UNDERBALANCED DRILLING (UBD) APPLYING CAPABILITY ON IRAQIS OIL FIELDS Introduction

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UNDERBALANCED DRILLING (UBD)

APPLYING CAPABILITY ON IRAQIS OIL FIELDS

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Introduction :

Underbalanced drilling-defined as drilling while maintaining well bore pressure less than the formation's pressure.

The **UBD** is a derivative from balanced drilling which is being defined as a drilling process that used a drilling fluids formed a hydrostatic pressure balanced to formation pressure and normally the conventional drilling process is the overbalanced drilling which is mean using a drilling fluids its hydrostatic pressure is overcome formation pressure to prevent the oil **&** gas to enter the wellbore and blow out the well**.**

The **UBD** is a technique being almost used to improve drilling costs, improve rate of penetration and avoid the loss of circulation plus stuck pipe**,** underbalanced drilling **(UBD)** is the most significant advancement in drilling science since the advent of rotary tools**.**

The **UBD** technique is being used as it cost highly rate than conventional drilling but there is no compartment between the cost of in between both types **(UBD & Conventional), i.e.:** the **UBD** cost as it consider at the final of oil well being completed **,** it is reduce the bulk economically expenditures as being it is a drilling project **,** the cost reduction will be even reduce when the well being produce under no skin damage **,** which will be effective on the whole oil quantity will be capable to extract from the reservoir and the whole time for well life production **,** so it is very interestingly technique used by drilling to improve several indications for the oil investment**.**

The UBD technique in spite of the increasing the daily cost of drilling operation temporarily**,** but as the whole well cost finally when the well under production with no skin damage **;** there is no compartment between two technique **(** the overbalanced **&** underbalanced **)** , the UBD technique will increase the whole oil recovery in accordance with quantity of oil in place through the whole well production life**,** reduce the pipe trips due to drilling reasons **,** reduce the number of bits which being used due to increase bit life specially when using the **(PDC Bits)** or the extended gauge bits which using the blades instead of the anti friction roller cones **(** the cones exchanged by blades **)** , allover the using these kind of bits is common on hard formations which need bog amount of **W**eight **O**n **B**it **(WOB).**

The **UBD** technique is reduce the stuck pipes which cost high due to the stuck pipes treatment**,** most of sticking problems caused by the big amount of pressure differential between the drilling fluid hydrostatic pressure **&** the formation pressure specially when it being drilling high permeability layer **,** the big amount or drilling hydrostatic pressure due to use high density drilling fluid **,** the **UBD** technique eliminated this problems due to use an underbalanced hydrostatic drilling fluid pressure which being forced to use low hydrostatic fluid pressure to be set the underbalanced case **,** which will eliminate the reason for this problem**.**

The **UBD** technique reducing the loss of circulation problems of drilling fluid due to the weakly formation or vuggy limestone formation which contain un expecting empty places or caving **,** the loss of circulation occur when the hydrostatic drilling fluid pressure is high due to high drilling fluid density **,** the same reason to

eliminate this problem will occur when being used low density drilling fluid to be set the underbalanced condition, the loss of circulation will be decreased or eliminated when using the **UBD** technique.

The main benefits to use the **UBD** is the eliminate of skin damage which affected the well productivity due to solids particles invasion the reservoir formation, the source of the solid particles is the drilling fluid and the force of the invasion is the drilling fluid density being used high fluid density which produce the high drilling fluid hydrostatic pressure, the skin damage problems will eliminate by using **UBD** and the low drilling fluid density to maintain the **UBD** condition.

UBD Definition:

UBD is define as a drilling operation by make the drilling fluid hydrostatic pressure may use at low value than the formation pressure being to be drill.

The **UBD** which this paper mentioned it here it may need before the drilling team think about , it need approach in decision to planning **&** evaluate the oil field which may use the **UBD** to develop , however to improve the **UBD** situation and get the right benefits if the owners decide to use the **UBD** technique.

The **UBD** technique often was used on offshore fields to drill the reservoir mainly to reduce the skin damage but even being used to drill the horizontal wells , whatever there is a need to increase the production , at the same time the **UBD** was used to drill vertical wells to improve the penetration rate **&** reduce the drilling problems of stuck pipes and loss of circulation , and to increase the production by eliminate the skin damage, but mainly to drill the reservoir to increase the recovery oil on old fields and the new fields, the **UBD** also being used to drill vertical wells to reduce the **Loss** of sever **Circulation** and its time **&** cost treatment like the sever **LC** on **south rumaila oil field on Basra south oil company.**

The UBD was used often in the fields suffered of **LC** problems like the limestone **&** dolomite which contain of common buggy and faults **&** carbonate formations which cause the complete **LC,** even though the sandstone and dolomite formation like dam am formation in south of Iraq oil fields which had a features of common gas influx **& H_2S** water**(** as Manson & west Quran knar bin umber oil fields **)** and this features forced the operator south oil company to used high density drilling fluid to control the influx.May be there is a needs to use **UBD** to penetrate the reservoir on the low density matrix of the reservoir in accordance of high permeability direction, however to guarantee the high **P**roductivity **I**ndex **(PI),** even to avoid the water**&** gas coning through the well productivity life. Underbalanced drilling can reduce lost circulation, minimize differential sticking, increase drilling rates, and, most importantly, create higher productivity completions because formation damage is minimized.The **UBD** technique mostly used associated with horizontal wells whenever need to drill horizontal wells which related to drilling conditions her in after.

There is two main restriction forces the operators to appeal to use underbalanced drilling technique, these include:

1. **Reservoir conditions :**

The reservoir condition is important side to make the operators to use the **UBD;**

The Reservoir condition includes:

a. The direction of porosity and permeability intensity.

b. The water coming through production period.

c. The thickness of the reservoir.

d. Type of rock of the litho logical column related to UBD conditions uses.

e. Water & Oil sensitive formations.

