بسم الله الرحمن الرحيم

Sudan university of science and technology
College of Petroleum and Mining engineering
Department of petroleum engineering

Project Title:

Reservoir surveillance for water cut diagnoses – case study field (x)

مراقبة المكمن لتشخيص المياه المنتجة مع الزيت – دراسة حالة الحقل (x)

Submitted in Partial Fulfillment of the Requirements of the Degree of B.Sc. in Petroleum Engineering

Prepared by:

1- **Ghassan Faisal Nayle.**

2- **Khalil Haroun Ahmed.**

3- **Mohammed Abdelbagi Mohammed.**

4- **Mohammed Kamal Yousef.**

Supervisor:

Eng. Fatima Khaled Khider.

November-2020

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Signature:…………………………………………………………………………

Date: / / 2020

الاستهلال

بِسْمِ اللَّــهِ الرَّحْمَـٰنِ الرَّحِيمِ

" يَرْفَعِ اللَّهُ الَّذِينَ آمَنُوا مِنكُمْ وَالَّذِينَ أُوتُوا الْعِلْمَ دَرَجَاتٍ "

سورة المجادلة

الاية (11)

Dedication

Dedicated to our parents who always devising us, nothing of this could be done without them.

To everyone who inspired our creativity, who always were with us step by step.

To anyone who taught us how to breath in this life.

Acknowledgment

The greatest thanks always to Allah before and after finish this project.

In the first we would like to thank **Eng. Osman Ali** who help us to understand all technical steps related to software (OFM) and complete practical part of project.

And we would like to thank our supervisor **Mrs. Fatima Khaled** for her support, follow up and caring in spite of the distance and the lag of meeting to keeping up with us and encouraging us to work hard.

Also, we thank **Mr. Hamza Ahmed** and **Eng. Samih** for their help.

Abstract

Reservoir management is the most important aspects that control and monitoring performance of work in the field, and the main role of reservoir management is receive the data that comes from the filed or reservoir and analyze it to get results that help to make the right decisions and give practical suggestions to improve the performance of well and therefore increase the production rate.

The project aims to decrease uncertainties of the monitored and analyzed well by one of the techniques of well surveillance which focus on directing the crew existing in the field during lifecycle of the project and follow the progress of the work until the end, and maintaining the production rate of oil higher than production rate of water and set clear solutions to treat the water production problem with prediction the future outcomes that may occur.

Oil field manager software (OFM) used to analyze the reservoir data which obtained from the field and extracted production reports that contained the production rates of oil, gas and water to present the events and problems graphically therefore to organize, analyze and interpret the data, and we found that we can solve the water production by plugging the perforation that producing water with cementing squeeze, and make a new perforation earlier than previous perforation.

التجريد

ادارة المكمن تعتبر من اهم الجوانب التي تتحكم في تسيير ومراقبة اداء العمل في الحقل ، ويتلخص دورها في عملية استقبال و تحليل البيانات المستخرجه من الابار ؛ للخروج بنتائج واقتراحات تساعد في تحسين ادائية عمل المكمن وبالتالي زيادة معدل الانتاج .

كما ان دور يهدف البحث الي تقليص المشاكل غير المتوقعة للبئر تحت الدراسة بواسطة احد تقنيات المراقبة التي يتركز دورها على توجيه طاقم العمل اثناء المشروع ومتابعة سريان العمل الى حين الانتهاء ، والمحافظة على معدل انتاج النفط اعلى من معدل انتاج الماء مع وضع حلول مناسبة لمعالجة مشكلة انتاج الماء مع التنبؤ بالنتائج المستقبلية التى قد تحدث في الحقل .

أُستخدم برنامج (OFM) لتحليل البيانات المكمنية التي تم التحصل عليها من الحقل واستخرجت تقارير خاصة بعملية الانتاج اوضحت فيها معدل انتاج كل من الزيت والغاز والماء كما اوضحت المشاكل وتسلسل الاحداث بيانياً ليتم تفسيرها وتحليلها بطريقة سلسة. وتم التوصل الى ان مشكلة انتاج الماء تتم معالجتها عن طريق ضخ الاسمنت لاغلاق ثقوب الطبقات المنتجة للماء ، وعمل ثقوب جديدة في عمق اقل من العمق السابق.

Table of Contents

List of figures

List of Tables

Nomenclatures

AG	Abu-Gabra
W.C	Water cut
Qf	Water production
Qo	Oil production
WOR	Water oil ratio
GOR	Gas oil ratio
Cum.W	Cumulative water production
Cum.O	Cumulative oil production
Cum.G	Cumulative gas production
Cum.F	Cumulative fluid production
Cum.S	Cumulative sand production

Chapter 1

1.1 Introduction:

Reservoir management concept in general mean manage and organizing the works in the field in addition to help the crew for solving the problems which faced them, Reservoir Management relies on the use of human, technological and financial resources to capitalize on profits from a reservoir by optimizing the hydrocarbon recovery while minimizing both the capital investments and the operating costs, and used to predict the future performance of reservoir.one of the tools of reservoir management is monitor and survey the well .

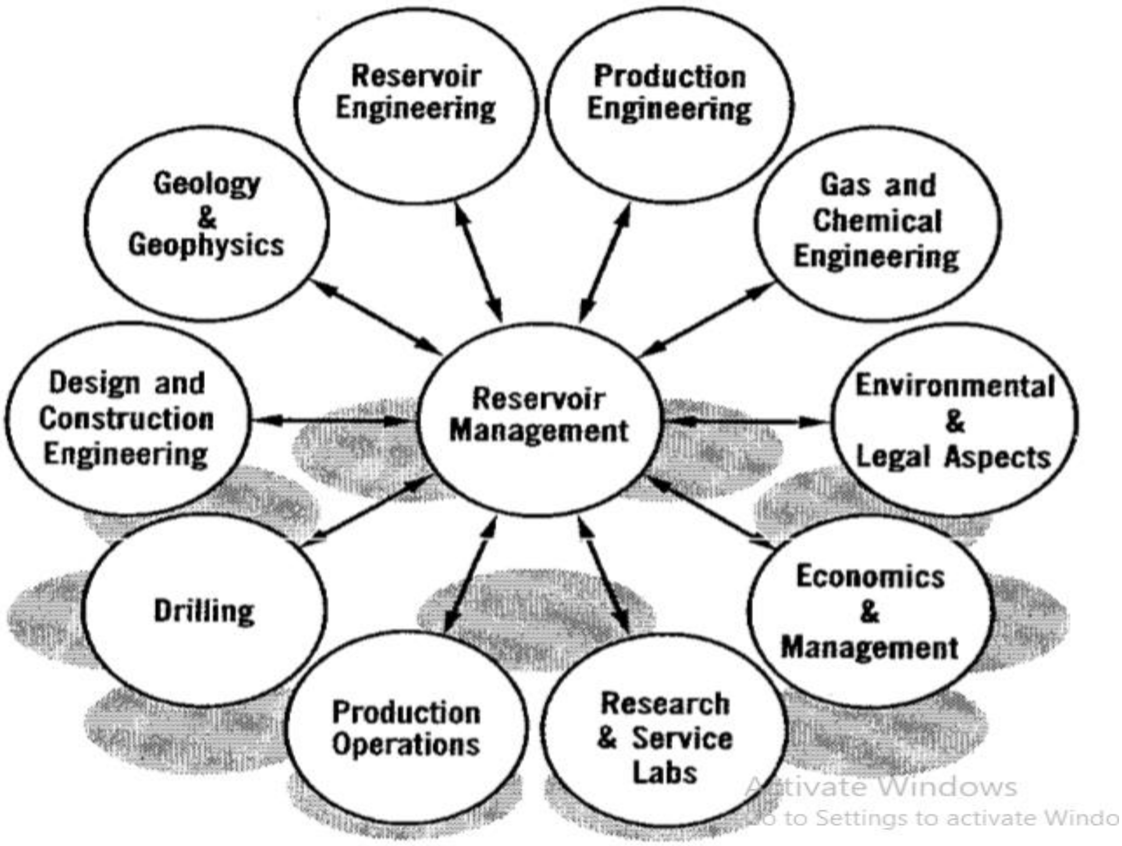

Figure 1 - 1 Reservoir management approach

(Sattar, Abdus; Thakur, Ganesh,1994).

The general idea of surveillance inspired from regular controlled camera, and here will focused on effective way to reduce uncertainties and risks that maybe occurs in reservoir by analyze the data of reservoir and predicting the future events that occurs in the wells.

1.2 problem statement:

The process of managing and producing oil and gas reservoirs, have become more complex and continues to evolve. Advance surveillance technologies now provide crucial information that enables operators to diagnose well and reservoir issues better, faster, and in a more efficient way (real time data). We ran this project to clarify the importance of using smart technologies in managing the reservoir, we studied field (x) by (OFM) to discuss the water cut and find treatments of it.

1.3 Objectives:

The objective of this work is diagnoses water production that may occurs in reservoir or appear in the future.

1. Minimize and handling water cut.
2. Discuss and find optimum solution to treat the water cut.

Chapter 2

Theoretical background and Literature review

2.1 theoretical background:

2.1.1 reservoir management:

2.1.1.1 Definition of reservoir management:

The Webster dictionary defines it as (judicious use of various means to maximize benefits or economic recovery). Thus, the main goal of reservoir management is to maximizing economic recovery for gas and oil.

Reservoir management has been defined by a number of other authors. Basically, sound reservoir management practice relies on utilization of available resources (i.e. human, technological, and financial) to maximize profit/profitability index from a reservoir by optimizing recovery while minimizing capital investment and operating expenses. (Thakur,1990).

2.1.1.2 History of reservoir management:

In the past people was thinking that reservoir management and reservoir engineering are the same. In the early 1970s, reservoir engineering was considered the most important technical item in management of reservoirs. However, after understanding the value of geology, synergism between geology and reservoir engineering became very important and very popular.

Reservoir management has advanced through various stages in the past 30 years. The techniques are better, the background knowledge of reservoir conditions has improved, and the automation using mainframe computers and personal computers has helped data processing and management. The developmental stages of reservoir management are described as the following:

Stage 1—before 1970, reservoir engineering was considered the most important technical item in the management of reservoir. *Wyllie* emphasized two key Items:

Clear thinking utilizing fundamental reservoir mechanic concepts.

Automation using basic computers.

Stage2—After 1970s. the synergism between geology and engineering took place. And then all wells transferred to intelligent wells using smart techniques tell now days. (Thakur,1990).

2.1.1.3 Fundamentals of reservoir management:

Basically, reservoir Management relies on the use of human, technological and financial resources to capitalize on profits from a reservoir by optimizing the hydrocarbon recovery while minimizing both the capital investments and the operating costs.

Reservoir management has advanced through various stages due to better-quality techniques, improved knowledge of reservoir behavior, and IT software that has helped the interpretation, processing and management of all available data. (Anon., 2017)

Main objectives of the reservoir management activities can be summarized as follows:

1. Decreasing of the risk.
2. Increasing of the oil and gas production.
3. Increasing of the oil and gas reserves.
4. Minimization of the capital expenditures.
5. Minimization of the operating costs.

6. Maximizing of the final hydrocarbon recovery.

2.1.1.4 synergy and team:

Successful reservoir management requires synergy and team efforts, we knew that reservoir management and engineering are not the same so success requires cooperated and integrated team any one has a little information can help in management can play a role in management (see fig 2.1). (Sattar, Abdus; Thakur, Ganesh,1994).

