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A comprehensive study of phase behavior in selected Iraqi oil fields

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ABSTRACT

This study interested in estimating the physical properties and prediction of the phase behavior for reservoir fluids of Buzurgan field /Mishrif formation. The prediction was done by using "PVTP"V 8.5 which has a regression technique to tune the PVT data and phase behavior for a samples of reservoir fluid and also a properties determination program.

PVTp uses Soave-Redlich-Kwong (SRK) and Peng-Robinson (PR) equations of state (EOS) in the EOS model to estimate the physical properties of reservoir fluid. The results of PR equation were more accurate than SRK equation, so that it were adopted for this study.

The second model which is used in this study by PVTp program is the black oil model. The model uses many correlations to calculate the physical properties of reservoir fluid. The best results were obtained by Lasater for (Bo, GOR, and Oil density) and Petrosky for Oil viscosity (Mo).

A (PVT) analysis has been accomplished to compare the results that are obtained by "PVTP" with the experimental (PVT) analysis of the field. The program is shown to be dependable for its purpose.

Introduction

Comprehension the properties of reservoir fluids i.e. liquid density ,oil formation volume factor, gas-oil-ratio, and liquid viscosity are quite important in petroleum reservoir engineering studies like well test inflow performance calculations ,numerical reservoir simulation and the estimation of reserves in an oil reservoir.

Fluid properties and phase equilibria can be obtained by using the solution of equations of state (EOS), laboratory analysis and correlations. As known The Experimental methods requires long time and also expensive; therefore, all the endeavors are be toward the solutions of EOS as an alternative method.

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Among a lot equations of state that suggested for predicting the phase behavior for hydrocarbon systems, the most "EOS" used in oil industry is the cubic type like Peng-Robinson "PR" and Soave-Redlich-Kwong "SRK" EOS .In this study, the two equations above are used in "PVTP"program.

Brief idea about the field

In this study, Buzurgan field was chosen to studythe properties and the phase behavior of the reservoir fluids. Buzurgan field/Mishrif formation is one of the Iraqi oil fields, it was discovered in 1970 in the South-Eastern part of Iraq, 40 Km North- East of Amara also near the Iranian border. Buzurgan oil field has an average depth of 3500 with a thickness of 305 and an API value of 23.

The Aim of the Study

1- The significant intention of the present work is to construct a black oil model and an EOS model to predict the phase behavior and the physical properties of the reservoir fluids by using PVTp (v.8.5)program.

2-Improving the reservoir models through the tuning processes to get the best match with an accurate results.

3-To illustrate how such an advanced program can help to design a proper sub-surface equipment in Iraqi oil fields, by Suggesting new development plans according to the various scenarios for Buzurgan field /Mishrif formation.

Equation of State (EOS) and black oil Modeling Software

PVTp (v8.5) is an advanced and versatile PVT (Pressure-Volume-Temperature) analysis software. It authorizes the user to simulate the experimental PVT data and fluid properties quickly and accurately.

PVTp (v8.5) software was used to build a PVT model to predict the reservoir fluid properties and the phase behavior of Buzirgan field/Mishrif formation. For EOS model this software uses two equations of state for the prediction of various reservoir fluid properties. These equations are Soave-Redlich-Kwong (SRK) and Peng-Robinson (PR).

For the black oil model , the soft uses five correlations for calculating the bubble point pressure (Pb) , Oil formation volume factor (Bo) , and Gas oil ratio (Rsb),these correlations are (Glaso et al, Standing et al, Lasater et al, Vasquez-Beggs, and Petrosky). There is also three correlations that used to calculate the oil viscosity (Mo), which they are Beal et al, Beggs et al, and Petrosky.

Fluid Properties for EOS and Black oil models

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According to PVT reports that obtained from Mishrif reservoir , the reservoir fluid in Buzurgan field is a black oil fluid with an initial reservoir pressure of 540 Kg/cma2 and an initial reservoir temperature of 113.3 C^0 at a reference depth of 3915 m, The API gravity is 22.5, and GOR of 110.32 m^3/m^3.

Table .1 shows reservoir fluid composition which was obtained by a Recombination process from separator fluids.

Table.1Reservoir fluid composition of Buzurgan field /Mishrif formation (Bu-6)

components	%molar
N2	0.48
CO2	1
C1	27.42
C2	12.37
C3	6.22
ISO C4	1.16
N C4	3.92
ISO C5	1.6
N C5	1.8
C6+	44.03
sum=	100

Well No.: BU-6
Reservoir Temperature, °C: 113.3
C_{6+} Molecular weight: 240
C_{6+} API: 21.5
C_{6+} sp.gr: 0.9250

Equation-of-State(EOS)Characterization

Cubic EOS have found widespread acceptance as tools that permit the convenient and flexible calculation of the phase behavior of reservoir fluids. Most equations of state requires just the acentric factor and the critical properties of each solo component of the hydrocarbon mixture.

The essential advantage of using an EOS is the ability of confirming consistency during phase equilibria calculations because the same equation can be applied to model the behavior of all existing phases.

In this study Peng Robinson (PR) and Soave-redlich-kwon (SRK) EOS have been used to obtain the superior match for PVT properties, however PR EOS was selected to generate the EOS model,

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because it has been found to give an adequate agreement with the experimental data of Buzurgan reservoir/ Mishrif field.

1. PVT EOS Data Used

PVT laboratory sample data of Mishrif Formation were used in the tuning processes of the EOS. PVT laboratory data included constant composition- expansion (CCE) and differential-liberation-expansion (DLE) experiments.

The main parameters that inserted into the PVTp software are components and their mole fractions **Table.1**C_{6+} (sp.gr, API and molecular Weight), DLE experiment (oil density, viscosity and GOR), and CCE experiment (Relative volumes).

2. PVTModel with Splitting and Lumping Processes

The analytical data for crude oils are available from C1 to C6 as a pure component.C6 is usually pure but sometimes may be presents as C_{6+}fraction as the data in **Table.1**. Representing the hydrocarbon component higher than C5 with one Pseudo component (C_{6+}) may cause errors in the calculations. For this reason, some components must be split and, then lumped (grouped) together to be represented as pseudo components and then the calculations can be performed efficiently and smoothly.