And another main restriction is a drilling condition

2. Drilling conditions :

The drilling conditions include:

a. Limits or frontier up and down than you are located the targets.

b. How strong is your formation to drill, if the formation is consolidated the possibility of deviations of your path are too low, if your formation is unconsolidated the deviation of the path would be high.

c. This technique was applied on **carbonated formations (limestone) and consolidated sands.**

d. How would be the pressure in the system to work, because need to considered the pressure applied to especially within loss circulation formations.

e. **Underbalanced drilling is not appropriate for most shale, salt, shattered coal sections, unconsolidated sections and chalk**, If these lithologies are present up, it may be appropriate to drill them overbalanced and then change to underbalanced conditions for the target formation.

f. Formation temperature which the UBD can be used on, because some of the UBD materials could not be use at the range of high temperatures (like foam fluid).

g. Availability of **UBD** materials that will use with the UBD drilling type **(** like drilling with aerated drilling fluid or **with parasite secondary annulus).**

The compartment between the **UBD** case **&** overbalanced case is shown by **(figure - 1)**

There is two main procedure to make the UBD condition :

1. Using the light drilling fluid like water plus diesel or crud oil , this case is consider the drilling fluid is a two phase fluid system or called multiphase drilling fluid.

2. The use of air fluid or foam drilling fluid or may use the gasified fluid , the common gas was used is the Nitrogen gas due to its feature **(non flammable gas).**

Underbalanced Drilling:

Underbalanced drilling can reduce lost circulation, minimize differential sticking, increase drilling rates, and, most importantly, create higher productivity completions because formation damage is minimized, to maximize benefits, extreme care must be taken to keep drilling and completion operations underbalanced at all times, the rate of return from wells drilled underbalanced is higher.

Techniques for drilling underbalanced include:

(1) lightweight drilling fluids.

(2) gas injection down the drill pipe.

(3) gas injection through a parasite string.

(4) foam injection Nitrogen is typically used because of its relatively low generation cost.

(scale control and low potential for downhole fires**).**

The primary value of underbalanced drilling is to minimize formation damage, negative differential pressure between the formation and the wellbore also stimulates the production of formation fluids and gasses, increased penetration rates are also often observed in wells drilled underbalanced.

Underbalanced drilling does not build a filter cake in the wellbore, during conventional drilling, this filter cake acts as a protective barrier, reducing damage to formation permeability from drill cuttings, when drilling horizontal wellbores, drill cuttings are ground into fine powder, in conventional drilling, if the wellbore does not have a filter cake and becomes overbalanced, this powder is carried into the formation, greatly reducing near-wellbore permeability**.**

Four techniques are currently available to achieve underbalanced conditions while drilling, these include using lightweight drilling fluids, injecting gas down the drillpipe, injecting gas into a parasite string, and use of foam**.**

Lightweight Drilling Fluids*:*

The simplest mechanism to reduce hydrostatic pressure in the wellbore is the use of lightweight drilling fluids, such as fresh water, diesel or lease crude, the primary problem with this approach is that hydrostatic pressure can not be reduced enough to remain underbalanced in many reservoirs**.**

Gas Injection Down Drillpipe:

With this technique**,** air or nitrogen is added to the drilling fluid and it is pumped directly down the drill pipe. Advantages of this technique include**:**

- Hydrostatic advantage gained over entire vertical depth**.**
- Wellbore does not have to be specifically designed for underbalanced condition,
- Less gas is required to achieve given pressure compared to parasite injection, and
- Penetration rate may be improved.

Disadvantages of this technique include:

(1) an overbalanced condition may occur if the well is shut down**.**

(2) exotic **MWD** systems are required.

Gas Injection Via Parasite String:

With this technique, a second pipe is run outside of the intermediate casing, advantages of this technique include:

- No operational differences,
- Constant bottom hole pressure is achieved, and
- Standard **Measured While Drilling(MWD)**equipment can be used.

Disadvantages of this technique include:

(1) additional costs are incurred.

(2) additional time is required.

(3) larger diameter surface casing is required.

The suitable case to use for the Iraq south oil fields may the use of secondary pipe to make a secondary annulus **(fig-)** with two phase drilling fluid like crud oil with water Or reservoir natural gas like what was being noticed on Majnoon field which the gas influx began to enter the drilling fluid system at depth **(90m)** and down**.**

UBD Requirement & Equipment :

The **UBD** requirement is begin with the first step "the planning" &the right choosing of the field to be use the **UBD** to develop it, the operations circumstances which must be taken in consideration is:

- The field to choose that if **UBD** may use will gain a significant economic benefits**.**
- The reservoir drive which constrain which drilling technique may be used to increase the production **(**determine the drive if it depletion drive or water flooded or gas drive**).**
- The amount of stimulation of the wells being used a conventional drilling from which other being used **UBD** , for both type how much the time & cost will be spend through over.
- The time &cost were spent of remedial the conventional drilling problems like differential sticking **,** **LC** problem
- The value of the field skin damage and the pressure decreases through the production life for the field drilled by conventional procedure , the skin damage factor **(S)** is determine by the equation below **:**

The maximum production without water or gas coning by Mayer& person procedure is extract by**:**

And all the two equation is for the vertical wells which the production restricted by the problems of coning in next future production life & in additional the perforation intervals which determine by the **HC** logs & the tope plus lower peck of the HC region, **i.e.:** determine the interval **(hc) ,** and this is the reason to drilling a horizontal reservoir section to eliminate this factor.

The basic requirement of UBD is:

1. Qualified drilling team with high efficiency.
2. Team management of work has good experience in the management and decision making operation without delay in leading the operations.
3. HSE team leading with strong drilling safety measurement.
4. High capability in moving and transportation.
5. Team one spirit working together.

And the UBD equipment requirement:

1. Pressurized separation equipment to working under pressure case during drilling operation by **UBD** like **4 phase** fluid separator.
2. Rolling bag preventer **(RBOP) .**
3. Rotating head **&** rotating diverter system.
4. Gas injection unit.
5. Secondary mud pumps in case of use the secondary annulus procedure.
6. Storage tanks to collect the multi fluid system being used.