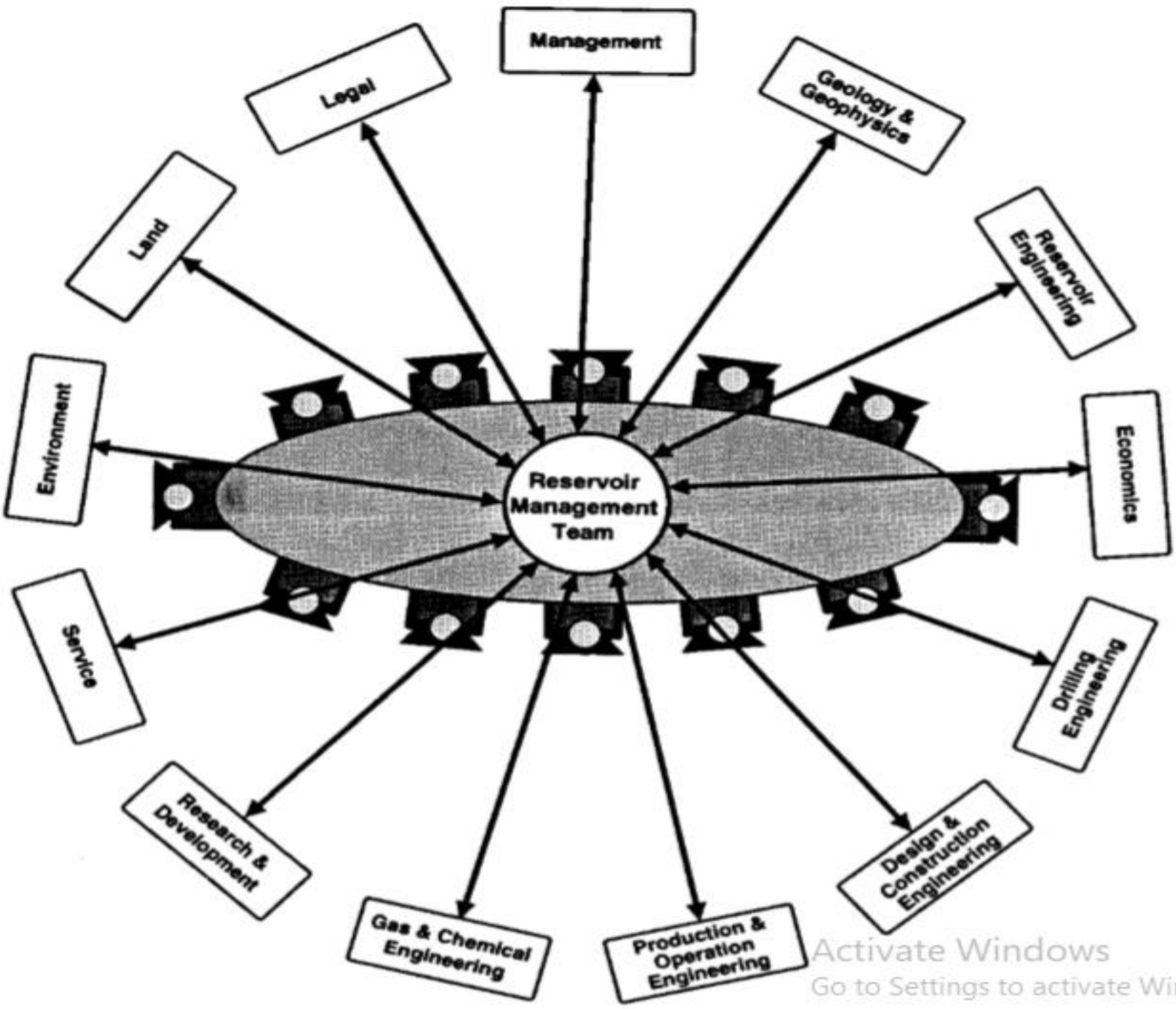

Figure 2 - 1 Reservoir management team

(Sattar, Abdus; Thakur, Ganesh,1994).

2.1.1.5 Reservoir Management Process:

The modern reservoir management process involves establishing a purpose or strategy and developing a plan, and evaluating the results (figure 2.2). None of the component of reservoir management is independent of the others. It is dynamic and ongoing.

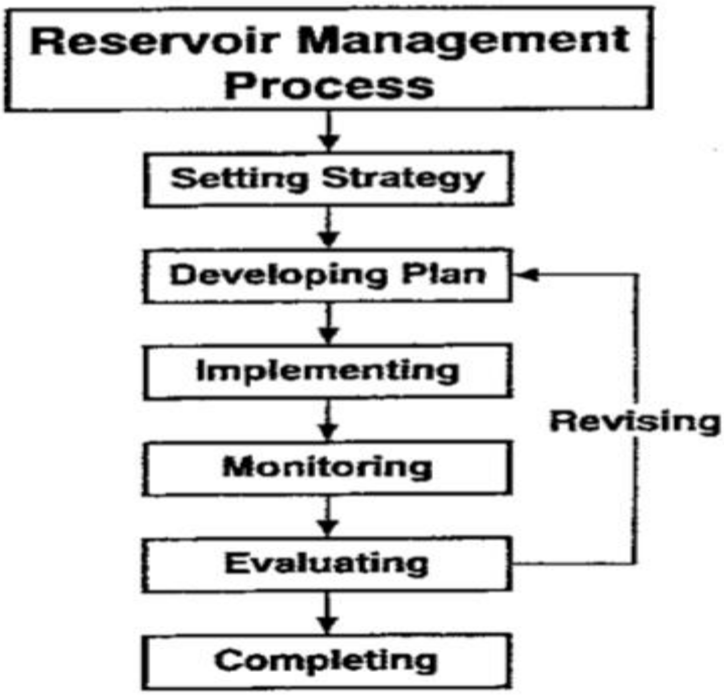

Figure 2 - 2 Reservoir management process

Setting goals:

Recognizing the specific need and what we are checking is the main goal. The key elements for setting a reservoir management goal are:

1\ Reservoir characteristics.

2\ Total environment.

3\ Available technology.

Understanding of each of these elements is the prerequisite to establishing short-and long-term strategies for managing reservoirs.

Developing plan and Economics.

Formulating a comprehensive reservoir management plan is essential for the success of a project. It needs to be carefully worked out involving many time-consuming development steps (figure 2.3). (Sattar, Abdus; Thakur, Ganesh,1994).

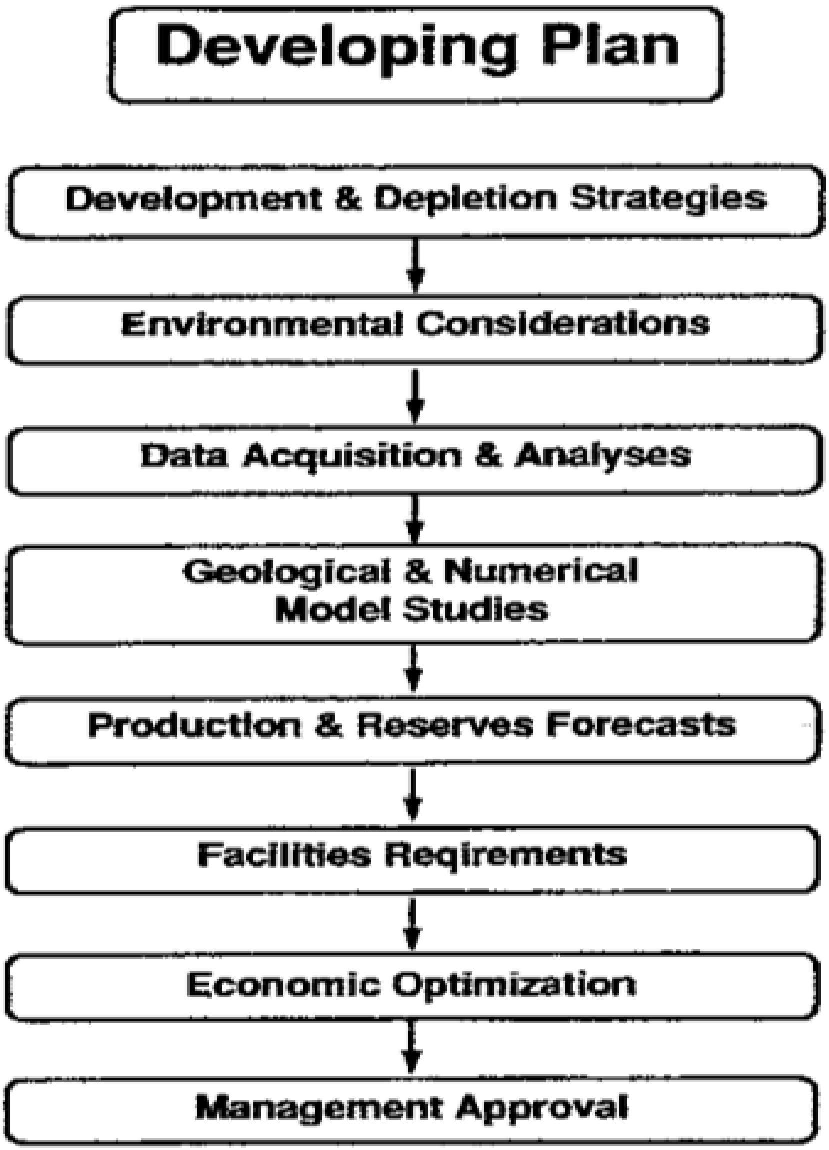

Figure 2 - 3 Developing plan

2.1.1.6 Implementation:

Once the goals and objectives have been set and an integrated reservoir management plan has been developed, the next step is to implement the plan.

describes a step-by-step procedure on how to improve success in implementing a reservoir management program.

- The first step involves starting with a plan of action, including all functions. If a plan is to be developed and implemented in the best way, it must have commitment from all disciplines, including management.
- The plan must be flexible. Even if the reservoir management team members prepare plans by involving all functional groups, it does not guaranty success if it cannot be adapted to surrounding circumstances (e.g. economic, legal, and environmental).
- The plan must have management support. No matter how technically good the plan, it must have local and higher-level management blessings. Without their support, it would not be approved. Thus, it is necessary that we get management plan involved from ‘day one’.
- No reservoir management plan can be implemented properly without the support of the field personnel. Time and time again we have seen reservoir management plans fail because either they are imposed on field on field personnel without thorough explanations or there are prepared without their involvement. Thus, the field personnel do not have a commitment to these plans.
- It is critical to have periodic review meeting, involving all team members. Most, if not all, of these meeting should be held in the

field offices. The success of these meeting will depend upon the ability of each team member to teach their functional objectives.

- The important reasons for failure to successfully implement a plan are:
- Lack of overall knowledge of the project on the part of all team members.
- Failure to interact and coordinate the various functional group.
- Delay in initiating the management process. (Sattar, Abdus; Thakur, Ganesh,1994).

2.1.2 Reservoir Surveillance:

•Reservoir surveillance is a process of creating several opportunities to understand the reservoir and adjust development strategies.

•Reservoir surveillance should be conducted through the entire course of the development life.

•The objective of reservoir surveillance is too capture and deliver information on reservoir performance to achieve better outcome. (Saadat, Aliasghar et.al, 2016).

2.1.2.1 Surveillance and monitoring:

Reservoir management requires consist monitoring and surveillance of the reservoir performance as a whole in order to determine if the reservoir performance is conforming to the management plan. In order to carry out the monitoring and surveillance program, coordinated efforts of the various functional groups working in the project are needed.

An integrated and comprehensive program needs to be developed for successful monitoring and surveillance of the management project. The engineers, geologist, and operations personnel should work together on the program with management support. The program will depend upon the nature of the project. Ordinarily, the major areas of monitoring and surveillance involving data acquisition and management include:

Oil, water and gas production.

Gas and water injection.

Static and flowing bottom hole pressures.

Production and injection tests.

Injection and production profiles, and any others aiding surveillance.

In case of enhanced oil recovery projects, the monitoring and surveillance program is particularly critical because of the inherent uncertainties. (Saadat, Aliasghar et.al, 2016).

2.1.2.2 Evaluation:

The plan must be reviewed periodically to ensure that it is being followed, that it is still the best plan. The success of the plan needs to be evaluated by checking the actual reservoir performance against the anticipated behavior.

It would be unrealistic to expect the actual project performance to match exactly the planned behavior. Therefore, certain technical and economic criteria need to be established the functional groups working on the project to determine the success of the project. A project may be a technical success but an economic failure. In the final analysis, the economic yardsticks will determine the success or failure of the project.

Reasons for failure of reservoir management programs:

There are numerous reasons why reservoir management programs have failed. Some of the reasons are listed below:

- Unintegrated system.
- Stating too late.
- Lack of maintenance.

2.1.2.3 Reservoir surveillance and monitoring:

Now days the process of managing and producing oil and gas reservoirs, have become more complex and continues to evolve. Advance surveillance technologies now provide critical information that enables operators to Diagnose well and reservoir issues better, faster, and in a more efficient way. It also helps engineers to be proactive and design remedial jobs, identify by-passed reserves, and place wells where needed to optimize production and recovery.