In (2007)Pedersen and Christensendeclared that the characterization of the plus fraction includes:

1-Estimation of the molar distribution (carbon Number vs mole fraction)

2-Estimation of ω, Pc and Tc, of the resulting carbon number Fractions.

3-Lumping (grouping) the carbon number fractions into a reasonable

Number of pseudo components.

In this study a multistep process on (C_{6+}) fraction that started by splitting the heavy components as suggested by Whitsonthen lumped to enhance the EOS.

3. Splitting

The Splitting schemes is breaking down the C_{6+}fractions into a hydrocarbon groups with a single (solo) carbon number which they Characterized by the same physical properties that used for pure components.

In (2004) Pedersen et alsuggested that for the regular reservoir fluids, C80 is a sensible choice as the heaviest component to take into consideration. Some components as heavy as C200 in heavy oils and that may affect the phase behavior.

In this study, C_{6+} is a black oil sample from well Buzurgan **Table.1** is consider as a normal heavy component, therefore; C_{6+} have been split until C34. The splitting process has been done with PVTp

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software. The total number of component after the splitting process was 34 pseudo components and pure

(CO2, C1, C2, C3, iC4, nC4, iC5, nC5 …Cn….. C34).

In this study many methods to split C_6+ have been tried to achieve the best matching between calculated and measured data, but it has been found that splitting the fractional (C_{6+}) into three pseudo components based on its mole fraction gave an accurate match. **Table.3** shows the new components after splitting. To match the observations the regression was applied on the 34-component mixture to tune the EOS.

Table.2 Reservoir Fluid Composition in MoleFractions (after splitting process)

components	%molar
N2	0.48
Carbon dioxide	1
methane	27.42
ethane	12.37
propane	6.22
i-butane	1.16
n-butane	3.92
i-pentane	1.6
n-pentane	1.8
C7::C9	11.8016
C10::C12	9.04263
C13::C16	8.44763
C17::C34	14.7381
SUM=	100

4 Regression to Experimental PVT Data

Models of Phase behavior that based on (EOS) often predicts the results improperly even if the model fluids are well characterized.

The Real reservoir fluids that composed of thousands components, are described by a finite number of pure substances and carbon groups. The carbon groups of these fluids are not fully defined, also the compositional results are not always too realistic.

The existing approach in the industry to confronting the insufficiencies that mentioned above is to tune (calibrate) an EOS model against (measured) laboratory data that generated at relevant conditions for particular reservoir fluid. The industry had not used a standard method for the tuning purpose, and those various methodsare generally similar. The difference between the measured and predicted values can be minimized, by adjusting theinaccurate values of some input data to phase behavior model.(Danesh).

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However, according to the open literature which showed that, there is no consistency in lumping schemes, an EOS tuning parameters, the number of (SCN) groups, and Weight factors which applied to the measured data when tuning an EOS for compositional analysis studies. (Raffie et al.)

5 Selection of Regression Variable

In 1987 Gani and Fredenslund proposed a new approach for tuning an EOS parameters based on specifying the predicted results sensitivity. After several tests they selected the (BIP) as the most effective parameters. The best approach for the regress is to calibrate the parameters according to the most effective parameters. The tuning then will achieved with only little modification in the original parameters.

The parameters that are used in this study tuning are, the (C_{6+}) pseudo components, critical pressure (P**c**), critical temperature (T**c**), acentric factor (ω) and binary interaction coefficients (δ). The volume shift (S.shift) of the C_{6+} Pseudo components were also regressed together, so that changes within the C_6+ fraction were consistent.

6 Weighting factors

The parameters should be weighting before starting the regression processes, the weighting factors are recommended by the PVTp are as follows:

Table.3 the weighting factors of Pvt Properties

Property	GOR and Bo	Oil density	Saturation pressure (Ps)	Relative volume
Weighting factor	Low From(1-4)	Medium (5)	High From(7-10)	Low From(1-4)

These factors are used to tune the EOS properly, but it should be note that the weighting is applied when if the regression is applied on more than one property.

The weighting factors are ranged from (1-10) in PVTp software while in text books (whitson, Riazi) are ranged from(1-40).

The reservoir fluid of Buzurgan field /Mishrif formation presented in **Table.1** was regressed according to the recommendations that mentioned above to obtain the best tuning results. The results were contain an acceptance predictions with small error percent as compared to the experimental pvt data, then the regression process was applied on the fluid sample using two experimental data (DLE and CCE) and compared the calculated result with the experimental data.

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7. Lumping

After splitting and regress all the measured data and gaining a satisfactory matching results , the next step is to lump (group) the 13- component EOS to form a new reduced pseudo component EOS from the existing components. The purpose of this reduction is to minimize the numerical complexity and the calculations time of the compositional reservoir.

There are several lumping schemes which proposed in literatures like Whitson et al. (1989), Pedersen et al. (1984), Leibovici (1993), Danesh et al. (1992), and Lomeland and Harstad (1994).

After lumping the component, the regressions must be applied again to tune the properties of the newly grouped pseudo component EOS.This process was repeated several times in order to choose the best grouping for each stage in the pseudoization process. The best criteria for lumping is to select components with similar molecular weight and properties also the components are preferred to be as few as necessary to match the PVT experiments.

A several grouping attempts were performed for the 13-component EOS model and the best results were obtained for these two attempts

The first one was for an 11-component EOS model by grouping (i-C**4**, n-C**4**) and (i-C**5**, n-C**5**) and leaving the other components ungrouped.

After the grouping process, the regression process was applied to tune the newly formed pseudo components and it found that only a slight tuning is required for matching the components. Finally after the regression process it found that, the PVT properties of the newly formed model (11-component EOS) matched the 13-component EOS model.

The second one was conducted from the 11-component EOS model which was contains only 7 component after grouping (N2, C1), (CO_2, C_2) and (C_3-C**5**).

The 7-component EOS model contained the following components:

(C_1, N2) (CO_2, C_2), (C_3-C_5), (C7:C9), (C10:C12), (C13:C16), (C17:C34).

The new components and their mole fractions after grouping process.

Are shown in **Table.4**.