By **UBD** technique , the permeability of the formations will keep as it original value &eliminate the skin damage cause by conventional over balanced drilling, additional benefits will gain by **UBD**; increase the penetration rate **(ROP)** by reduce the chip hold pressure which caused to decrease the **ROP** by prevent the rock cutting from take off from its original rock due to these pressure what was cause regrinding the cuttings by the bit and delay in drilling time operations, and as sequences in cost , more drilling bits, more pipe tripping.

Benefits Gain By Using UBD: there is many important benefits may gain by using the **UBD** technique, these benefits is **:**

1. Reduce the skin damage result by the invasion of drilling fluid solids particles which cause the skin damage lead to partial permeability losses ,these damage will cause additional pressure deplete , more time& cost expenditure for stimulation and next future of work over operations.
2. Increase the Rate Of Penetration **(ROP),** due to reduce the reason decrease the **ROP (** mainly by **chip hold pressure).**

3. Eliminate the differential sticking of pipes which may happen in conventional drilling due to differential drilling fluid density& formation and this reason will reduce the time& cost will spend for the pipes stuck remedial.

4. Eliminate the **LC** problems due to use low drilling fluids density and this will lead to reduce the cost **&** time for the remedial this problems in contrast with case of conventional drilling.

5. Capability of evaluation the well productivity during drilling operation, this case will make the earlier well production therefore this technique called **(Flow Control Drilling).**

6. This technique is useful on low pressure reservoir , may reduce the casing will run inside well .

7. Capability to use the **Measured While Drilling(MWD)&Logging Wile Drilling (LWD)** equipment when using **UBD.**

The UBD drilling fluids Designing & Selection:

The basic principles of **UBD** technique is to drill with hydrostatic drilling fluid column pressure below the formation pressure, one of the axiomatic of drilling fluid to be reduce its density is by add the light weight fluid to the drilling fluid such as crud oil Or diesel **,** whenever adds the crude oil to the drilling fluid will cause reducing of the drilling fluid **,** this fact is taken a place when using **UBD** due to being the fluid of **UBD** use must be low hydrostatic column forced toward the formation, when using like these type of fluid will make the drilling fluid type of multi phase fluid than single phase used in balanced drilling fluid in conventional drilling**,** the **UBD** fluid simply will consist of two phase type of fluid what was basically of water **&** crud oil or diesel **,** it may use the reservoir fluids **(** Crude Oil Or Gas **)** later when allow to the reservoir to flow as a part of production tests**.**

The selection of **UBD** fluids is difficult because to be set a fluid to be maintain the underbalanced condition at all operations line**,** however the selection may consist of at earlier case to be consist of water and crud oil**,** these case or the water polymer**&** gas may frequently noticed on **Majnoon fields, Nahr Bin Umr fields (North east Basra governorate),** it is a basement in drilling fluid mechanism that when it need to decrease the density**,** the procedure is to add either crude oil or diesel**,** or any lighter fluid**,** so when it need to drilling by a fluid its hydrostatic column pressure must be lower that the formation pressure it set the condition of **UBD,** it will be set up a drilling fluid of two material like water polymer **&** crud oil until it reach the density value of the **UBD**, these type of fluid is two phase fluid system, these type of fluid is nonlinear relationship**.**

The two phase drilling fluid it had several style of flow **(**Slug flow pattern**,** Wave flow**,** Dispersed bubble froth**,** Annular mist **),** because of the multi pattern regime flow of the multi phase drilling fluid**,** there is additional attention must give to control the **SPM,** pressure to maintain the **UBD** condition to keep the circulating pressure at **UBD** condition**,** to keep the **B**ore **H**ole **P**ressure **(BHP)**at steady values at all operations time**.**

The **UBD** doesn't require the Mud cake**&** Filtration, because these two mud feature that it need to in conventional drilling**, UBD** these two feature is forced to absent to allow the reservoir t flow or the fluid formation to flow and contribute the **UBD** drilling fluid which cause a significant reduction in drilling cost which may considered In reservoir flow for production tests**,** by using the **UBD** there is no needs to high viscosity or filtration to build the mud cake to give the stability to the well bore wall due to there is no pressure exert by the **UBD** drilling fluid toward the well wall**,** because of this feature the skin damage will be reduce or eliminate which when the skin damage caused by the invasion of solids particles when the solids forced to enter the formation pores and cause the skin damage**.**

The viscosity when it increased cause additional pressure which caused the **BHP** to increase, by **UBD** the viscosity is avoided for this reason**,** when the **UBD** drilling fluid by two phase or multiphase**,** the **BHP** will

depend on the percentage of each component either the liquid or crude oil if it is used two phase , or the gas percentage to increase when used multiphase **(** liquid **&** gas **).**

The two phase fluid **(** Water **&** Crud Oil **)** its pressure will depend on the percentage of each part**,** when start adds the crude oil the **BHP** begin to decrease, the adding of crude oil will continue until the **BHP** reach the value that make the **UBD** situation**,** this percentage value of each component will stopped at this point**, this point named the equilibrium point which consider the level that achieve the UBD condition& UBD BHP.**

The equilibrium point is the level that determine the percentage of the drilling individual fluid that contribute in **UBD** drilling fluid, and determine the injection rate of each individual to keep the individual at its percentage to maintain the underbalanced condition at all operation time, however the operations need to keep the **BHP** below the formation pressure, and to keep the main target of reservoir without skin damage**,** so to be maintain the viscosity at lower value to eliminate the additional pressure and its effects on **BHP.**