This work, however, comes at considerable cost, and generating economic opportunities in new or mature fields is key to success of an oil and gas company. Managing the cost of data acquisition and reservoir surveillance, by applying new technology and, integrating the data effectively can enhance these opportunities. The right action is a response to accurate knowledge that is derived from accurate information and reliable measurements. This is a basic requirement to monitor and control complex and crucial operations successfully. (Saadat, Aliasghar et.al, 2016).

2.1.2.4 Well and Reservoir Surveillance –Scope of Work:

Monitoring of well and reservoir performance is more necessary to maximize the recovery and minimize the expenditure and minimizing the uncertainties and maximizing the understanding of the reservoir performance which will ultimately lead to practical business decisions to improve the overall performance of the reservoir and the field. the surveillance data that we gathered in order to make practical decision must be available and visible to the whole team in order to create involvement by all for shared understanding of reservoir management needs. The major areas for surveillance need to reduce key uncertainties and for better reservoir management are listed below:

1) Well Integrity.

2) Reservoir Production / injection allocation.

3) Reservoir /well fluid flow geometry.

4) Reservoir description /Characterization.

5) Reservoir bypassed oils.

6) Reservoir continuity.

7) Reservoir zones pressure distribution.

(Saadat, Aliasghar et.al, 2016).

2.1.2.4.1 Well Integrity:

Well Integrity is defined by SPE and accepted by the Industry to be “the application of technical, operational and organizational solutions to reduce risk of uncontrolled release of formation fluids throughout the life cycle of a well. “It’s all about the safety of people, our environment, our equipment and our business reputation. (Saadat, Aliasghar et.al, 2016).

2.1.2.4.2 Production / injection allocation:

In a thick perforated interval, in a long horizontal section, or vertically, in a multi-layered reservoir what You see on a PLT (flow meter) is not necessarily coming from the zone you expect, due to several possible Reasons. Among these, cross flow due to different pressure regimes in a multi-layer reservoir, or a leak in the pipe, Can all result in wrong evaluation of the production Performance of the well. If the production and injection zones are not precisely identified, it will end up in wrong production and injection allocation. Wrong allocation will ultimately affect decisions on further reservoir management and development, and thus the ultimate recovery, any wrong decision will end up in heavy losses.

Knowing the actual source and quantifying the contribution from each zone or reservoir layer is important for reservoir simulation and for reservoir management in general. (Saadat, Aliasghar et.al, 2016).

2.1.2.4.3 Fluid flow geometry:

Throughout the life of a reservoir, large amount of data of various types are collected to evaluate the reservoir performance. Knowing where the produced fluid is coming from in the reservoir, which layer, and what path does it take to get into the wellbore and then to the surface is critical for effective reservoir management. If there is a channel in the cement, the fluid may follow the path of least resistance and travel through the channel to a different set of perforations, for example. It would then appear to be produced form the zone across those perforations, when in reality it is coming from a different zone. Similarly, flow may occur in an injector where the fluid appears to be entering the formation at a certain depth, but then it may travel behind pipe, up or down, depending on the quality of cement or, formation damage. Cross-flow may also happen when two zones have different pressure due to preferential depletion or injection. Knowing the actual contribution of each zone is the only way sweep can be evaluated and by-passed oil can be assessed. Production Logging Tool (PLT) survey is an integrated survey and has been in use in the industry since quite some time. Conventional PLT is helpless in identification of possible channeling behind the casing, whereas High Precision Temperature and Spectral Noise Logging is an excellent combination to evaluate and quantify the flow behind completion strings even in wells completed with multiple tubing strings and behind multiple casings. (Saadat, Aliasghar et.al, 2016).

2.1.2.4.4 Reservoir Description:

Reservoir characteristics such as natural heterogeneity, permeability anisotropy, variation of porosity, porous media properties and spatial distribution of oil & water predominantly control the flow, reservoir performance, development strategies and hence the economic return on investments.

Reservoir characterization determines ultimate recovery, sweep efficiency, optimum rate, type of stimulation, and type of artificial lift. For example, producing from a fractured reservoir, or from loose sand reservoir, can make a difference in all of the above parameters. In recent years, technological innovations and advancements including computing power, have led to advances of reservoir characterization through simple methodology and techniques. (Saadat, Aliasghar et.al, 2016).

2.1.2.4.5 By-passed oil:

It is probably safe to say that a perfectly homogeneous reservoir does not exist even in a single layer over 5-10 ft. thick. Type of deposit, sorting, and packing can all affect porosity and permeability, making each layer behaves differently.

By passed oil can be the result of not only reservoir heterogeneity, or permeability anisotropy, but also due to preferential injection, faulting, geological features unaccounted for in open-hole logs and pressure differences due to preferential depletion.

Indications of by-passed oil should be inferred from the acquired data in addition to the flow geometry from the reservoir, distribution of water injection, water-flood balance, and flux calibration vs. permeability from cores or open-hole logs. Further verification of these inferences of the existence of by-passed oil can be obtained from pressure interference testing and reservoir continuity as explained in the next section. It is also important to acquire and analyze offset well data to understand the reservoir dynamics before undertaking cost intensive infill drilling campaign etc. The case study below is from a Middle Eastern field where successful infill drilling was carried out based on HPT-SNL survey data to evaluate water movement and identify bypassed oil in the reservoir. (Saadat, Aliasghar et.al, 2016).

2.1.2.4.6 Reservoir continuity:

Reservoir continuity, or lack of it, can make or break a water-flood or an EOR project. Knowing where the faults are and if they are sealing or not, for example, can help determine where to locate future wells.

Reservoir continuity can determine the quality of sweep, the maximum economic rate to produce at, and ultimate recovery. Lack of continuity can also lead to having to drill more wells to develop the reservoir, which, will increase expenditure, and operating cost.

New advances in pressure pulse and interference testing analysis will enable engineers to evaluate reservoir continuity, balance water-flood accordingly, and develop the reservoir for maximum recovery. Pressure Pulse Test provides information on reservoir continuity and reservoir properties. (Saadat, Aliasghar et.al, 2016).

2.1.2.4.7 Pressure distribution:

A look at almost any pressure map of an oil field will show the source and sink areas around the field. This can be due to location, depth, depletion in mature fields, and pressure support from an active water-flood. Reservoir heterogeneity, faulting, geological feature like fractures, can impose pressure distribution and control recovery, rates, and water breakthroughs. It is, therefore, of utmost importance to have a clear idea about reservoir continuity, vertically and laterally, in order to be able to manage the reservoir economically and efficiently. Vertical isolation of different zones by geologically impervious strata or, lateral separation between fault-locks cannot be taken for granted. Cement failure, pipe leaks, communication after stimulation by hydraulic fracturing, for example, any of these can breach what was thought to be good integrity. Premature watering out, or unexpected fast depletion, can be some of the results of integrity failures. It is, therefore, critical to monitor well and reservoir performance and be able to account for any deviation from expected performance. If in doubt, run the right logging tools and verify the cause for any deviation from the forecast because, the sooner a problem is diagnosed accurately, the better are the chances for a successful remedial job. With new tools, it is no longer necessary to isolate each zone with a packer, run pressure gauges, and shut in the well for days to get the reservoir pressure. Monitoring the reservoir pressures throughout the production life of the field is considered as a cornerstone for reservoir management and optimization of the development plans. (Saadat, Aliasghar et.al, 2016).

2.1.2.5 importance of well surveillance:

In the aspect of oilfield development and optimization

•Surveillance is an effective way to reduce uncertainties and risks.

•Surveillance is an important course that both geologists and engineers should familiar with.

•Surveillance should be conducted throughout the whole life of oilfield development, but the focus varies in different development stages.

Objective of well surveillance:

- Understand the purpose of reservoir surveillance
- Understand common surveillance data types
- Understand the application of major surveillance data

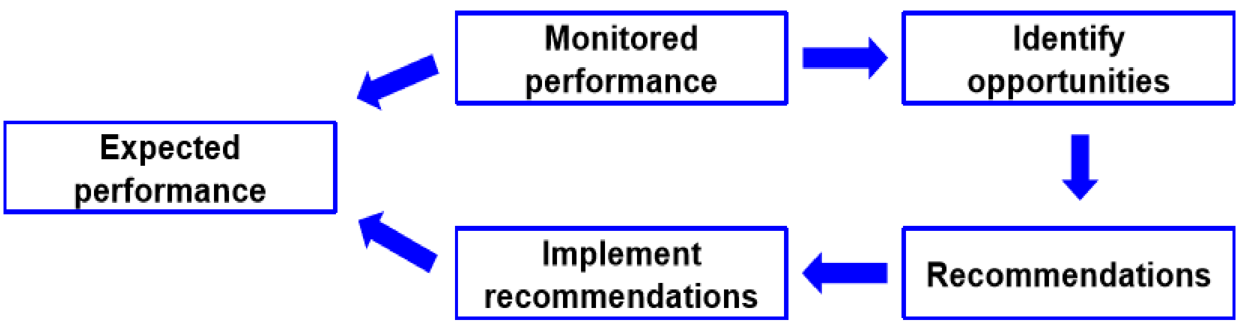

Figure 2 - 5 Role of surveillance in reservoir management

2.1.2.6 Principles of proposing surveillance plan:

1.Surveillance plan should be proposed based on specific geological settings, well pattern and spacing, and different development stages etc.

2.The representativeness and accuracy of surveillance data should be ensured to satisfy the requirement of field operation and research.

3.The integrity of selected wells should meet the requirement of surveillance job.

4.Fixed and systematic surveillance for certain wells, emphasized surveillance for random wells

5.Focus varies in different development stages

(Chenji , D. W., 2016).

2.1.2.7 Surveillance data:

- Routine wellhead flow test.
- Bottom hole flowing pressure and reservoir pressure.
- Well testing.
- Production logging test.
- Saturation log.
- Wireline formation pressure test.
- Sealed coring.
- Tracers.
- **Routine wellhead flow test:**

Wellhead pressure, water cut, gas oil ratio and flow rate measurement.

- **Bottom hole flowing pressure and static pressure**:

Can be used for well productivity calculation, pressure mapping, reference for well stimulation.

- **Well test (Pressure buildup and pressure fall-off)**:

    Well test can be used to evaluate parameters such as permeability, production index, well bottom hole damage (skin factor), boundary and static pressure.

- **Production logging test**:

    Vertical production profile.

- **Saturation logging:**

    To evaluate current oil saturation, identify workover candidates, locate by-pass oil combined with production logging data.

    (Chenji , D. W., 2016).

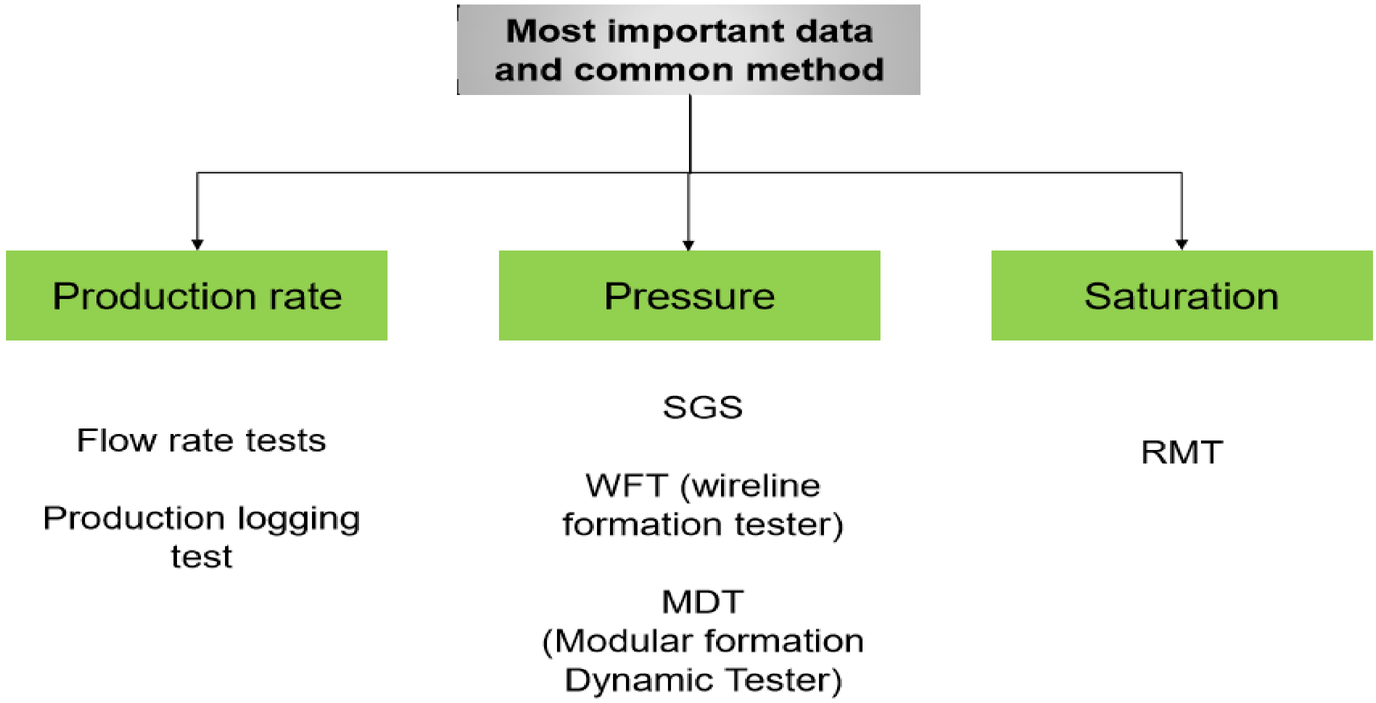

Figure 2 - 6 Surveillance data

(Chenji , D. W., 2016).