Table.4 Reservoir Fluid Compositions (After lumping process)

components	%molar
(C1,N2)	27.9
(C2,CO2)	13.37
C3-C5	14.7
C7:C9	11.8

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C10:C12	9.04
C13:C16	8.44
C17:C34	14.73
SUM=	100

The Regression was applied again and the 7-component EOS model predicted PVT properties very similar to the 11-component EOS model. So the 7-component EOS model was chosen to use in the reservoir compositional simulation.

Table.5 summarizes the best regression parameters of EOS for Buzurgan reservoir after splitting and grouping processes.

Table.5 Best Regression Parameters and Critical Properties for Buzurgan Bu-6 Reservoir Fluid after Splitting and Lumping Processes.

component	Mole fraction	Molecular weight	SG	P_c Kg/cm^2	T_c deg. C	V_c Ft^3/lb.mole	Acentric factor	Omega A	Omega B
GP1	27.9	16.2459354	0.425511807	47.1050186	-83.6243134	1.4188149	0.01148172	0.457235515	0.0777960718
GP2	13.37	31.1403885	0.587510824	51.7212868	32.0224838	3.12154555	0.109471202	0.457235515	0.0777960718
GP3	14.7	55.4374123	0.599612236	39.5382347	136.512085	4.83325672	0.187688425	0.457235515	0.0777960718
C7: C9	11.8016	136.126999	0.847342014	22.8504105	202.098846	8.65878773	0.13453275	0.457235515	0.0777960718
C10:C12	9.04263	183.440002	0.897998989	21.7292557	476.223511	12.5371857	0.533275008	0.457235515	0.0777960718
C13:C16	8.44763	236.625	0.939454973	16.9340038	577.174377	17.2030106	0.733716667	0.457235515	0.0777960718
C17:C34	14.7381	359.813995	0.995465994	14.9661942	671.723755	20.8089905	0.910880864	0.457235515	0.0777960718

Black oil Model

The second PVT model that available in PVTp program is the black oil model. Its technique Considered to be accurate and fast. It's based on values of density and GOR that measured at surface conditions to predict the reservoir fluid properties at reservoir pressure and temperature.

This model uses five empirical correlations for calculating the bubble point pressure (Pb) , Oil formation volume factor (Bo) , and Gas oil ratio (Rsb),these correlations are Glaso et al, Standing et al, Lasater et al, Vasquez-Beggs, and Petrosky. There is also three correlations that used to calculate the oil viscosity (Mo),

Which they are Beal et al, Beggs et al, and Petrosky.

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In this study, Lasater's correlation for (Rsb , Bo , and Pb) and Petrosky's correlation for oil viscosity(Mo) was selected to generate the black oil model because it has been found to give an adequate agreement with the experimental data of Buzurgan reservoir/ Mishrif field.

1. PVT Black oil Data Used

PVT laboratory sample data of Mishrif Formation were used in the matching processes of the Black oil model. PVT laboratory data included gas oil ratio, oil gravity, gas gravity, oil formation volume factor (Bo), and oil viscosity (Mo).

2. Regression to Experimental PVT Data

The reservoir fluid of Buzurgan field / Mishrif formation was regressed by using Lasater for (Rsb, Bo, and Pb) and Petrosky for (Mo). The calculated results were contained an acceptance predictions with a small error percent as compared to the experimental pvt data.

Results and Discussions

1-Constant composition expansion (CCE)

This simulator has been used to predict the relative-volume for reservoir crude oil**s** by using PR and SRK EOS at a specific range of reservoir pressure and reservoir temperature.

The results of relative volume at different reservoir pressure are listed in **Table.6**for (Bu-6) and plotted with the pressure at reservoir temperature as seen through **figure.1** The results were contained a good agreement with the experimental data after regression analysis. PR EOS results were adopted in this study which contains accurate results.

4.3 Differential liberation

The PVTp simulator has been used for predicting the Differentia**l** liberationprocesses(DLE) for reservoir crude oilby using PR and SRK EOS ,so that to find the accurate estimation for fluid behavior at the specified range of reservoir pressure and temperature and to check the validity of the used equations(PR and SRK).

The relations between reservoir pressure and different reservoir fluid properties (GOR,B_o, γo, and μo) are listed from **Table.7** to **Table.10**for (Bu-6) and plotted with the pressure at reservoir temperature from **Fig.2** to **Fig.5**. The results were contained a good agreement with the experimental data after regression analysis. These results indicate that (PR EOS) gives more acceptable results to estimate the reservoir fluids behavior.

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4.4 Phase behavior

The second purpose of this study is to predict the behavior of Buzurgan reservoir fluid at various pressure and temperature.

Figure.6 and **Figure.7**shows the phase envelope of Buzurgan reservoir fluid composition (After Splitting, regression and Lumping Processes) .The P-T diagram shows a Cricondentherm and a Cricondenbar with values of 560.3 °C and 273.3 Kg/cm2, respectively For DLE and 564.1 °C and 267.8 Kg/cm2 for CCE.

4.5 Black oil

The second model in PVTp simulator which is based on several empirical correlations. This simulator has been used for predicting reservoir fluid properties (Rsb, Bo, Pb and Mo)for five reservoirs crude oils, so that to find the accurate estimation for fluid properties at the specified range of reservoir pressure and temperature.

The relations between reservoir pressure and different reservoir fluid properties (Rsb,B_o, γ_o, and μ_o) for Lasater and Petrosky correlations are listed in tables from **Table.11** to **Table.12**For (Bu-6) and plotted with the pressure at reservoir temperature. The figures are describes the best correlation (Lasater and Petrosky) that selected for matching with the experimental data from **Figure.8** to **Figure.11**.The results were contained a good agreement with the experimental data after regression analysis.

It should be note that the obtained data from the black oil model by were more accurate than that of EOS model for the fluid properties specifically for (Mo, Bo).

Conclusions

1- The PVT tables of Buzurgan reservoir which was obtained by using **PVTp** (vol-8.5) program are shown a good matching as compared to the experimental PVT tables, so that the program considered to be suitable to calculate the fluid properties and the phase behavior of the reservoir.

2- In this study (PR) EOS was chosen to build the EOS model which gave more accurate results than (SRK) EOS, and was successfully tuned to the experimental data for differential liberation (DLE) and constant composition expansion (CCE), as the oil sample of Buzurgan reservoir was a black oil type. This result emphasizes with the previous studies.