The concentration of each individual component of **UBD** drilling fluid is restrict the flow regime dominated on the circulation system **,** that will lead to monitoring the percentage of each to control the injection of each to keep the **UBD** condition, the actual operation led to that when percentage of any individual increase will gain a consequent result in form of unstable of **BHP** which may drive the operation to unstable bore hole pressure and at the same time well stability problems, the basic drilling fluid begin by adding the water to the bentonite in conventional drilling, here the **UBD** drilling fluid begin by adding the crud oil to the basic fluid of water, when the **UBD** begin the operation at the required hydrostatic column to exert the **BHP** of **UBD** by continue adding the crud oil the **BHP** begin to decrease as shown **in figure() ,** the decreasing in **BHP** will continue and the flow regime will start with steady state case until reaching to the equilibrium point then the flow regime will exchange to the friction dominated state **(**this is the two common case when each individual component of the **UBD** fluid at the desire concentrate to make the **UBD** condition **).**

The drilling fluid here may expose several flow regime depend on the basic fluid and the number of the phases will consist of**,** at the beginning **;**the circulation pressure **&** circulating rate depend on the desire **BHP** it need it to control the formation pressure the injection rate of each component must be maintain to keep **BHP** at the pint of achievement the desired **BHP** upon to obtain the **UBD** condition, however when it reached this point the flow regime will recognized on which individual component affect on the flow**& BHP** value**,** when adding the crud oil to the system the flow regime will begin with steady state flow with decreasing in **BHP** value until it reached to the equilibrium point after that, continue adding more crud oil the **BHP** will increase **&** the flow regime will change to friction dominated flow on annulus**.**

The viscosity of the fluid **&** filtration is unpreferable because of the viscosity problems which may cause the pressure loss increase as a result of increased the friction on the annulus consequently increase BHP**,** unpreferable filtration due to the solids invasion of the formation which cause the skin damage**,** when the **BHP** increased by the steady state dominated regime the injection rate of the crud oil need to be increase in case of using two phase fluid consist of water**&** crud oil **,** or need to be increase the gas injection rate in case multiphase fluid consist of water polymer **&** gas**,** the viscosity increasing even caused result in inefficient of separating fluid system on fluid system at surface**.**

The **BHP** requirement as the conventional drilling determined by the summation of the pressure losses on the circulation system**&** borehole **,** the calculation equation **(** 1 **)**as below **:**

$$BHP = P_h + P_f + P_a \quad \text{---------- (1)}$$

BHP : Bottom **H**ole **P**ressure

P_h : **h**ydrostatic **P**ressure

P_f : **f**riction **p**ressure losses

P_a : **a**nnulus **p**ressure losses

As in conventional drilling, the circulation pressure will be determined depend on this above equation but by **UBD** this pressure must be below the formation pressure at all time of drilling, and the pressure will be depend on the multiphase drilling fluid component sharing which the **BHP** is completely depend on, the multiphase fluid here is a nonlinear curve due to multi patterned flow which results in no **{ Equivalent Circulation Density(ECD)}**[i] case to be calculating when using **UBD**, the fluid may show a slug flow when there is a interruption in circulation fluid after the resumed circulation fluid is due to the connection, these interruption because of the fluid separation component during the stopped case for connection, however, the resumed circulation and try to return to **UBD** conditions will consume more time and instability of BHP until the fluid reached each component to its share distributed in fluid and get the underbalanced situation therefore the drilling fluid may shows the steady state flow regime apparently but the true flow regime is nonsteady state, especially when use the gas as third phase of fluid, the flow patterned will be more instability and more flow regime ; steady state flow to slug flow on friction dominated region to turbulent flow depending on the each component sharing in the system and its injection rate , the more important thing here is to use the reservoir fluid flow to support the fluid system which mean more reduction in cost, the gas injection in the fluid system will lead to restrict the other component injection rate depending on **Gas Liquid Ratio (GLR)** which result on **BHP** values to adjusting the component injection rate.

First Case History of Using UBD :

The first practically case of using UBD was used a multiphase phase drilling fluid consist of water& crud oil and injected gas downhole through dill string, the gas was Nitrogen **(N_2)** due to high point inflammable and this is the reason to use these kind of gases, the case being used on Weyburn field on Canada, the crud oil was **(38 API)** , the **(N_2)** injection was with crud oil at surface then to be inject through drill string, figure **()** shows that increase the **(N2)** injection rate decreased the **P_h** and increased **(GLR)**, the **figure ()** shows that the increase in **N2** injection rate will increase the (**GLR)** and decreased the hydrostatic pressure of the fluid column, which decreased the **BHP.**

There is a computer simulation of **UBD**, achieve during this simulation the **UBD** operations and condition then it was applied on the weyburn field, the basic fluid was of three phase **(water crud oil& N2 gas)**, these fluid system gave an minimum **BHP** value of about **(250psi)** which was kept the borehole **BHP** underbalanced, results in improved **ROP, BHP,** the **ROP** was **(375m) in (16hr)on Saudi Arabia** when used **UBD** on Saudi Arabia oil field in a formation where being known as a hard formation, like what is similar to some oil fields here like west qurna **(Tayarat and Tanuma& Khaseeb vuggy's Dolomite & Anhydrite formations known as hard and the ROP may reached to (6m/hr),which led to the hard formation deeper than sheranish (2000m and more)) is drilled of five days or more.**

The **figure ()** shows that increased gaS injection will reduce hydrostatic fluid column pressure accordingly with **BHP** until reach the equilibrium point**(Optimum Point)** because of increased in **(GLR),** consequently decrease **BHP,** when it begin the increase in crud oil injection rate, the **BHP** begin to decreased until reached the optimum point of its rate then the **BHP** start to increase , **Figure ()** shows this relationship between the injection of the gas and crud oil.

The figure **(2)** shows the different liquid rate of crud oil with the decreasing of BHP, but in each rate we noticed an increasing of BHP after the optimum point.

