Applicability of Downhole oil/water separation Technology in Jalo Field

Wanis Salem Abdala
Abdallah Mohamed Alshobaky

الملخص:

تم في الآونة الأخيرة تكثيف الدراسات من أجل تطوير تقنية الفصل تحت السطح داخل البئر وذلك لغرض التقليل من المياه المصاحبة للنفط المنتجة على السطح وكذلك التقليل من المشاكل والآثار البيئية، وتسمى هذه التقنية عملية فصل المياه عن النفط داخل البئر (Downhole oil–water separation (DOWS)) والتي تشمل فصل المياه عن النفط ثم حقن المياه في طبقات أخرى وضخ النفط مع نسبة من المياه إلى السطح، عن طريق هذه التقنية يمكن أيضاً التقليل من تكلفة استخراج المياه، وكذلك زيادة إنتاج النفط.

لاختبار هذه التقنية، تم تنفيذ العديد من التطبيقات التجريبية الفعلية على الآبار حول العالم مما ساهم في تقييم هذه التقنية و إمكانية تطبيقها.

بالإضافة إلى مراجعة وعرض بعض التطبيقات الناجحة لهذه التقنية حول العالم، تم في هذا البحث تقييم إمكانية تطبيق تقنية فصل المياه عن النفط تحت السطح على بعض آبار حقل جالو النفطي، وخلص البحث بنتائج و توصيات تحث الشركة المشغلة لهذا الحقل على الإسراع في تجريب تطبيق هذه التقنية على الحقل ولو في نطاق ضيق (ثلاثة آبار مثلاً).

Abstract

Recently, the technique of downhole separation to eliminate the amount of water that carried out to the surface and decrease the chance of surface impacts has been developed. This can be mentioned as downhole oil/water separation (DHOWS) technology. This technique separates water from oil in the wellbore. So, the water is injected into a different layer, and most of the oil with some water is lifted to the surface. This technique can also reduce associated water

handling costs and increase oil and gas production in the right application. Several trials have been applied to test the technology.
These trials gave good ideas on the feasibility of the DHOWS technology. The review summarizes some successful applications dealing with DHOWS technology. This paper reviews the applicability of Downhole oil/water separation techniquie in Jalo Field that is operated by Waha Company, Libya. The finding is recommending the Company that operating the field to start immediately implementing this techniquie in Jalo field; even in narrow range (like three wells). 1.

1. Introduction

In conventional oil production the oil and water are produced together as a combination to the surface and use the gravity and chemicals to separate them at the surface. As a reservoir matures, the associated water production will increase and a corresponding increase in lifting and disposal costs(John A. Veil, 1999).

The increased amount of water will add maintenance expenses for production and equipments and treatment for corrosion, bacteria, scale, and naturally occurring radioactive material (NORM).

Environmental regulations related to oil associated water are expected to become more stringent in the future necessitating new practices and techniques of managing produced water(Baton Rouge, 2000). Downhole oil-water separation (DHOWS) techniquie was studied in the 1990's and further work is conducted to assess its feasibility. Downhole oil/water separators (DOWS, also referred to as DHOWS) separate oil from water in the wellbore itself. DHOWS technique decreases the quantity of associated water that is handled at the surface by injecting it underground.

A DHOWS set includes many components, but the most important ones are an oil-water separation system and at least one pump to lift oil up to the surface and send the water to different layer(Lyle A. Johnson, 2001). Two types of DHOWS systems have been developed. One using hydrocyclones device to separate oil and water mechanically, and the other type is relying on the gravity difference that can be found in the well bore.