Flow rate tests:

The most common, convenient, and important surveillance.

Black Oil Description Used for Multi-Phase Analysis			
Solution GOR:	492.9	scf/STB	
Water Cut:	0	%	Measured
Gas Specific Gravity:	0.7845		
Oil Specific Gravity:	25.0	°API	From Client Provided Data
Bubble Point Pressure (Pb):	1954	psia	
Reservoir Temperature (Tb):	76.7	°C	

Figure 2 - 7 Flow rate test black oil description

FSJ No.:	**625-49**	Field Service Personnel On-Site
Client:	**Rumaila Operating Organisation**	**Arshad Jameel**
DGS:	**DS2**	**Mohammed Abdul Razaq**
Reservoir:	**Mishrif / East Flank**	
Well(s):	**R-165**	
Service Date:	**10-May-2014 & 16-May-2014**	
Job Type:	**Production Testing**	

Well Description: Test #1 Tubing Open & Casing Closed					
Upstream Pressure:	190.7	psig	**Upstream Temperature*:**	49.7	degC
Downstream Pressure:	150.4	psig	**Downstream Temperature:**	47.8	degC
Annulus Pressure:	n/a	psig	**Annulus Temperature*:**	n/a	degC
Tubing Valve Setting:	Open		**Casing Valve Setting:**	Closed	
Well Flow Type:	Natural				
Production Choke Size:	75	1/64th			
Measured Oil SG @ °F:	0.899 @ 104.6 F		**Measured Oil SG @ 60°F:**	0.915	
Measured Water Cut:	0.0	%	**Sampling Point:**	12 o'clock	

Figure 2 - 8 Flow rate test well description

Production logging test:

The measurement of fluid parameters on a zone-by-zone basis to yield information about the type and movement of fluids within and near the wellbore

Applications of reservoir surveillance:

- Monitor reservoir performance and variations
- Evaluate completion performance
- Diagnose well problems
- Well testing (rate vs pressure)

Case studies:

•Case 1 - Using PLT to identify thief zone

Based on PLT, flow test, and saturation log, 93 producers are water breakthrough.

Thief zones are developed, several wells are observed thickness less than 20% but contributing more than 70% of production or injection

•Case 2 - Using RMT data to monitor fresh water flood and characterize remaining oil

•Case 3 - Using RFT data to identify barriers and propose detailed water injection plan

•Case 4 - Water flooding pilot design and surveillance proposal.

(Chenji , D. W., 2016).

2.3 Literature Review:

M.R. Konopczynski and A. Ajayi (2008) presented the compare between methods of reservoir surveillance and production optimization in the "old world" to generation intelligent fields, the result is to improve their ability, optimize production, minimize expenses and improve reserve recovery. The real value of intelligent wells and smart field systems come from ongoing exploitation of new technology in day to day operations.

Ahmed Al-Azkawi et al (2009) described how proactive surveillance adds value in fields that follow a clear well and reservoir management, to evolve the activities by exploitation available technology, outcome of the reviews, field maturity, drive mechanism and oil prices.

Jorge Yero and Thomas A. Moroney (2010) presented the design and use of the exception-based surveillance tool as well as the integration of the tool in a collaborative work environment, to improvement of reservoir and facility surveillance.

Kewen Li et al (2011) applied a new model that correlates water cut and production time in oil reservoirs, to predict water production and estimate the performance as a function of production time.

Mark J. Lochmann (2012) addition advanced analytics, expert systems and process automation, to replaced monitoring wells against a target with managing production assets against their potential in a safe environmentally-responsible way.

Al-Jasmi et al (2013) used intelligent digital oilfield (iDOF) operation to develop the production surveillance smart flow, which provide engineers with automated artificial intelligence that analyzes data and provide guidance on well operations.

Chapter 3

Methodology

3.1 Introduction:

The primary purpose of a reservoir management and surveillance is to predict future performance of a reservoir and find ways to increase ultimate recovery, decrease water cut and minimize total cost. there are more computers systems that analyze and predicting performance of reservoir, the oil field manager software (OFM) is one of these computers systems that used widely to evaluate the reservoir and makes predict for future performance of wells, and designed to aid in the day to day surveillance and management of oil and gas field.

Also perform basic or complex analyses for individual or multiple completions, group of wells, an entire filed, or several fields.

3.2 Required data:

- Master data (well name, coordinate for each well (x, y) and well & reservoir data).
- Production data (oil, gas and water production, pump data).

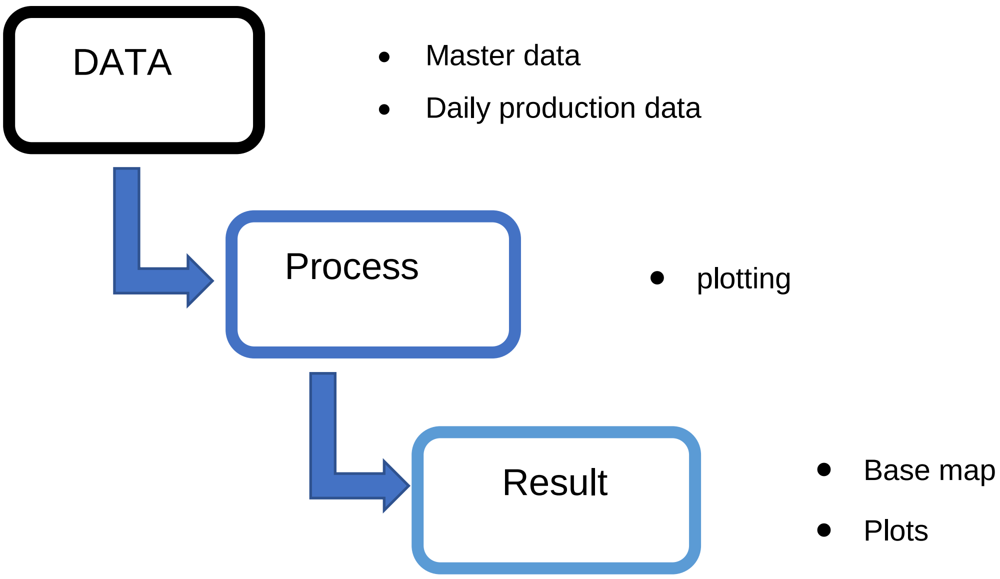

Figure 3 - 1 OFM software flow chart

3.3 Process:

Firstly, gathering all available data and scheduled it in a certain way.

Secondly, after inserting data in software the layout will present the location of any well in the field.

Thirdly, present the date graphically to identifying any decline in production rates and water cut effect.

Suggest solutions to handling water cut.