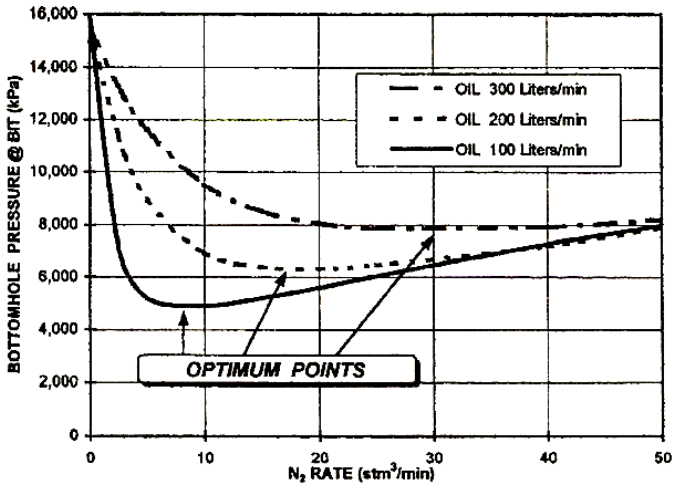

Figure No.(2)

It was noticed when start inject the N2 gas the BHP start to decrease until the optimum point at the same time the friction pressure losses start to increase specially after the optimum point as per figure No(3).

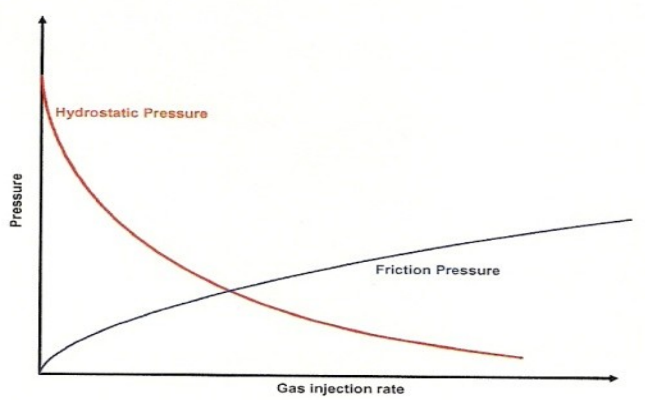

Figure No.(3)

It must be care in case of using gas to establish multiphase fluid, to be notice where the BHP affected by flow of dominated regime fluid to be set the optimum point to keep the drilling process in UBD situation, however the monitoring injection rates plus BHP value will give the UBD optimum hydraulics for bits , in additional the optimum **WOB(Weight On Bit) .**

Global Application Cases Of UBD :

The UBD was applied on several worldwide oil fields , one of the UBD applied case is on **Oman safah oil field**, the safah oil field is of type depleted reservoir, therefore the PDO Oman used the water flooding system to keep the production rate at the level of the expectation, the main pay reservoir on safah field is **Shuaibah carbonate layer (Limestone)** , the depth of reservoir is **(6500ft Or 2031m) with reservoir pressure (1300psi TO 1400psi OR 0.2 psi/ft gradient),** the reservoir was depleted too enough which made the PDO think to increase the production by drilling horizontal wells **{ the horizontal more effective procedure to increase the**

recovery due to increase the drainage flow(Figure No.()) when perforate the reservoir upon production law as below }.

$$PI = \frac{0.00708 * kh}{\mu B_o (\ln \frac{r_e}{r_w} - \frac{1}{2} + s)}$$

---------- (**2**)

K = reservoir permeability

h = reservoir thickness

u_o = reservoir fluid viscosity

B_o= reservoir Bulk Volume factor

r_e = drainage area radius

r_w = well radius

S = skin damage factor

The drainage area will increase and the restriction of the perforation interval will eliminated in horizontal wells which affect as in conventional drilling which the perforation restricted by an agent of water& gas conning expectation.

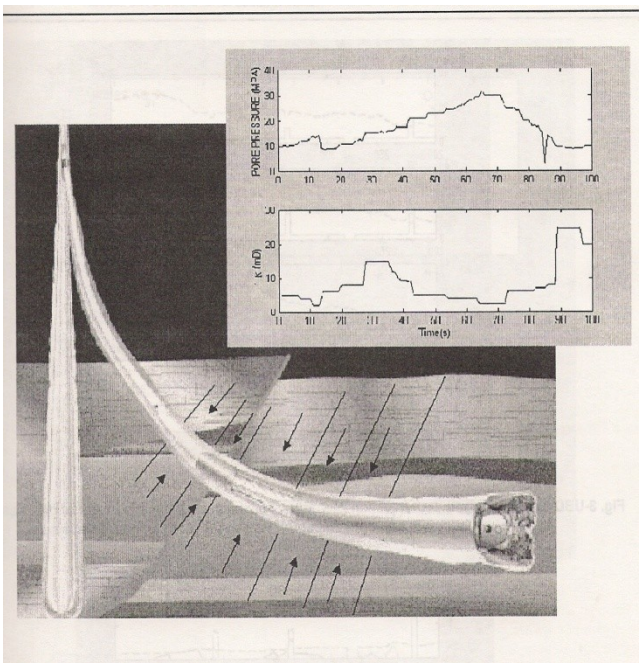

Figure No.(4)

The **PDO** authorities appealed to drill horizontal wells due to the reduction in crud daily rate, the team drilled two horizontal well **{ sfah(158) & safah(170) }**by the conventional drilling**(Overbalanced)** but with significant drilling problems such as pipe sticking & LC problems and they were stopped , so then the decision was taken to use the UBD technique , the production increased on **(safah 158 from 200 STB/day TO 800STB/day , the same increasing of safah 170 to 1500STB/day** after being closed due to drilling problems.

UBD Consideration :

There are several consideration must be taken during **UBD** operations as following **:**

1. **Well Stability :** On conventional drilling, the viscosity be established to be make a mud cake to improve the hole cleaning**&** reduce the filtration adjacent the well wall in high permeable zones, also the filtration to improve the formation cut off and give a stability to well wall , by **UBD** this factors will eliminate due to underbalanced condition due to increasing the pressure of BHP by high viscosity which will lead to reduce the skin damage, therefore it will be depend on the fluid velocity to achieve the hole cleaning by controlling the fluid **&** gas rate injection if the fluid is multiphase , or of crud oil if the drilling fluid of **UBD** is being consist of water **&** crud oil,the high pressure will lead to increase the fluid velocity consequently to stability of the well wall specially during the connection when the circulation is stopped, this instability will be clear when passing shale formation, therefore it must paid cure for fluid velocity to improve the hole cleaning &well stability .