3- The Calculations of phase behavior of this study that based on (PR) EOS can be used in engineering studies and may reduce the amount of the required laboratory measurements.

4- The tuning processes has been applied to fit PVT data and phase behavior for Buzurgan Samples of reservoir fluid. The results indicate that the tuning method provides a reasonable and effective tool for representing the phase behavior and PVT properties of reservoir fluid.

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5-It obvious through this study the advantages of the graphical and numerical capabilities of this program to estimate the properties of Buzurgan reservoir fluids.

6- The reservoir properties in the black oil model that predicted by Lasater and Petrosky shows the best matching results as compared with the remaining correlation.

7- From the results of this study it has been found that, the obtained data of fluid properties by the black oil model were more accurate than that of EOS model specifically for (Mo, Bo).

Nomenclature

AAPE Absolute Average Percentage Error

API American Petroleum Institute

A, B Parameter in various equations of state, dimensionless

BHP = Bottom hole pressure, psiaBIP = binary interaction coefficient

B_o =Oil FVF, bbl/STB

Bu = Buzurgan field

BWR = Bendict, Webb and Rubin

EOS=Equation of state

FVF =Formation Volume Factor

GOR =Gas-Oil Ratio,cf/ STB

$K_{i,j}$= Binary interaction Parameter

M =Mass,lb.

MW = Molecular weight,lb/lb.mole

N = Number of moles,lb. Mole

P = Pressure, Kg/cm^2

P_b = bubble point Pressure,Kg/cm^2

P_c= Critical Pressure, Kg/cm^2

PR =Peng-Robinson

PVT=Pressure,Volume,Temperature

PVTp = Petroleum Experts' advanced **P**ressure **V**olume and **T**emperature analysis software.

RD = Relative Deviation

R-K =Redlich O. and Kwong

Rs = Solution gas oil ratio

SG =specific gravity, dimensionless

S.shift= Stream volume shift

SCN = single carbon number

SRK = Soave-Redlich-Kwong

T =Temperature,c^o

T_B=Boiling point Temperature,R^o

T_c=Critical Temperature

Vc = Critical Volume,ft^3/lb.mole.

γ = Specific gravity , dimensionless

μ_o, = viscosity of oil ,cp

ρ= Density,lb/ft^3

ω=Acentric factor,dimensionless.

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Appendix:

Table.6 The experimental relative volume with the relative- volume calculated by PR and SRK EOS for BU-6.

Pressure (Kg/cm^2)	Exp Relative-volume	Relative-volume calculated by SRK EOS	RD% WITH SRK EOS	Relative-volume calculated by PR EOS	RD% WITH PR EOS
140	1.0977	1.10055	0.002589614	1.09778	7.28743E-05
150	1.0676	1.07019	0.002420131	1.06793	0.000309009
160	1.0416	1.04471	0.002976903	1.04318	0.0015146
170	1.0218	1.02314	0.001309694	1.02253	0.000713915
175	1.0122	1.01358	0.001361511	1.0135	0.001282684
183	1	0.999967	3.30011E-05	1.00059	0.000589652
200	0.9972	0.996294	0.00090937	0.996794	0.000407306
225	0.9931	0.991196	0.001920912	0.992234	0.000872778
250	0.9894	0.986426	0.003014925	0.987961	0.001456535
275	0.9861	0.981948	0.00422833	0.983947	0.002188126
300	0.9828	0.977733	0.005182396	0.980166	0.0026873

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325	0.9798	0.973757	0.00620586	0.976595	0.003281811
350	0.9769	0.969997	0.007116517	0.973215	0.003786419
375	0.9741	0.966434	0.007932254	0.970011	0.004215416
400	0.9715	0.963052	0.008772112	0.966966	0.004688893
425	0.9691	0.959836	0.009651649	0.964068	0.005219549
450	0.967	0.956773	0.010689056	0.961305	0.005924238
AAPE			0%		0%

Table.7 The experimentalGOR of Bu-6 with the calculated by SRK and PR EOS.

Pressure (Kg/cm^2)	Exp. GOR (m^3/m^3)	Final GOR after regression (m^3/m^3) SRK EOS	RD% WITH SRK EOS	Final GOR after regression (m^3/m^3) PR EOS	RD% WITH PR EOS
450					
183	110.2	113.656	0.03040755	112.406	0.019625287
160	97.87	99.6831	0.01818864	98.9378	0.010792639
130	82.06	82.1521	0.00112109	82.0108	0.000599921
100	66.25	65.206	0.01601079	65.5841	0.010153376
80	55.84	54.1666	0.03089357	54.8262	0.018491159
60	45.32	43.0297	0.05322603	43.9044	0.032242782
40	35.55	33.2299	0.06981965	32.2132	0.103584866
20	22.45	18.734	0.19835593	21.91	0.02464628
10	14.32	11.54	0.24090121	13.84	0.034682081
AAPE			7%		3%

Table.8 The experimental oil FVF Bu-6 with that calculated by SRK and PR.

Pressure (Kg/cm^2)	Exp. Bo (RB/STB)	Final Bo (after regression) (RB/STB) with SRK EOS	RD% WITH SRK EOS	Final Bo after regression (RB/STB) with PR EOS	RD% WITH PR EOS
450	1.3874	1.37713	0.007457539	1.37852	0.006441691
183	1.4348	1.4423	0.005200028	1.42887	0.004150133

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160	1.414	1.40088	0.009365542	1.39066	0.016783398
130	1.359	1.34829	0.007943395	1.34211	0.012584661
100	1.3147	1.29637	0.014139482	1.29398	0.016012612
80	1.2868	1.26177	0.019837213	1.26167	0.019918045
60	1.2576	1.22572	0.026009203	1.22756	0.024471309
40	1.2281	1.18538	0.036039076	1.18837	0.033432349
20	1.1873	1.12813	0.052449629	1.12869	0.051927456
10	1.1643	1.07606	0.082002862	1.06904	0.089107985
AAPE			3%		3%