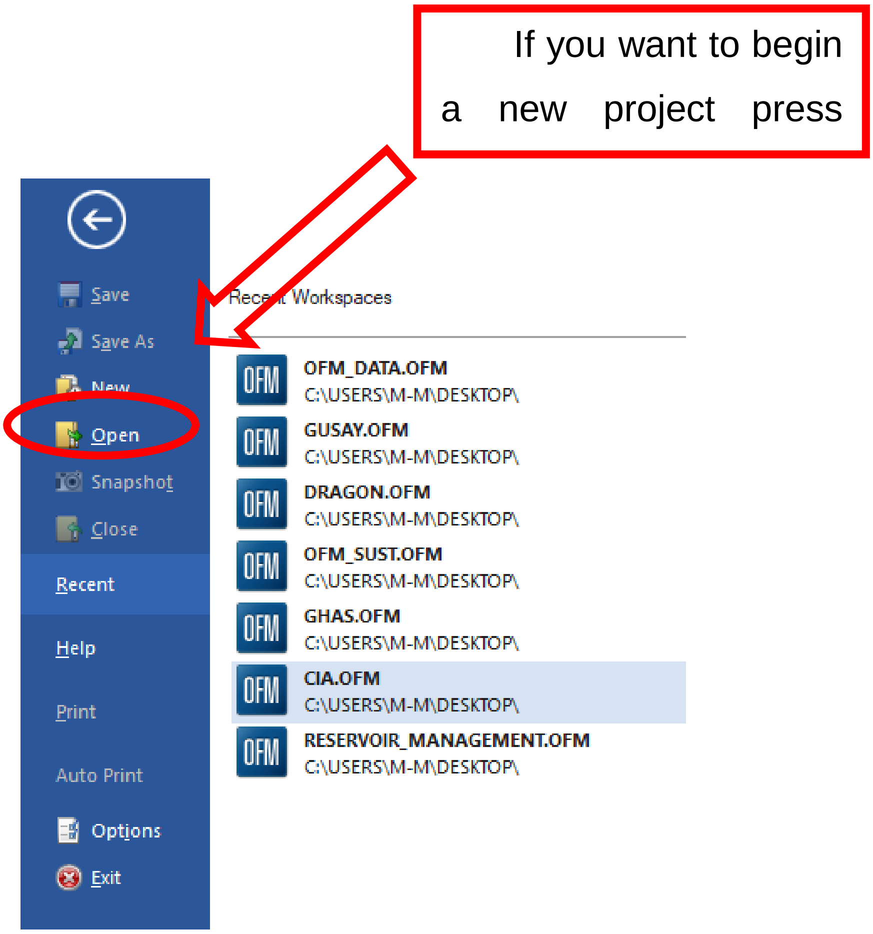

Figure 3 - 2 How to create a new project

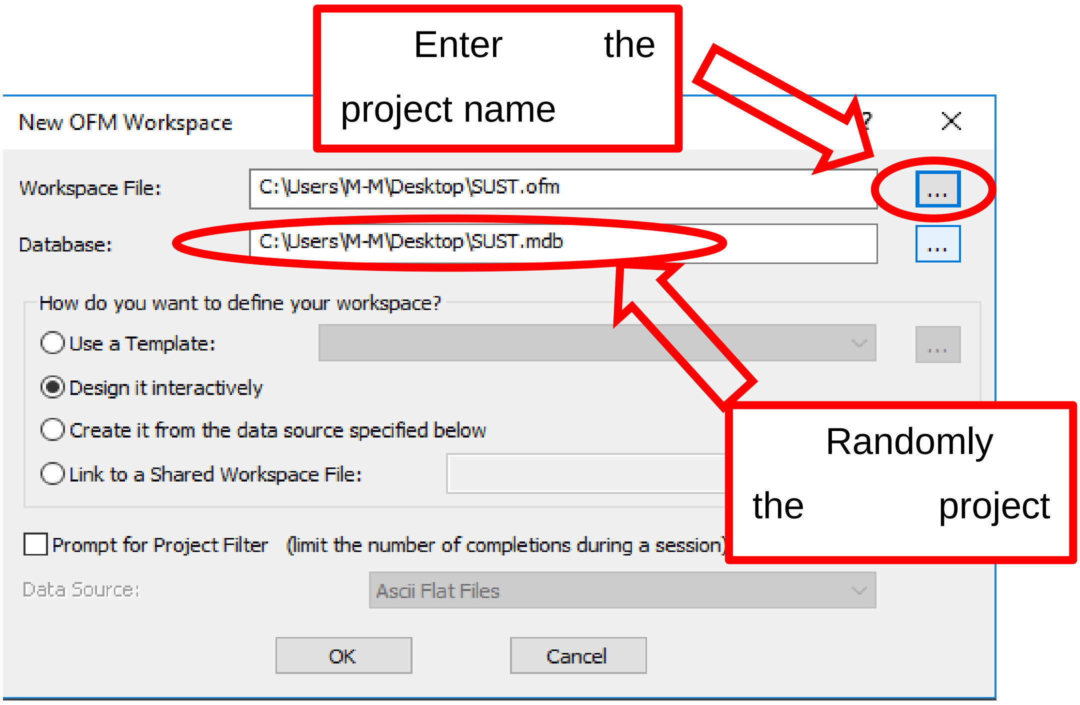

Figure 3 - 4 Entering the project name

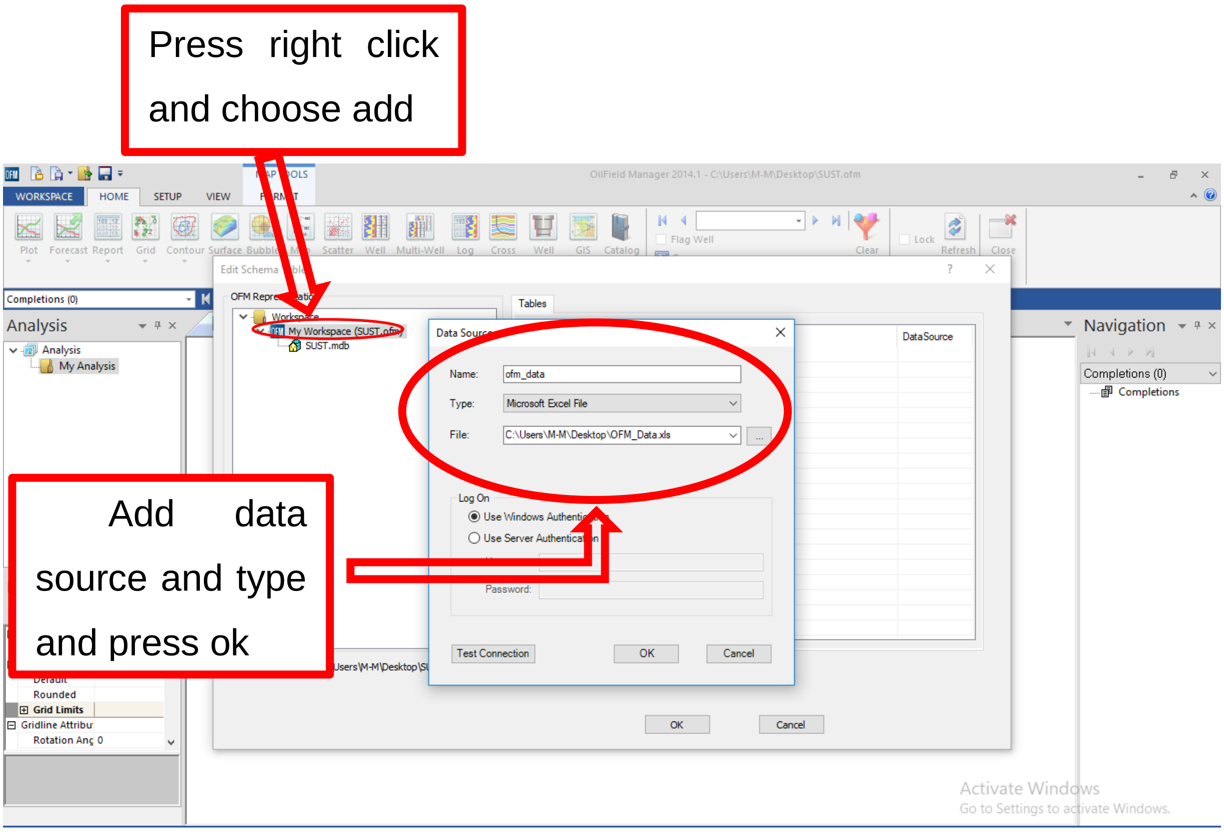

Figure 3 - 7 Entering the data source

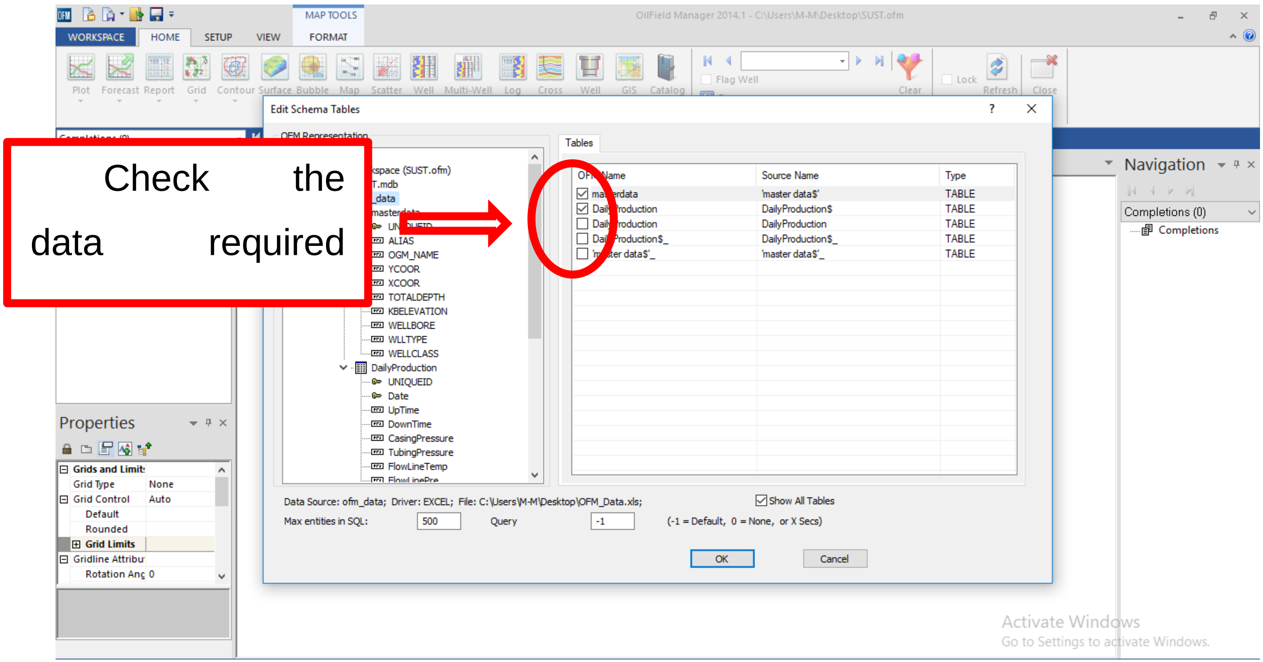

Figure 3 - 6 Choosing the data table

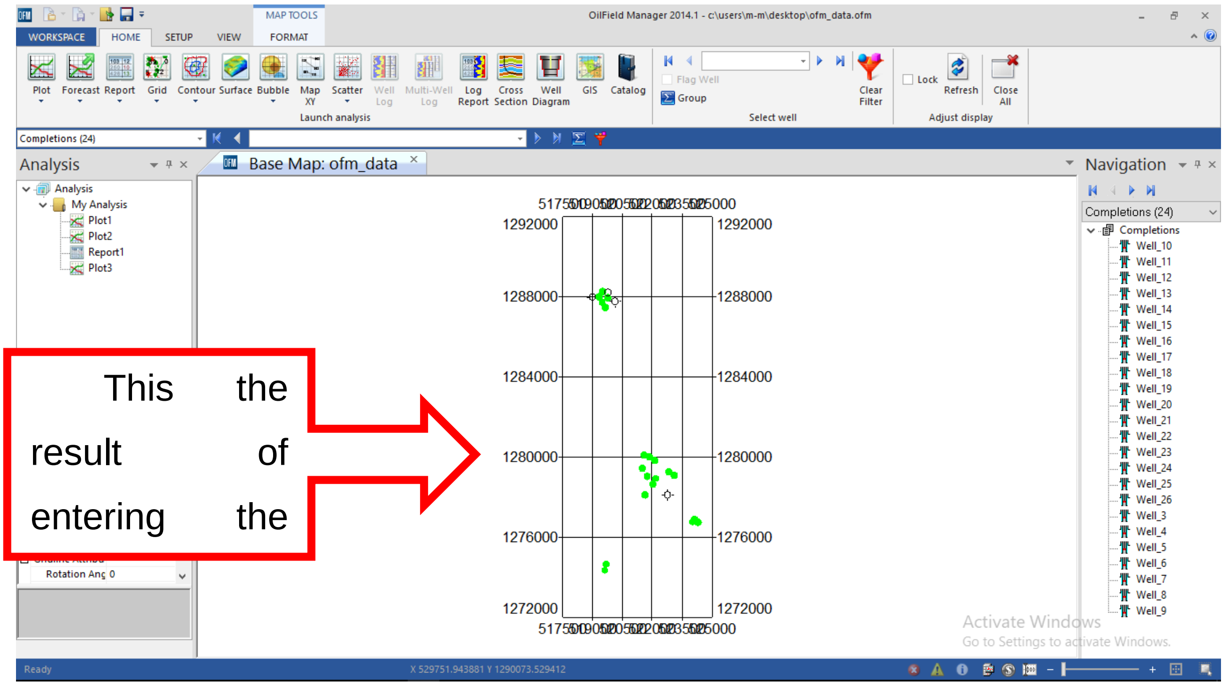

Figure 3 - 12 Locations of wells

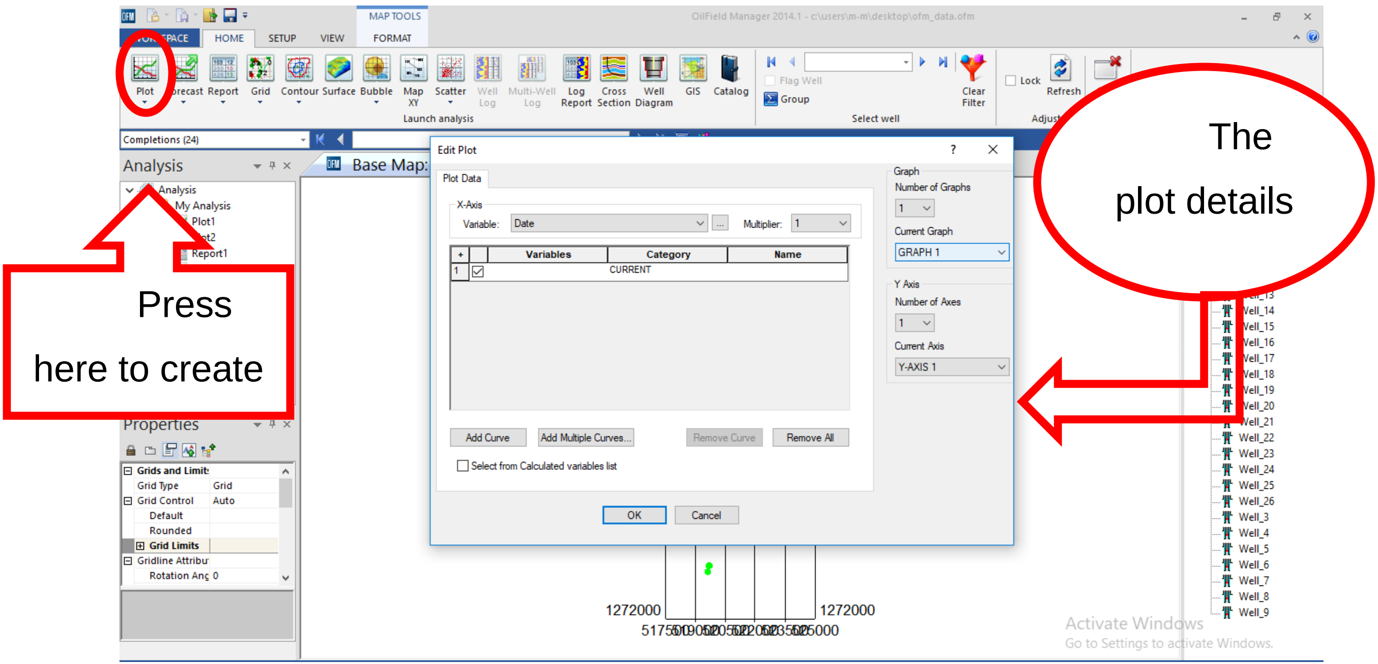

Figure 3 - 11 Create a plot

We used the equation below in (OFM) software to make analysis

Table 3 - 1 The semblance of equations that software calculated it

Calculated Variable	Equation
Freq.Monthly	@Change(@Month(Date))
Prod_Days	@ClrTSum(Dailyproduction.Uptime ,Freq.Month)/24
WOR	@If(Dailyproduction.Oil > 0 ,Dailyproduction.Water / Dailyproduction.Oil ,@Null( ))
W.C	@If(Dailyproduction.Fluid > 0 ,Dailyproduction.Water / Dailyproduction.Fluid ,@Null( ))
GOR	@If(Dailyproduction.Oil > 0 ,Dailyproduction.Gas / Dailyproduction.Oil ,@Null( ))
Monthly Oil	@ClrTSum(Dailyproduction.Oil ,Freq.Month)
Monthly water	@ClrTSum(Dailyproduction.Water ,Freq.Month)
Monthly sand	@ClrTSum(Dailyproduction.Sand ,Freq.Month)
Monthly gas	@ClrTSum(Dailyproduction.Gas ,Freq.Month)
Monthly Oil Rate	@If(Prod_Days > 0 ,Monthly.Oil / Prod_Days ,@Null( ))
Monthly gas rate	@If(Prod_Days > 0 ,Monthly.Gas / Prod_Days ,@Null( ))
Monthly water rate	@If(Prod_Days > 0 ,Monthly.Water / Prod_Days ,@Null( ))
Monthly fluid rate	Monthly.Oil_Rate + Monthly.Water_Rate
D.WOR	@ABS((Cum.Water-@PREVIOUS(Cum.Water))/(Cum.Oil - @Previous(Cum.Oil))/(Days - @Previous(Days)))
Days	@ElapsedDays(Date, @first(Date))
Cum. Water	@CumInput(Dailyproduction.Water)
Cum. Sand	@CumInput(Dailyproduction.Sand)
Cum. Oil	@CumInput(Dailyproduction.Oil)
Cum. Gas	@CumInput(Dailyproduction.Gas)
Cum. Fluid	Cum.Oil + Cum.Water
Fit, dWOR	@FIT(Days,dWOR,dWOR>0,@daily(Days),"deg 2 opt ylog")
Fit, WOR	@Fit(Days ,WOR , WOR>@null(),@daily(Days),"deg 2 opt ylog")

$$water\ cut = \frac{production\ of\ water}{production\ of\ fluid}$$

$$W.C = \frac{Qw}{Qf} \quad \text{...} \quad (3.1)$$

$$Qf = Qw + Qo \quad \text{.......................................} \quad (3.2)$$

$$WOR = \frac{Qw}{Qo} \quad \text{...} \quad (3.3)$$

$$WOR + 1 = \frac{Qw + Qo}{Qo} \quad \text{.....................................} \quad (3.4)$$

$$W.C = \frac{WOR}{WOR + 1} \quad \text{...} \quad (3.5)$$

Chapter 4

Result and discussion

4.1 introduction:

This chapter describes results of the (OFM) data entering and their analysis.

Based on the previous analytics we get more results that clarify progress of production rates and water cut, and before any outcomes the below figure shows the location of 24 well that founded in field (x), any one of these wells has globally unique coordinates.

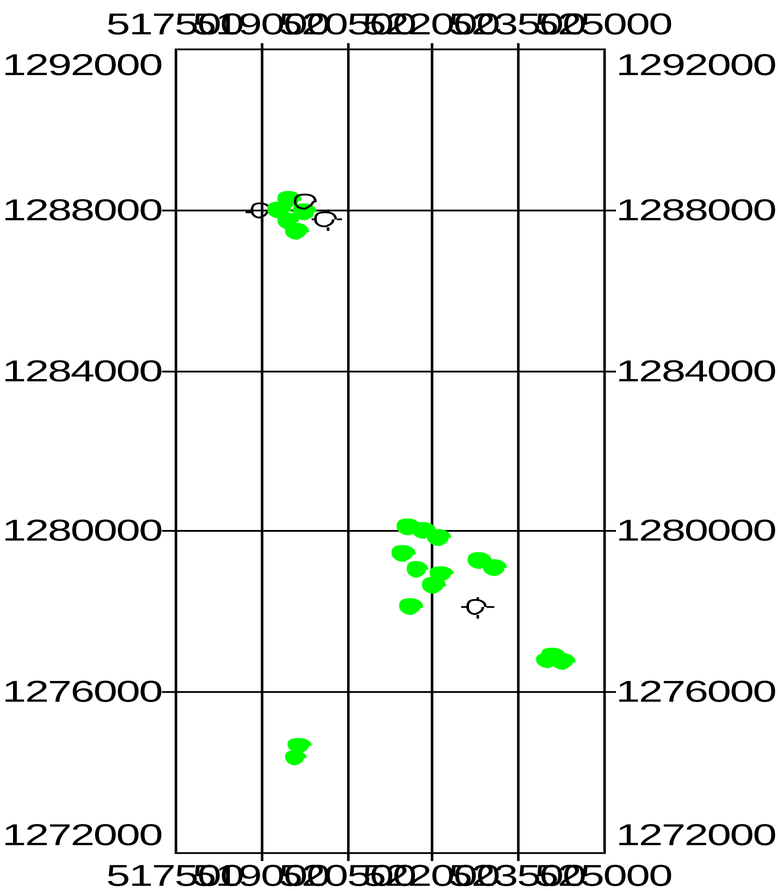

Figure 4 - 1 Location of wells in field (x)

4.2 Case study:

The field (x) that located in Sudan state composed of three reservoirs (AG, Bentiu and Zarga) and 24 well, we evaluated this field and approached to results that help us to understand all problems related to these three reservoirs such as: water cut, bypass oil and etc., and suggest solutions lead to handling these problems.

Table 4 - 1 Master data

UNIQUEID	ALIAS	YCOOR	XCOOR	T.D	KB.E	WELLBORE	WLLTYPE
Well_3	Well_3	1278109.207	522773.668	3600	473.326	AG	Dry
Well_4	Well_4	1279978.631	521874.766	4000	477.775	Bentiu	Oil
Well_5	Well_5	1279816.967	522137.029	1850	474.056	Bentiu	Oil
Well_6	Well_6	1279229.998	522851.031	2000	472.866	Bentiu	Oil
Well_7	Well_7	1279073.988	523116.017	1850	474.798	Bentiu	Oil
Well_8	Well_8	1280081.802	521587.510	1850	479.15	Bentiu	Oil
Well_9	Well_9	1278081.204	521637.633	3800	473.671	Zarqa	Oil
Well_10	Well_10	1276883.237	524106.658	2200	473.548	Bentiu	Oil
Well_11	Well_11	1276727.192	524308.545	1800	470.464	Bentiu	Oil
Well_12	Well_12	1276747.09	524027.22		473.501	Bentiu	Oil
Well_13	Well_13	1278620.922	522029.132	3550	473.098	AG	Oil
Well_14	Well_14	1278912.227	522173.219	3550	473.121	AG	Oil
Well_15	Well_15	1279407.321	521516.872	3550	478.291	AG	Oil
Well_16	Well_16	1279039.248	521756.312		477.370	AG	Oil
Well_17	Well_17	1274635.507	519699.024	3100	465.593	AG	Oil
Well_18	Well_18	1274320.026	519641.797	2950	469.686	AG	Oil
Well_19	Well_19	1288229.985	519526.496	3567	479.730	AG	Oil