2. **Hole cleaning :** As the fact that the using of multi phase drilling fluid by **UBD** , the hole cleaning will confused due to instable of the fluid viscosity , consequently the **BHP**, specially during the connection, the high viscosity value is unwillingness here due to be cause increase the BHP, at the same time the low viscosity will lead to poor hole cleaning efficiency , therefore it will depend by **UBD** to decrease the viscosity and improve the jet velocity to obtain the good efficiency of hole cleaning, which lead to depend on multiphase viscosity gradient by adjust the rate injection of the crud oil and the water base fluid, the multiphase fluid give a high apparent viscosity as the apparent viscosity depend on the fluid component rate , the multiphase fluid give a multi styles of flow as shown in **figure (5).**

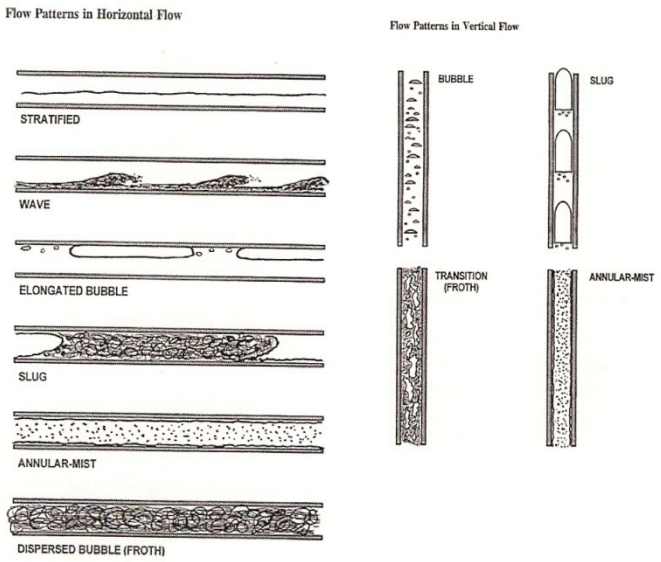

Figure (5) showing flow patterns

3. **Pipes Connection Operations :** The pipes connection is the most difficult situation when drill by **UBD** ,difficult to resume the flow pattern before the connection consequently a difficult to stabilized the ideal injection rate keeping the steady state flow to maintain the **BHP** at **UBD** conditions , difficult to establish again the before connection flow regime due to fluctuation of the fluid components to its origin base line, this will lead to spike fluid flow and slug state pattern after the circulation interruption due to connection, this eventually cause a differential BHP value which result in loss the **UBD** circumstances, therefore it must be paid an attention to reduced the connection time which result in reduce the fluid components to its base line and reduce the spike affection on **BHP**

   The spike case is result by fluid separation components will effect on **BH**P due to fluid acceleration to resume the circulation system, therefore when reduce connection time will reduce the affect of the spike due to reduce the amount of fluid separated for its base line and keep the fluid acceleration a little bit continuously which help to reduce the difficulties to resume the circulation and reduce the differentiated **BHP**, so on it is very helpful to using a secondary annulus and secondary circulation system to keep the circulation interruption at minimum effective case.

4. **Well Control :** The well control system and application is different from the practices in conventional drilling correspondingly with UBD conditions, in conventional drilling all the circulation system and fluid component is designed to prevent the formation fluid to enter the wellbore by main means the BOP stacks, here is different because the BHP is below the formation pressure so it will be allowing to the formation fluid to flow , this is what named of **UBD** is **(Flow Control Drilling)**, the fluid flow of the formation will share the circulation fluid system to reduce the cost of the UBD fluid components supplying by using the formation fluids to contribute the fluid system to establish the ,multiphase fluid and keep it to maintain the **UBD** conditions .

   Also the BOP's prevention is differ by using Rotating Head or Diverter system or Rotating **BOP** as it shown in Figure **(6)&(7).**

Figure (6) Rotating diverter System

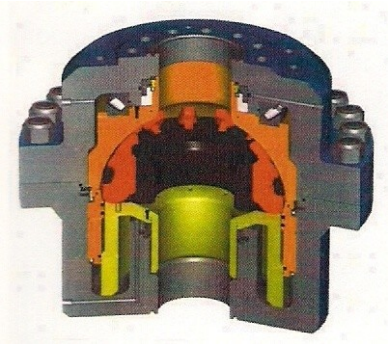

Figure (7) Rotating Head System

It being for the using of multiphase fluid system will be forced to use the four phase separator to maintain the fluid component and remove the solids and cuttings from the fluid.

The separator is consider a protective system in additional with security manifold system as a second protection line and all the equipment at surface like the storage tanks .

Weyburn Oil Field Drilled By UBD Case: it is common that **UBD** used to drill a horizontal wells to increase the oil recovery when it is difficult to do so on by vertical which depleted the reservoir, it had been used this technique to drill horizontal wells because of increased the drainage area and eliminated the water **&** gas conning restrictions in vertical wells which restrict the perforation intervals, on weyburn oil field on Canada , the production from this field was below of the expectations, when it was drilled and produced by vertical wells due to skin damage , neither from horizontal wells drilled by overbalanced, the field was discovered by fifty's decade with water drive producing, the field was under water flood pattern production, the produced reservoir is Mississippian formation **(Mississippian Charles Dolostone Formation)**, it consist of thin tapes of **dolomite interfered by marly sandstone** , the depth of reservoir is **(1450m)** and the thickness of it about **(375m),** average permeability about**(10 millidarcy)** , the **porosity is (28%) , average BHP is(1740 psi), the reservoir is vuggy as most of the dolomite common features(fractured) .**

