977	2217.02	-5.51	-0.11	85.54	-0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	50.01	45	1227.61	1195.87	31.74	67.5	8.74919	2224.64	-5.51	-0.11	85.54	-0.01	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	50.51	45.5	1226.97	1195.23	31.74	68.25	8.846403	2231.62	-5.59	-0.11	85.54	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	51.01	46	1226.34	1194.6	31.74	69	8.943616	2238.6	-5.59	-0.11	85.54	-0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	51.51	46.5	1226.34	1193.96	32.38	69.75	9.04083	2245.59	-5.59	-0.11	85.85	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	52.01	47	1225.7	1193.33	32.37	70.5	9.138043	2252.57	-5.59	-0.11	85.85	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	52.51	47.5	1223.8	1193.33	30.47	71.25	9.235256	2259.55	-5.59	-0.11	85.85	-0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	53.01	48	1223.8	1191.43	32.37	72	9.332469	2266.53	-5.51	-0.11	85.85	0	1.5	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	53.51	48.5	1223.16	1191.43	31.73	72.75	9.429682	2272.25	-5.59	-0.11	85.85	-0.01	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	54.01	49	1222.53	1190.16	32.37	73.5	9.526896	2279.86	-5.67	-0.11	85.85	0.01	1.5	1.5	0	0	0	12.682	0	0	Auto
3/1/2012	########	54.51	49.5	1220.63	1189.52	31.11	74.25	9.624109	2286.85	-5.59	-0.1	85.85	0.02	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	55.01	50	1219.99	1187.62	32.37	75	9.721322	2293.2	-5.67	-0.1	85.85	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	55.51	50.5	1219.36	1187.62	31.74	75.75	9.818535	2300.18	-5.59	-0.11	86.17	0	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	56.01	51	1218.72	1186.35	32.37	76.5	9.915749	2307.16	-5.67	-0.1	86.17	-0.01	1.5	1.5	0	0	0	12.682	0	0	Auto
3/1/2012	########	56.51	51.5	1218.72	1186.35	32.37	77.25	10.01296	2312.87	-5.59	-0.11	86.17	-0.02	1.5	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	57.01	52	1217.45	1184.44	33.01	78	10.11017	2319.86	-5.59	-0.1	86.17	1.11	0.54	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	57.51	52.5	1217.45	1183.81	33.64	78.75	10.20739	2326.84	-5.67	-0.1	86.17	1.5	-60	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	58.01	53	1216.18	1183.81	32.37	79.5	10.3046	2333.19	-5.59	-0.1	86.17	1.5	-60	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	58.51	53.5	1215.55	1183.17	32.38	80.25	10.40181	2340.8	-5.59	-0.11	86.17	1.5	-0.015	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	59.01	54	1214.91	1181.27	33.64	81	10.49903	2347.15	-5.59	-0.1	86.81	1.5	-0.008	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	59.51	54.5	1214.28	1181.27	33.01	81.75	10.59624	2353.5	-5.59	-0.11	86.81	1.5	-0.013	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	60.01	55	1213.64	1179.36	34.28	82.5	10.69345	2360.48	-5.59	-0.11	86.81	1.5	0.004	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	60.51	55.5	1212.37	1178.73	33.64	83.25	10.79067	2367.46	-5.59	-0.1	86.81	1.5	-0.013	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	61.01	56	1211.74	1178.1	33.64	84	10.88788	2373.18	-5.51	-0.1	86.81	1.5	0.004	1.5	0	0	0	13.047	0	0	Auto
3/1/2012	########	61.51	56.5	1211.1	1177.46	33.64	84.75	10.98509	2379.52	-5.59	-0.1	86.81	1.5	0.005	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	62.01	57	1210.47	1176.19	34.28	85.5	11.08231	2385.87	-5.51	-0.11	86.81	1.5	-0.005	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	62.51	57.5	1209.83	1175.56	34.27	86.25	11.17952	2392.85	-5.59	-0.11	86.81	1.5	0.012	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	63.01	58	1208.56	1174.92	33.64	87	11.27673	2399.84	-5.59	-0.11	87.12	1.5	-0.013	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	63.51	58.5	1207.93	1174.29	33.64	87.75	11.37395	2406.19	-5.59	-0.1	87.12	1.5	-0.001	1.5	0	0	0	12.682	0	0	Auto
3/1/2012	########	64.01	59	1207.29	1174.29	33	88.5		2412.53	-5.59	-0.1	87.12	1.5	-0.006	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	64.51	59.5	1206.66	1172.38	34.28	89.25		2418.25	-5.67	-0.1	87.12	1.5	-0.008	1.5	0	0	0	12.682	0	0	Auto
3/1/2012	########	65.01	60	1206.03	1171.75	34.28	90		2425.23	-5.59	-0.11	87.12	1.5	-0.001	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	65.51	60.5	1205.39	1171.75	33.64	90.75		2431.58	-5.67	-0.1	87.12	1.5	-0.004	1.5	0	0	0	12.682	0	0	Auto
3/1/2012	########	66.01	61	1204.12	1170.48	33.64	91.5		2436.65	-5.67	-0.1	87.12	1.5	-0.011	1.5	0	0	0	12.682	0	0	Auto
3/1/2012	########	66.51	61.5	1203.49	1170.48	33.01	92.25		2443.64	-5.67	-0.1	87.44	1.5	0.011	1.5	0	0	0	12.682	0	0	Auto
3/1/2012	########	67.01	62	1203.49	1169.21	34.28	93		2449.35	-5.67	-0.1	87.44	1.5	0.004	1.5	0	0	0	12.682	0	0	Auto
3/1/2012	########	67.51	62.5	1202.85	1169.21	33.64	93.75		2454.43	-5.59	-0.1	87.12	1.5	0.003	1.5	0	0	0	12.862	0	0	Auto
3/1/2012	########	68.01	63	1202.22	1167.94	34.28	94.5		2461.41	-5.59	-0.1	87.44	1.5	0	1.5	0	0	0	12.862	0	0	Auto