Table.9 The experimental oil density of Bu-6with that calculated by SRK and PR

Pressure (Kg/cm^2)	Exp. Oil density (g/cc)	Final oil density (after regression) (g/cc) with SRK EOS	RD% WITH SRK EOS	Final oil density after regression (g/cc) with PR EOS	RD% WITH PR EOS
450	0.7895	0.794992	0.006908246	0.787186	0.002939585
183	0.7634	0.758548	0.006396431	0.759189	0.005546708
160	0.7653	0.76914	0.004992589	0.768687	0.004406215
130	0.7842	0.783656	0.000694182	0.781609	0.003314957
100	0.7984	0.799085	0.00085723	0.795338	0.003849935
80	0.8073	0.809931	0.003248425	0.805049	0.002796103
60	0.817	0.821515	0.005495943	0.815607	0.00170793
40	0.8278	0.834416	0.007928899	0.827884	0.000101463
20	0.8419	0.851003	0.01069679	0.84611	0.004975712
10	0.8477	0.863419	0.018205529	0.864026	0.018895265
AAPE			1%		0%

Table.10 Experimental oil viscosity of Bu-6 with that calculated by SRK and PR

Pressure (Kg/cm^2)	Exp. Oil viscosity (c.p)	Final oil viscosity (after regression) (c.p) with SRK EOS	RD% WITH SRK EOS	Final oil viscosity after regression (c.p) with PR EOS	RD% WITH PR EOS
450	1.831	2.01657	0.092022593	1.91609	0.044408144
183	1.34	1.15819	0.156977698	1.2601	0.063407666
160	1.44	1.32363	0.087917318	1.39807	0.029991345
130	1.57	1.60755	0.023358527	1.61579	0.028339079
100	1.8	1.97655	0.089322304	1.89064	0.038949774

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80	2.06	2.28057	0.096717049	2.11555	0.002103472
60	2.46	2.63839	0.067613204	2.39124	0.008882421
40	2.78	3.04051	0.085679705	2.74749	0.011832618
20	3.25	3.31216	0.018767209	3.24107	0.003415539
10	3.51	2.97625	0.179336413	3.43395	0.022146508
AAPE			9%		3%

Table.11 The experimental GOR with the calculated by Lasater correlation for BU-6

Pressure (Kg/cm^2)	Exp. GOR for Bu-6(b) (m^3/m^3)	GOR by Lasater correlation (m^3/m^3)	RD% of GOR by Lasater
10	14.32	17.6348	0.1879692
20	22.45	23.0689	0.0268283
40	35.55	34.1049	0.0423722
60	45.32	44.994	0.0072454
80	55.84	55.6875	0.0027385
100	66.25	66.928	0.0101303
130	82.06	82.4274	0.0044573
160	97.87	97.8703	3.068E-06
183	110.32	110.32	0
450			
AAPE			3%

Table.12 The experimental oil density with the calculatedby Lasater correlation of Bu-6

Pressure (Kg/cm^2)	Exp. Oil densityfor Bu-6(b) (g/cc)	Oil density by Lasater correlation (g/cc)	RD% of oil density by Lasater
10	0.8477	0.796693	0.0640234
20	0.8419	0.792225	0.0627031
40	0.8278	0.783121	0.0570525
60	0.817	0.774155	0.0553442
80	0.8073	0.765414	0.0547233
100	0.7984	0.756331	0.0556225
130	0.7842	0.744036	0.0539813
160	0.7653	0.732097	0.0453533
183	0.7634	0.719448	0.0610913
450	0.7895	0.75228	0.0494763

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AAPE			6%

Table.13The experimental Bo with the calculated by Lasater of Bu-6.

Pressure (Kg/cm^2)	Exp. Bo for Bu-6(b) (RB/STB)	Bo by Lasater correlation (RB/STB)	RD% of Bo by Lasater
10	1.1643	1.17838	0.0119486
20	1.1873	1.19279	0.0046026
40	1.2281	1.22259	0.0045068
60	1.2576	1.25266	0.0039436
80	1.2868	1.28277	0.0031416
100	1.3147	1.31499	0.0002205
130	1.359	1.36028	0.0009409
160	1.414	1.40632	0.0054611
183	1.4348	1.45062	0.0109057
450	1.3874	1.38731	6.487E-05
AAPE			0%

Table.14 The Experimental Mo with the calculated by Petrosky correlation for Bu-6.

Pressure (Kg/cm^2)	Exp. Mo for Bu-6(b) (c.p)	Mo by Petrosky correlation (c.p)	RD% of Mo by Petrosky
10	3.51	3.4876	0.0064228
20	3.23	3.19467	0.0110591
40	2.78	2.71494	0.0239637
60	2.37	2.35394	0.0068226
80	2.12	2.0768	0.0208012
100	1.817	1.84563	0.0155123
130	1.57	1.59933	0.0183389
160	1.44	1.41289	0.0191876
183	1.34	1.2932	0.0361893
450	1.831	1.90775	0.0402306
AAPE			2%

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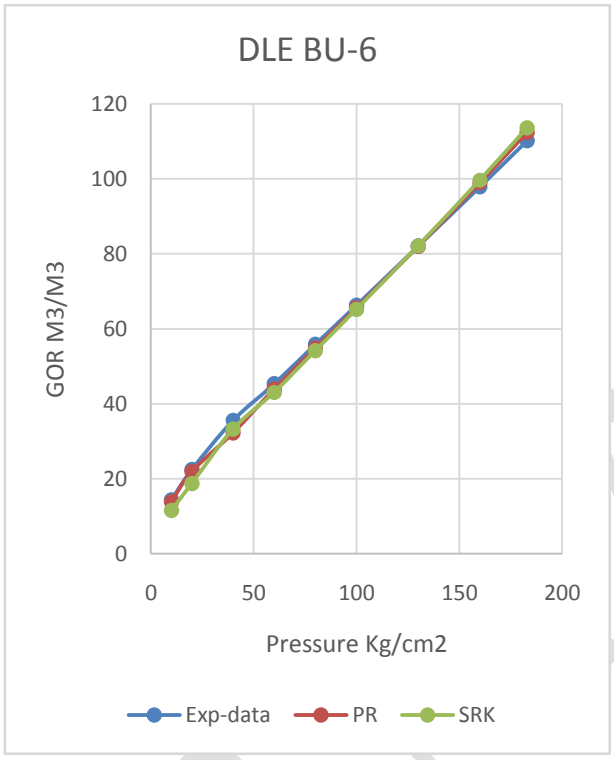