By 1991 it was drilled a vertical well by overbalanced, the production was unexpected under the skin damage**&**water flooding patterns, so the decision was taken to drill a horizontal wells and complete the wells by conventional drilling **&** completion practices to knows how is the horizontal section may effect on the production rate either increased or decreased, the wells was drilled by conventional drilling using drilling fluid consist of polymer base perpendicular to the fractures direction , but the production rate was below the expectation by(1.5 times), they reasoned that to the solds skin damage because that the horizontal section was exposed for elongated time to the skin damage by fluid solids during the connection stopping time interruption of the circulation when there was needs good hole cleaning, that was the first stage to develop the field, late of 1992 the decision was taken to be drill several wells by UBD to try to increase the production, two of wells drilled perpendicular to the fracture direction which dominated the reservoir , and one parallel to these fractures, the length of the horizontal section is about (559m), setting the casing vertically, the production interval drilled bare foot(open hole), the **UBD** conditions was achieved by using (N2 gas)injection at rate (**30SCF/min)&**using the reservoir water to set a multiphase fluid at rate **(0.5 m^3/min),** the final production rate of crud was increased by **(93%)** more than the previous rate. The increasing production rate in horizontal wells is obtain due to increasing the drainage area and no restriction perforation interval as in vertical wells due to the avoiding the water**&** gas conning, and the peak of crud area which determined by the **logs(Induction Log , HC resistivity)**.

Economical Consideration By using UBD : several economical consideration will be setting by using UBD herby:

1. Increase the Production rates: it is an axiom that the whole oil industry is based on reducing the time and cost and increasing the production consequently the income, in the conventional drilling the production rate will affect by skin damage than the value expected as the field in his virginity , even the production power drive time will increased due to future workover operation< the residual in place will be something high level, bu using **UBD** these facts will eliminated which accelerate the production and its rate which lead to the production life and oil quantities recovery, figure **(8)** shown the production power drive by pressure with& without skin damage .

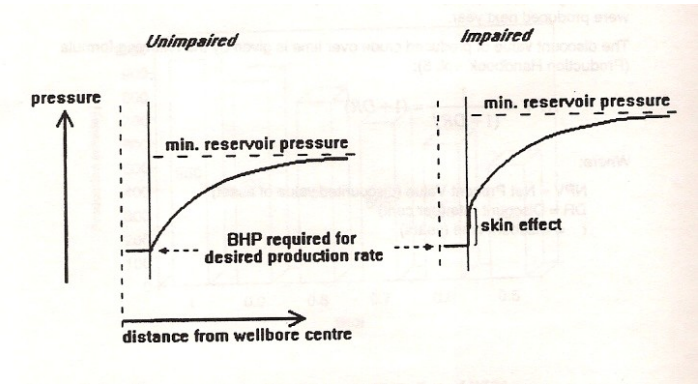

Figure (8) shown the different between with&without skin damage

Figure (9) shown the production rate and the well life time with conventional **&UBD** drilling **(next page) .**

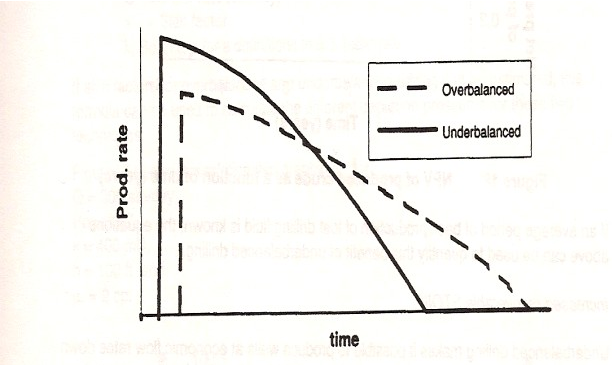

Figure (9)

2. Increasing **ROP (Rate Of Penetration):** the main reason of low penetration rate is the high fluid density which result on increasing chip hold pressure which effect on the cut off and rising the cuttings as soon as it cut of and removed by jets, by UBD this factor will be deleted and allow to the jets to remove the cuttings by jet**&**formation pressure when it allow to the formation to flow , maximum penetration rate is set by the equation **(3)**below**:**

$$\text{Max penetration rate (ft/hr)} = \frac{0.025 \times \text{flowrate (gpm)} \times 0.1337}{\left(\frac{\text{Bit size (inch)}}{12}\right)^2 \times \frac{\pi}{4}} \times 60$$

-- -- -(3)

It is noted by this equation there is affection agents such as bore diameter, hole cleaning by circulation rate to obtain of maximum penetration rate which will have no limitation by using **UBD.**

3. Completion : It is an important advantages by Using **UBD** to be complete the well drilled with **UBD** to complete at the same **UBD** conditions , if not all advantages will be no effects and the well will be under skin damage case.The overbalanced completion is result in skin damage when used the brine water fluid which will not removed the solids invasion during overbalanced drilling, it was laboratory experiments found by flooding a cypress sandstone sample by conventional overbalanced completion fluid that the sample loss over than (85%) of its origin permeability, by back flow using the completion fluid like HEC will recover about (45%) of the loss permeability of the sample , and that what cause a decreasing in production rate below of the rate expected , then will need more stimulatiom, more workover to keep the production& field drive at constant level until final oil recovery , **figure (10)** shown the destroyed permeability y solids when use conventional completion to complete the well.