Well_20	Well_20	1287701.000	519509.023	3250	468.989	AG	Oil
Well_21	Well_21	1287766.003	520163.009	2000	479.342	Bentiu	Dry
Well_22	Well_22	1287971.790	519023.676	2945.79	480.407	AG	Dry
Well_23	Well_23	1287436.022	519654.637	3200	477.761	AG	Oil
Well_24	Well_24	1287940.125	519783.652	2002	478.622	Bentiu	Oil
Well_25	Well_25	1287963.187	519341.544	3220	482.540	AG	Oil
Well_26	Well_26	1288183.867	519799.698		479.638	Bentiu	

Table 4 - 2 Production daily data

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T
1	ALIAS	Date	UpTime	DownTime	CasingPressure	TubingPressure	FlowLineTemp	FlowLinePre	Current	Speed	Freq	Fluid	Oil	Gas	Water	Sand	DFL	PumpSubmergence	WaterCut	SandCut
2	Well_4	17/12/2012	13.00	11.00	114.55	44.95	33.00	42.05	39.00	25.00	5.00	51.28	51.28	0.00	0.00	0.00	297.73	599.98	0.00	0.00
3	Well_4	17/12/2012	13.00	11.00	114.55	44.95	33.00	42.05	39.00	25.00	5.00	51.28	51.28	0.00	0.00	0.00	297.73	599.98	0.00	0.00
4	Well_4	17/12/2012	13.00	11.00	114.55	44.95	33.00	42.05	39.00	25.00	5.00	51.28	51.28	0.00	0.00	0.00	297.73	599.98	0.00	0.00
5	Well_4	18/12/2012	24.00	0.00	114.55	44.95	33.00	42.05	39.00	25.00	5.00	94.66	94.28	0.00	0.38	0.01	297.70	600.01	0.40	0.01
6	Well_4	18/12/2012	24.00	0.00	114.55	44.95	33.00	42.05	39.00	25.00	5.00	94.66	94.28	0.00	0.38	0.01	297.70	600.01	0.40	0.01
7	Well_4	18/12/2012	24.00	0.00	114.55	44.95	33.00	42.05	39.00	25.00	5.00	94.66	94.28	0.00	0.38	0.01	297.70	600.01	0.40	0.01
8	Well_4	19/12/2012	24.00	0.00	114.55	44.95	33.00	42.05	39.00	25.00	5.00	94.66	94.61	0.00	0.05	0.01	297.70	600.01	0.05	0.01
9	Well_4	19/12/2012	24.00	0.00	114.55	44.95	33.00	42.05	39.00	25.00	5.00	94.66	94.61	0.00	0.05	0.01	297.70	600.01	0.05	0.01
10	Well_4	19/12/2012	24.00	0.00	114.55	44.95	33.00	42.05	39.00	25.00	5.00	94.66	94.61	0.00	0.05	0.01	297.70	600.01	0.05	0.01
11	Well_4	20/12/2012	24.00	0.00	114.55	44.95	33.00	42.05	39.00	25.00	5.00	94.66	94.66	0.00	0.00	0.00	297.70	600.01	0.00	0.00
12	Well_4	20/12/2012	24.00	0.00	114.55	44.95	33.00	42.05	39.00	25.00	5.00	94.66	94.66	0.00	0.00	0.00	297.70	600.01	0.00	0.00
13	Well_4	20/12/2012	24.00	0.00	114.55	44.95	33.00	42.05	39.00	25.00	5.00	94.66	94.66	0.00	0.00	0.00	297.70	600.01	0.00	0.00
14	Well_4	21/12/2012	9.00	15.00	114.55	44.95	33.00	42.05	39.00	25.00	5.00	35.50	35.50	0.00	0.00	0.00	297.70	600.01	0.00	0.00
15	Well_4	21/12/2012	9.00	15.00	114.55	44.95	33.00	42.05	39.00	25.00	5.00	35.50	35.50	0.00	0.00	0.00	297.70	600.01	0.00	0.00
16	Well_4	21/12/2012	9.00	15.00	114.55	44.95	33.00	42.05	39.00	25.00	5.00	35.50	35.50	0.00	0.00	0.00	297.70	600.01	0.00	0.00
17	Well_4	22/12/2012	0.00	24.00	114.55	44.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
18	Well_4	22/12/2012	0.00	24.00	114.55	44.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
19	Well_4	22/12/2012	0.00	24.00	114.55	44.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
20	Well_4	23/12/2012	0.00	24.00	114.55	44.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
21	Well_4	23/12/2012	0.00	24.00	114.55	44.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
22	Well_4	23/12/2012	0.00	24.00	114.55	44.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
23	Well_4	24/12/2012	0.00	24.00	114.55	44.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
24	Well_4	24/12/2012	0.00	24.00	114.55	44.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
25	Well_4	24/12/2012	0.00	24.00	114.55	44.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
26	Well_4	25/12/2012	0.00	24.00	114.55	44.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
27	Well_4	25/12/2012	0.00	24.00	114.55	44.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
28	Well_4	25/12/2012	0.00	24.00	114.55	44.95	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00				
29	Well_4	26/12/2012	1.00	23.00	116.00	101.50	37.00	65.25	43.00	25.00	5.00	3.94	3.94	0.00	0.00	0.00	297.70		0.00	0.00
30	Well_4	26/12/2012	1.00	23.00	116.00	101.50	37.00	65.25	43.00	25.00	5.00	3.94	3.94	0.00	0.00	0.00	297.70		0.00	0.00
31	Well_4	26/12/2012	1.00	23.00	116.00	101.50	37.00	65.25	43.00	25.00	5.00	3.94	3.94	0.00	0.00	0.00	297.70		0.00	0.00

4.2.1 Field (x):

The field (x) data was studied and analyzed for approach to their main problem occurs in it. In the first the production of oil began with high rates and then decline squeaky after the four months.