Figure.2 Gas oil ratio for Bu-6 at 113.3 c

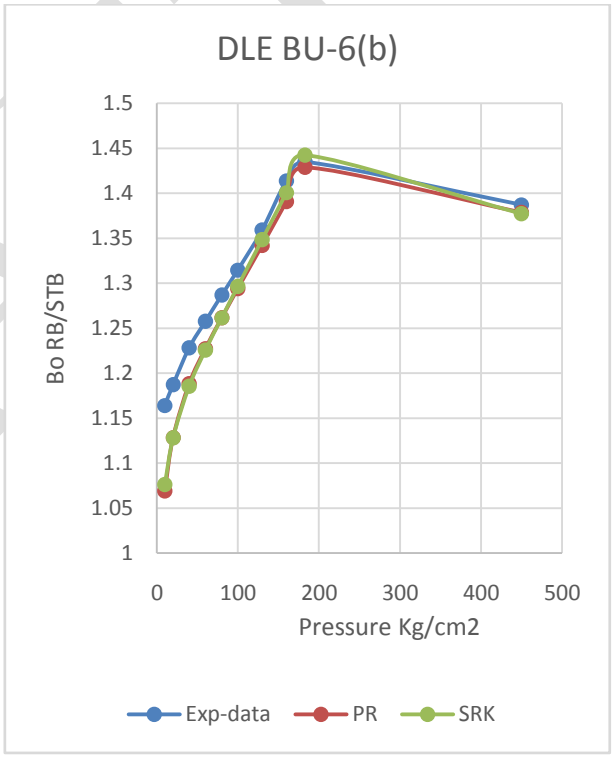

Figure.3 oil formation volume factor for Bu-6 at 113.3 co

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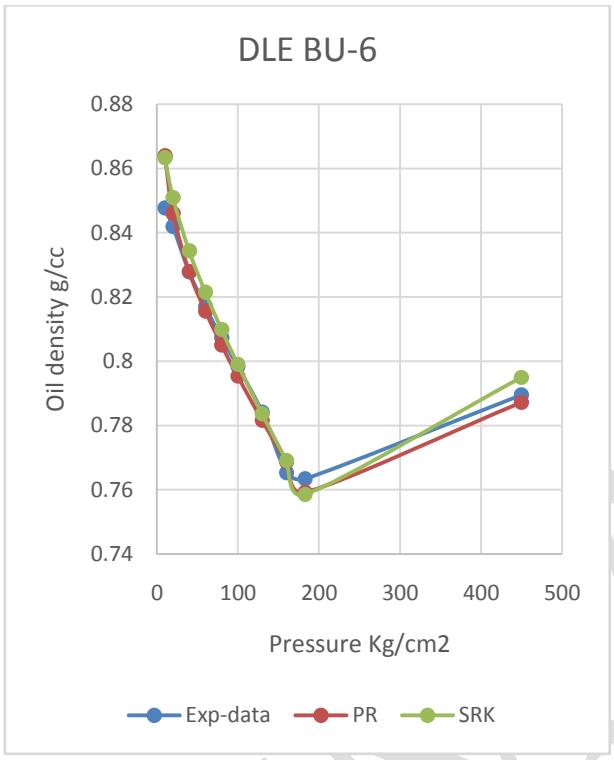

Figure.4 oil density for Bu-6 at 113.3 c

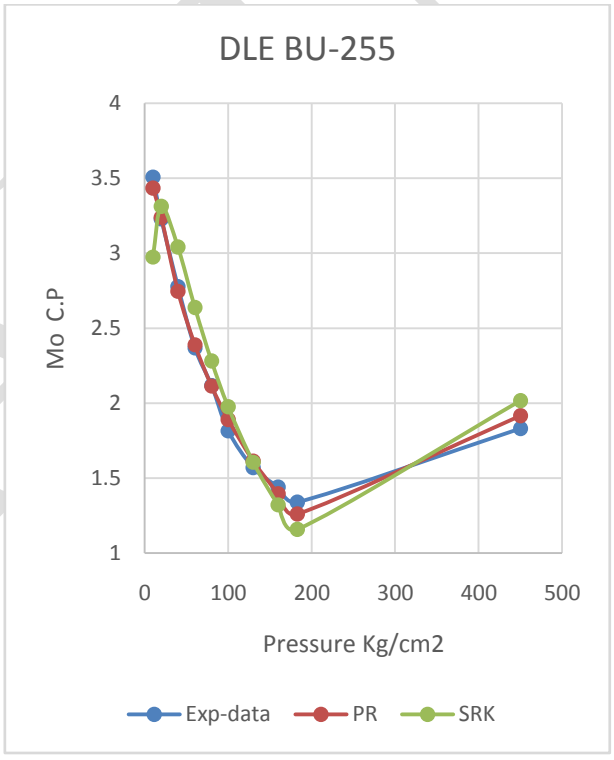

Figure.5 oil viscosity for Bu-6 at 113.3 c

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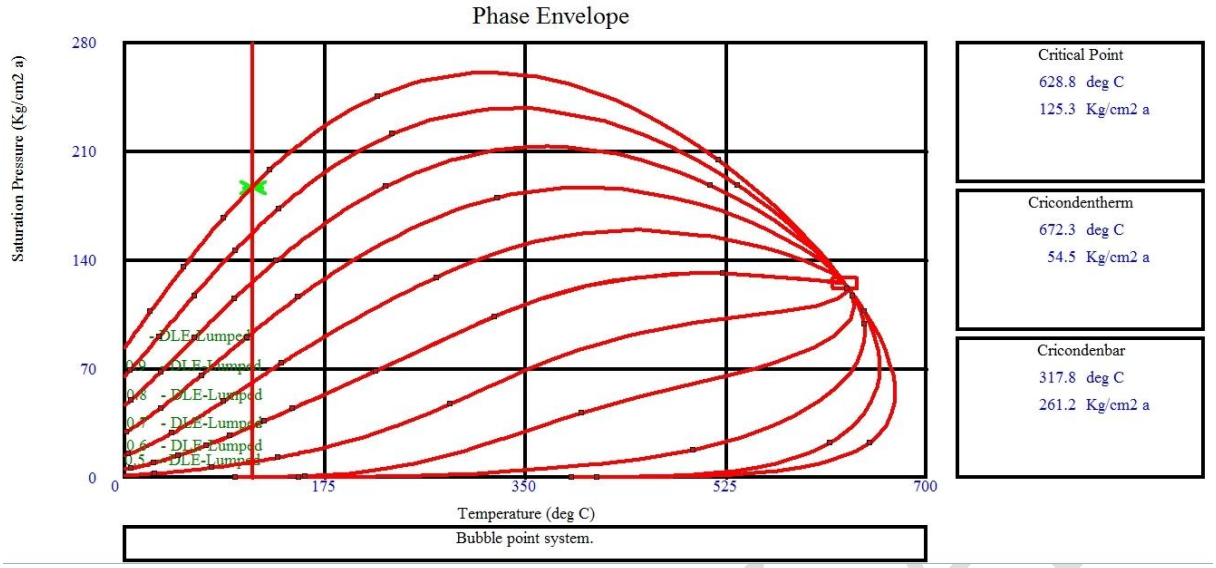