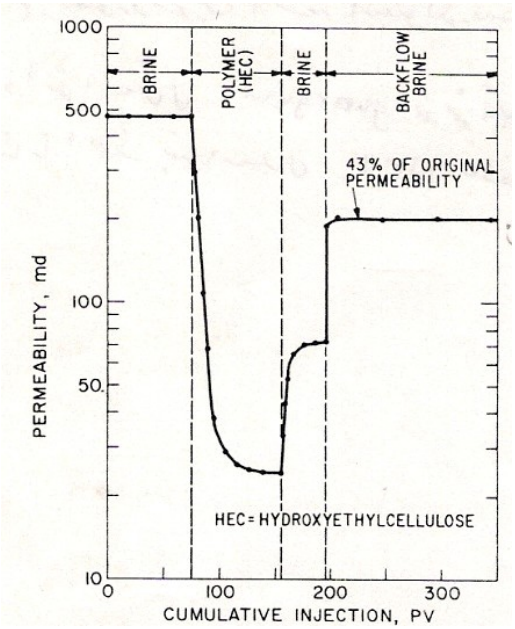

Figure (10) showing the loss permeability by conventional completion

The reduction in production rate is obtain by :

$$P_R = \frac{\ln(r_e/r_w)}{\ln(r_e/r_d) + \frac{k_f}{k_d}\ln(r_d/r_w)} \quad \text{----------(4)}$$

P_R = Reduction in Productivity **rd=Radius of damage zone**

kd= permeability of damage zone **kf= permeability of formation**

rw= radius of well **re= radius of drainage**

Therefore it is more important to design a perfect **UBD** completion and its fluid to keep the **UBD** advantages**.**

Capabilities Of UBD Implementation on Iraq Oil Fields :

Recently most of Iraq oil fields suffer by skin damage and reduction in both production &reservoir pressure, it may an important to see the matter if the using of UBD is solve this problems , specially most Iraqis southern oil fields composite is vuggy Dolomite& Anhydrite interfered by sloughing shale and two main layers had a drilling problems, the Dammam formation ,the formation is of Vuggy Dolomite which the problem of partial or completely loss of circulation is attended, and the Tayarat (Bituminous shale) which a problem is flow of sulphur water flow.

As the using of UBD will increasing daily cost with no compartment with the whole cost after gain the UBD advantages , as the daily cost will increased about (50%) of the conventional drilling cost if it being used gas injection to achieve the UBD conditions at first stage, however it will be set a cost reduction after gain the UBD advantages by increasing the production rate and reduce future time & cost of the stimulation and

workover needed , and the attractive production rate without skin damage, it will being there is a significant time reduction of drilling and the time spend on the drilling problems treatment like LC problems & pipes Sticking , it may be substitute the increasing daily cost by make the reservoir sharing the circulation system fluid &allow to the reservoir to produce the crud oil during the UBD drilling, by using UBD the number of wells required will be reduce related to the whole wells required to drill due to obtaining the production rate it may gain it with less well drilled than the conventional vertical development drilled wells .

Most Iraqis oil fields is produced from vuggy fractured carbonates reservoirs , sandstone formations reservoirs , after passing important drilling problems formations like Dammam, Tayarat, and shuaibah vuggy Dolomite sever completely LC .

As the lithology of the intended field , for the West Qurna for example, the lithology shown the formations and its depth, we have main drilling problem on it, the reservoir depth is at 2400m to 25550m , the reservoir is a limestone rocks porous &the porosity about 22% with average permeability about 74md , the thickness about 175m , the main pay part is range from 27m to 70m , the first problem is the partial or completely LC at depth (720m), and the sulphur water flow happened at (1620m), it is better to plan a drilling to be drill by UBD in some depths as well as to drill the problems depth with balanced or overbalanced practice, there is a chance to drill the formations from surface to inside of Dammam about 50m (to dpth 650m – 700m) to set the conductor CSG by conventional drilling when we need high viscosity fluid because of sand and gravel formations, it may be good practice to drill the under beneath by UBD to depth to the depth before the top of Tayarat formation at 1400m , then to set the surface CSG 13 3/8 at that depth , then to continue drilling by conventional to the top of mishrif formation to set the intermediate CSG 9 5/8" and then to continue drilling the mishrif reservoir by UBD to the funal depth o the production depth if the mishrif is the well target , or then to continue drilling by UBD to the final depth at 3450m the final depth of Zubair formation by UBD if the Zubair is the well target.

We will obtain by this practice a good & faster penetration to reach final depth of the reservoir with low skin damage level, then to complete the well by normal completion operations with polymer brine fluid completion due to the restricted capability of S.O.C. and no UBD equipment can be supplying .

The South Rumailah field its composite is the same of West Qurna with a little bit of differences in depth and the main reservoir is here the Zubair Sandstone formation with oil in mishrif, Nahr Umr ; Limestone,shaley limestone, sandstone respectively.

There are the same problems with same formation , above top of Dammam at (420m) is the lower faris shaly formation which shown a shale problems, and Dammam vuggy Dolomite with complete or partial LC, after Damam formation down to the end of mishrif (Limestone) the second f ormation oil staining, there is the second drilling problem zone the Tayarat (grey shale) of sulphur water flow case, it may better to be drill by overbalance to the top of mishrif , then to revert to be drill the down formation to the bottom of Zubair formation the final production formation (loss sandstone to be drill by UBD and its fluid(low solids polymer water base) .

Although there are another field can be planned as the above fields , the Safwan (Zubair main reservoir), for the most southern Iraqis oil fields , it may drill the several surface formations which contain a large quantities of unconsolidated sand &gravel by balanced hydrostatic column fluid pressure to gain several accelerated days, than the recent drilling days, eventhough the deeper formations which drilled past time

ago with more delay time due to the its hardness & overbalanced chip hold down pressure due to big value of fluid density to be controlled the Tayarat formation and reservoirs and prevent them to flow.

The casing programs will be change a little bit to be helpful to use the UBD , in the conventional drilling programs past time , the surface casing was set at depth top of Dammam(450m), the intermediate casing was set at depth (1850m)i.e.: top of Sa'adi formation, the production casing was set at dept (3450m), here with the proposed UBD program it can be as the requirement of UBD to be help the drilling days to gain additional days.

When drill the reservoirs by UBD , it may allow to the reservoir fluids to contribute the UBD fluids systems by use the reservoir flow fluid to be enter the system, it may controlled this fluid by using the manifold chock valve to be adjusted whenever need to reduces the hazardous of the reservoir fluid as the kick being controlled and removed out in driller method with each purpose of the two procedure control , the second one is to be use while drill the reservoir by UBD.

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The Author in Brief

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