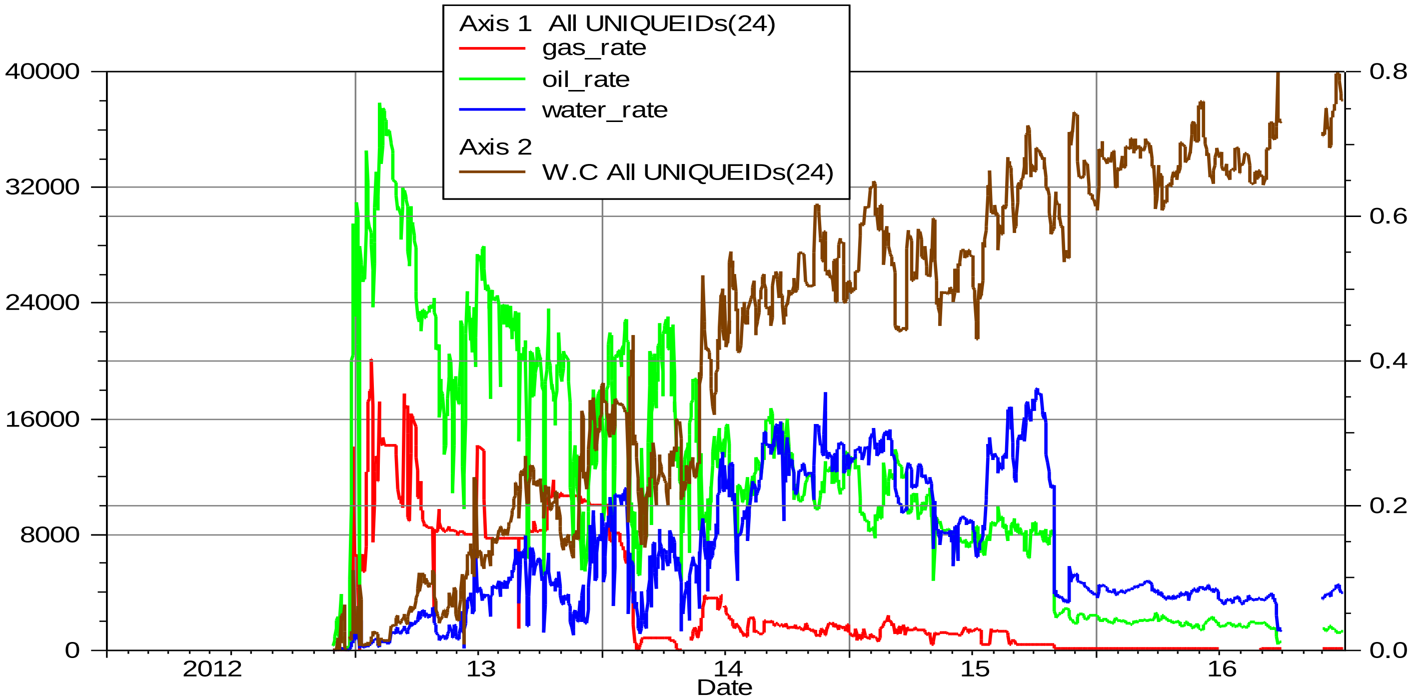

Figure 4 - 3 Production rates and water cut of field (x)

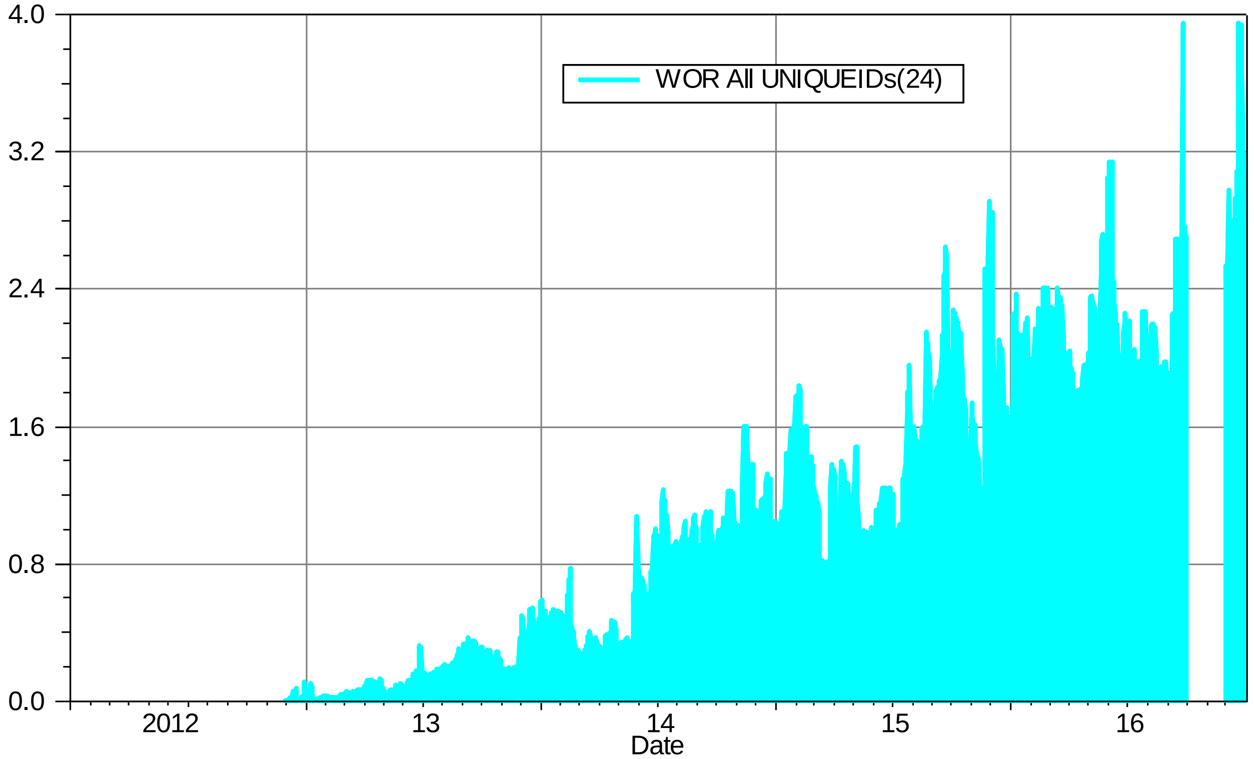

Figure 4 - 2 Water oil ratio of field (x)

These plots illustrate that we have a high percent of water cut, field (x) started with a high oil production rate, by time we notice that the water production start to increase gradually, Day by day we have a new increase in water production.

4.2.2 Abu-gabra wellbore:

Wells in this wellbore started to produce since 2013 at first stage the production was at highest rate then the rate decreased gradually, while the water production rate increased due to the oil depletion.

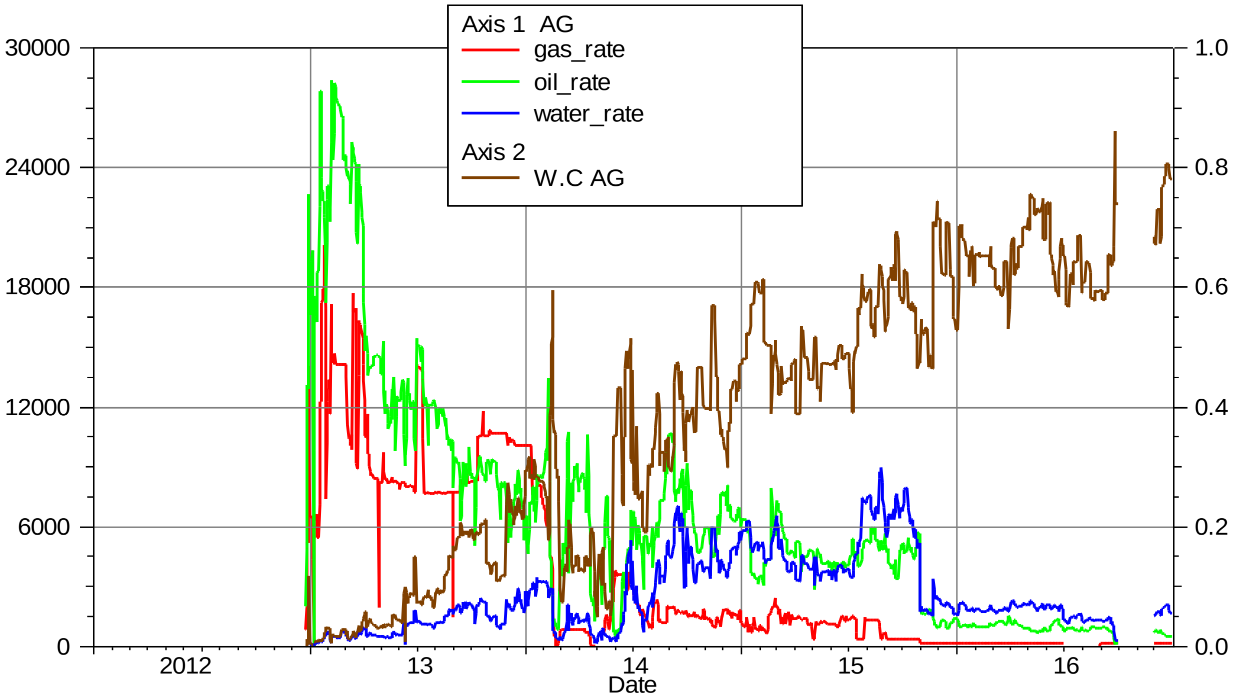

Figure 4 - 4 Production rates and water cut of AG wellbore

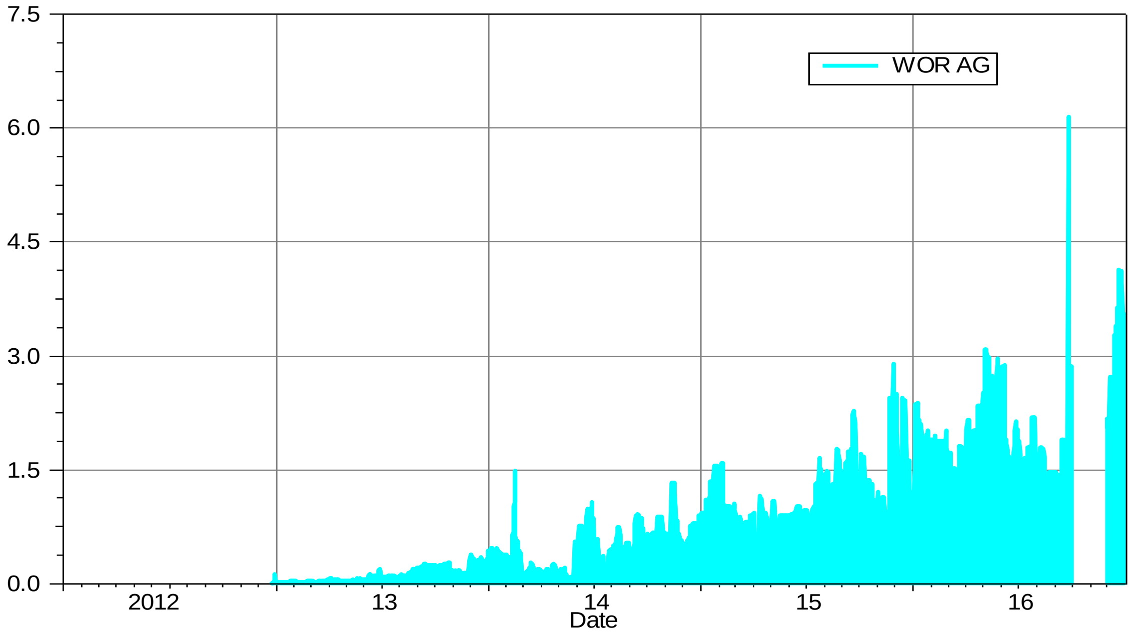

Figure 4 - 5 Water oil ratio of AG wellbore

in the begin of 2013 a pressure drops occurred in the reservoir result in increase of water oil ratio.