Figure.6DLE Phase Behavior Diagram of Buzurgan-6 Reservoir Fluid.

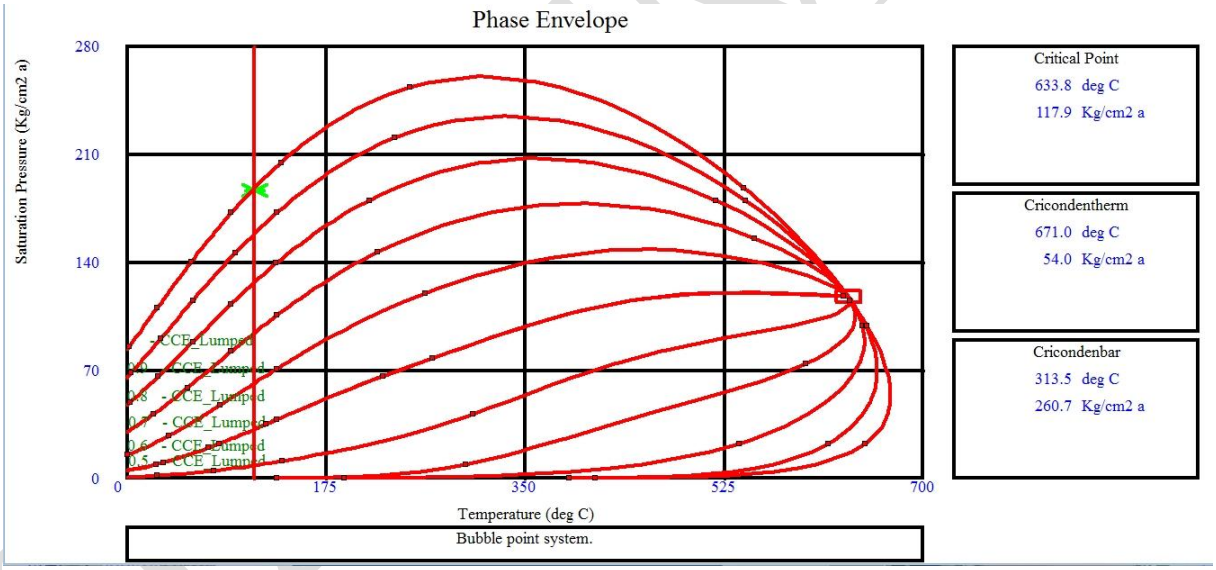

Figure.7CCE Phase Behavior Diagram of Buzurgan-6 Reservoir Fluid.

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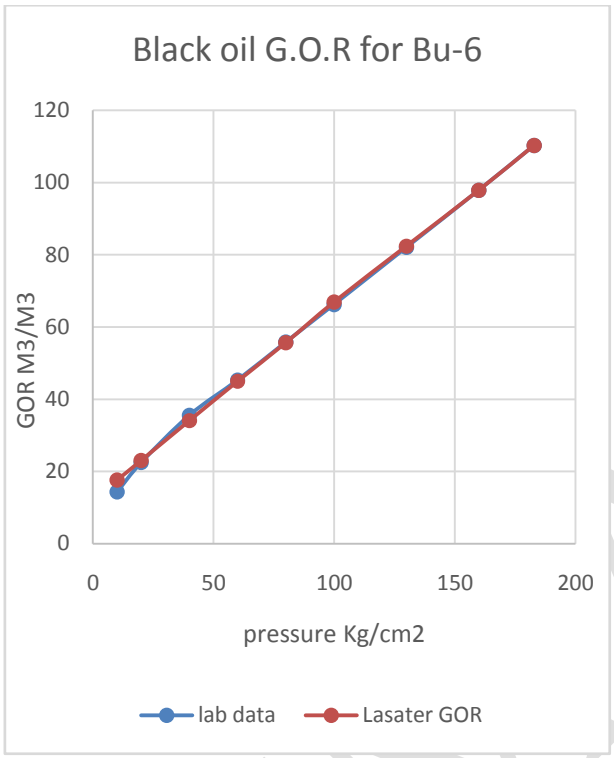

Figure.8 GOR for Bu-6 at 113.3 c^{o} by Lasater correlation.

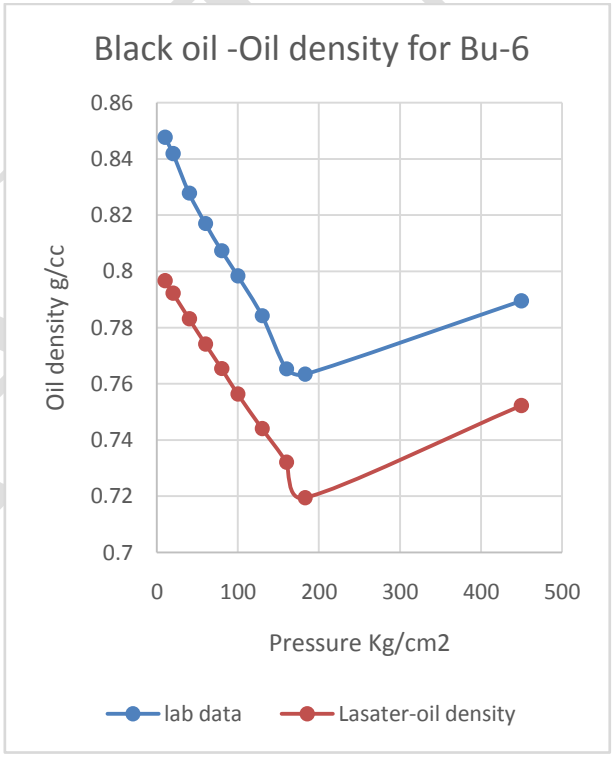

Figure.9 Oil density for Bu-6 at 113.3 c^{o} by Lasater correlation.

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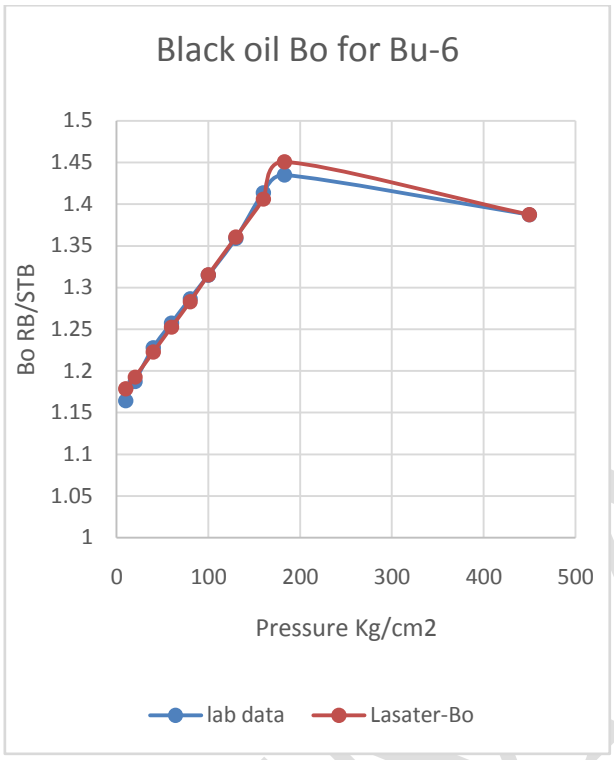

Figure.10 Oil fvf for Bu-6 at 113.3 c^{o} by Lasater correlation

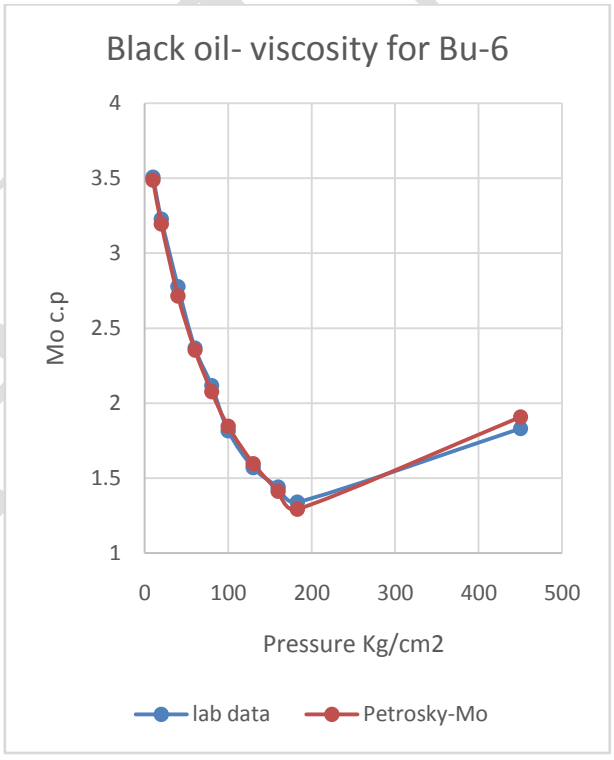

Figure.11 Oil viscosity for Bu-6 at 113.3 by Petrosky correlation.

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دراسة السلوك الطوري لتكوين مشرف في حقل بازركان النفطي في جنوب العراق

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الخلاصة

ان معرفة خواص الموائع المكمنية مهمة جدا في مختلف الدراسات المكمنية, حيث تدخل تلك الخواص في حساب في حسابات ادائية المكامن النفطية والمخزون النفطي وكذلك في التمثيل العددي للمكامن الهايدروكاربونية. لذا فان معرفة طرق الحصول على قيم دقيقة لتلك الخواص مهم جدا في مختلف الصناعات النفطية. المصدر الرئيسي للحصول على تللك الخواص يتم بواسطة القياسات المختبرية , لكن في حالات كثيرة تكون تلك القياسات غير متوفرة, لذلك يلجأ لاستخدام طرق أخرى بديلة.

هذه الدراسة تهتم بالتنبوء بالسلوك الطوري والخواص الفيزيائية لموائع المكمنية الموجودة في حقل بازركان/تكوين مشرف النفطي ,وتم ذلك باستخدام برنامج(PVTp vol 8.5) وهو برنامج تحديد الخواص الفيزيائية والتوازن المتعدد الاطوار حيث يحتوي على تقنية الحساب التراجعي لتنغيم البيانات المختبرية والجريان الطوري الخاص بها .
في هذا البرنامج اعتمدت معادلة الحالة ل(Soave-Redlich-Kwong)ومعادلة الحالة ل(Peng and Robinson) لحساب الخواص الفيزيائية لموائع المكمن .وقد اعتمدت النتائج الخاصة بمعادلة(PR)في هذه الدراسة لكونها اكثر دقة من معادلة (SRK).
النموذج الثاني الذي تم استخدامه في برنامج (PVTp vol 8.5)هو نموذج ال (Black oil) , حيث يستخدم العديد من المعادلات لحساب الخصائص الفيزيائية للموائع المكمنية . أفضل نتائج تم الحصول عليها من خلال معادلة (Lasater)لحساب (Bo, GOR, and Oil density) ومعادلة (Petrosky) لحساب لزوجة النفط (Mo) .
تم مقارنة النتائج التي تم الحصول عليها من برنامج PVTp مع النتائج المختبرية للحقل , وعندها تبين ان البرنامج يمكن الاعتماد عليه لاغراض هذه الدراسة.