4.2.3 Bentiu wellbore:

The production in the first stage was sort of stable but by time the water production shows up, also water production increased gradually.

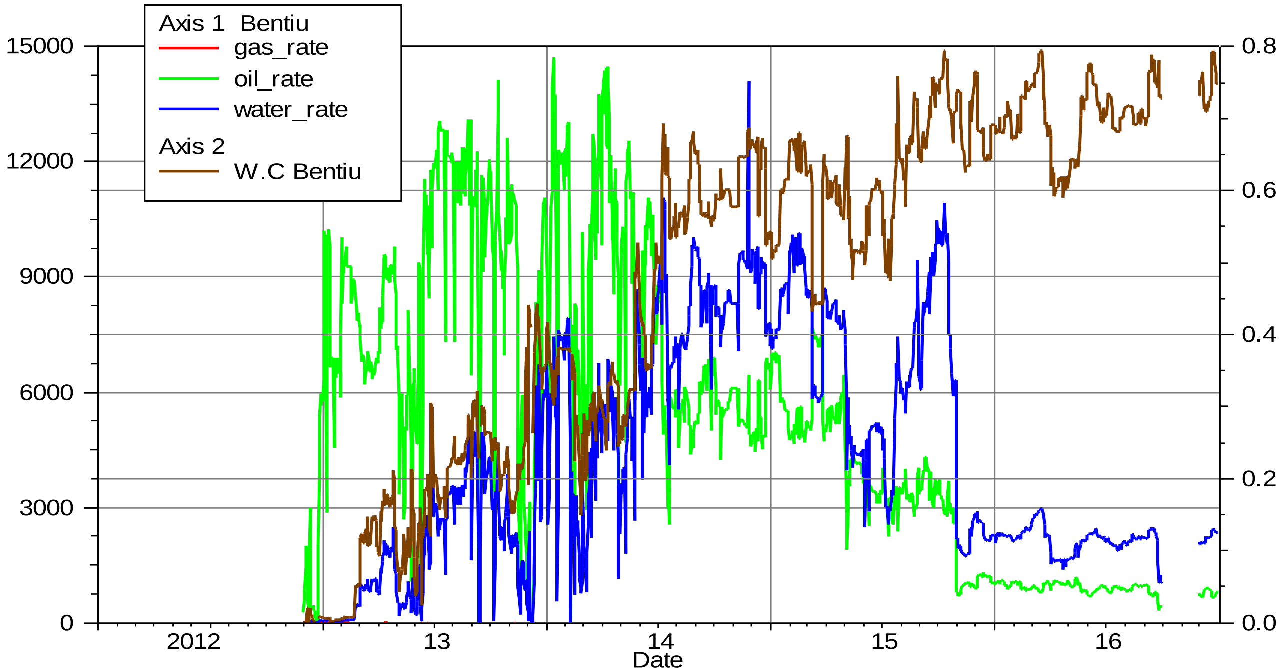

Figure 4 - 6 Production rates and water cut of bentiu wellbore

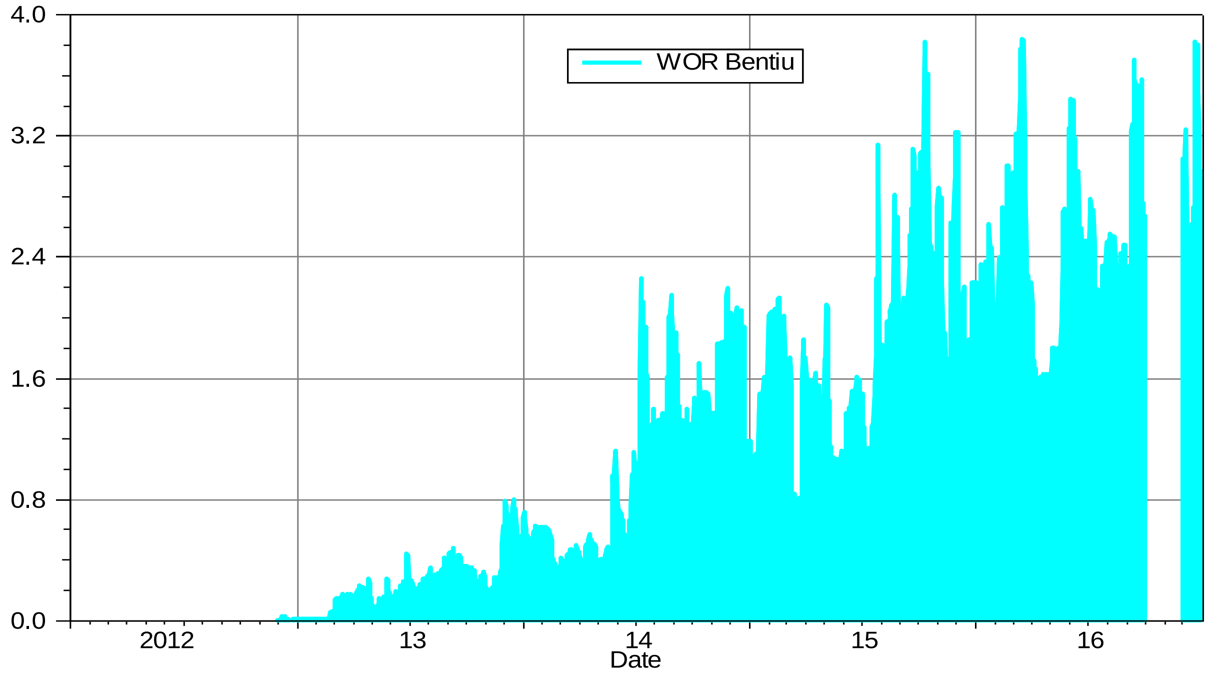

Figure 4 - 7 Water oil ratio of bentiu wellbore

4.2.4 Zarqa wellbore:

The reservoir of zarqa wasn't ongoing production because it has a high-water production and water cut, we notice from the plot that the well start and stop running in few days, because the water production was very high.

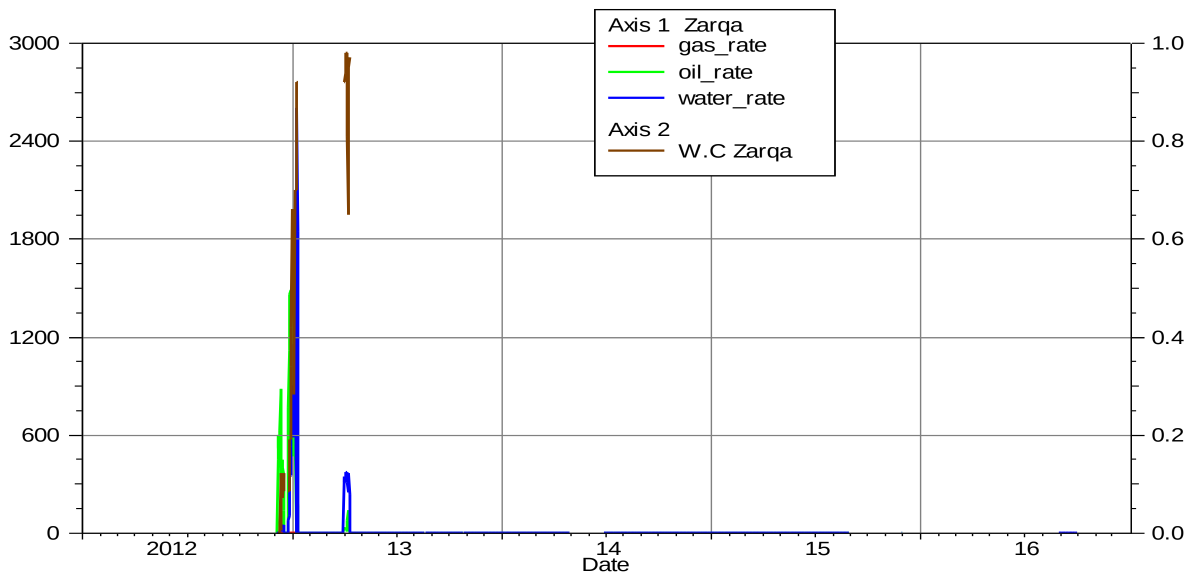

Figure 4 - 8 Production rates and water cut of zarqa wellbore

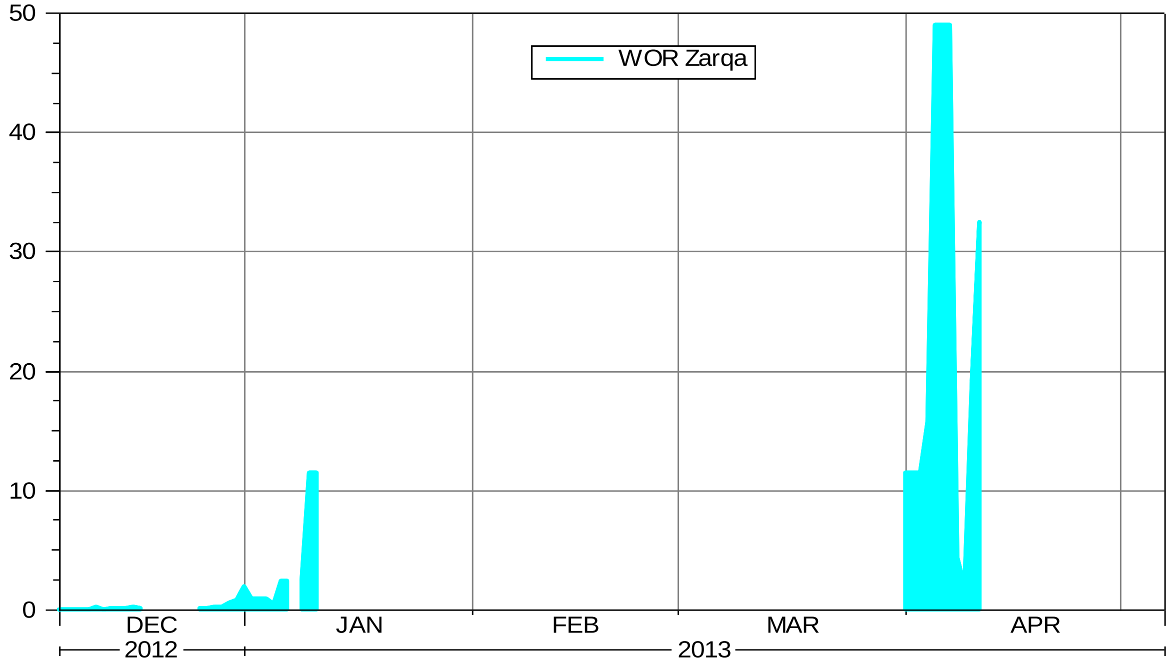

Figure 4 - 9 Water oil ratio of zarqa wellbore

The water production after a long term reached uncontrolled level, this level now is untreatable, hence we can give a temporally solution such as:

- use cementing squeeze job and plug the previous perforation.
- Decrease the perforation depth to target the bay-zone.
- Decrease the oil production rate to prevent faster depletion hence we avoid water production.

Chapter 5

5.1 conclusion:

We studied the field(x) to detect the water cut to find the optimum solution to keep the oil production rate higher than water production, we used cementing squeeze to plug the current perforation to decrease the water production and make a new perforation in a lower depth than the previous.

5.2 Recommendation:

- advise to use cementing squeeze.
- Cementing that used in handling water cut must be prepared with appropriate properties.

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