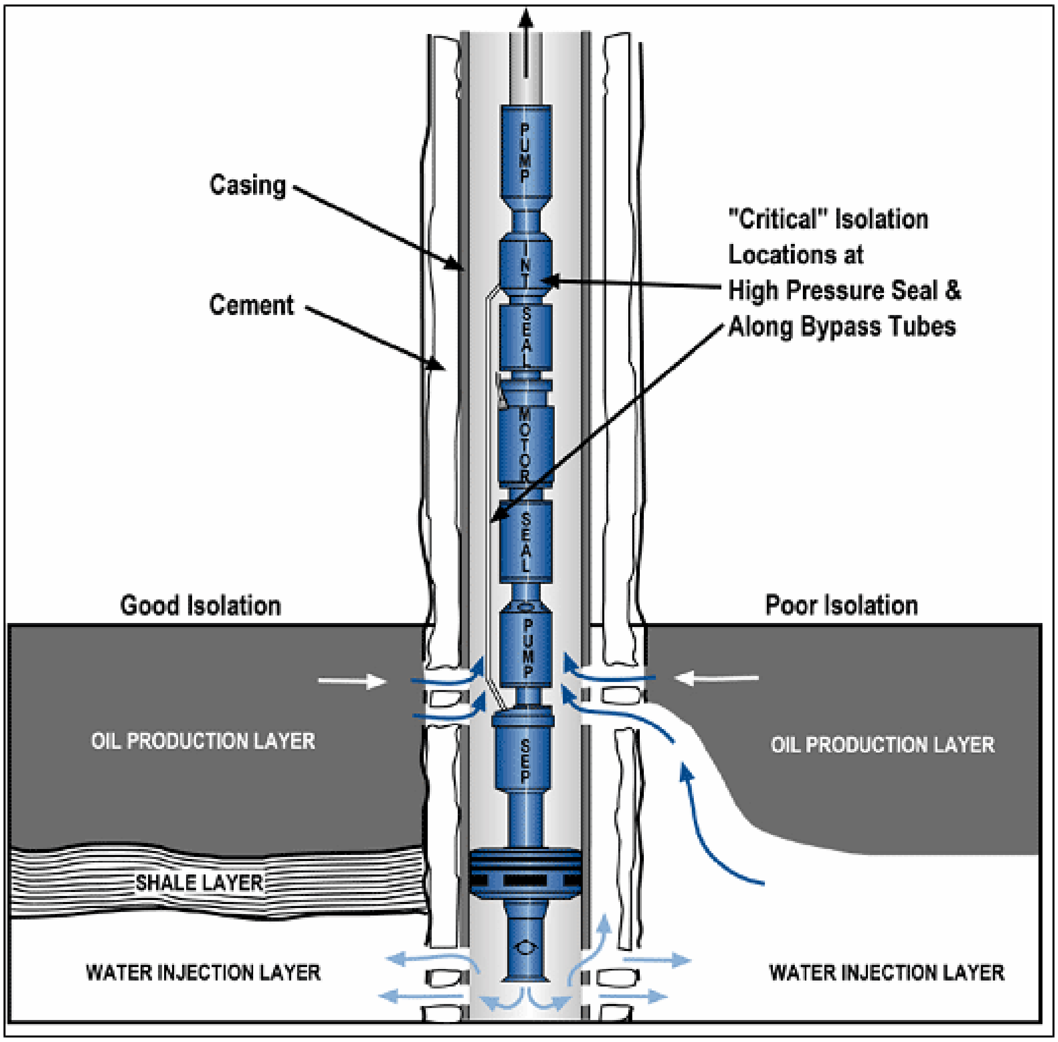

Figure (1). Downhole oil water separation system.

2. Downhole oil/water separators types

2.1 Hydrocyclone-type of DOWS:

Hydrocyclones use centrifugal force to separate fluids of different specific gravities without any moving parts. A mixture of oil and water enters the hydrocyclone at a high velocity from the side of a conical chamber. The subsequent swirling action causes the heavier water to move to the outside of the chamber and exit through one end, while the lighter oil remains in the interior of the chamber and exits through a second end. The water fraction, containing a low concentration of oil (typically less than 500 mg/L), can then be injected, and the oil fraction along with some water is pumped to the surface.

Hydrocyclone-type DOWS have been designed for vertical and horizontal wells with electric submersible pumps, progressing cavity pumps, gas lift pumps, and rod pumps.

2.2 Gravity separator-type of DOWS:

DOWS are designed to allow the oil droplets that enter the wellbore through the perforations to rise and form a discrete oil layer in the well. Most gravity separator tools are vertically oriented and have two intakes, one in the oil layer and the other in the water layer. This type of gravity separator-type DOWS uses rod pumps. As the sucker rods move up and down, the oil is lifted to the surface and the water is injected deeper. The downhole conditions allow for rapid separation of oil and water.

3. Examples for successful DOWS applications:

The following examples represents a Downhole oil water separation applications in Canadian and American oil fields, Table (1), Figure (2).

Table (1). Downhole oil water separation application.

Operator and WELL name	OIL		WATER		WATER CUT	
	Pre-Dhows	Post-Dhows	Pre-Dhows	Post-Dhows	Pre-Dhows	Post-Dhows
Imperial Redwater # 1-26	19	24	1780	59	99%	71%
Pinnacle-Alliance 7C2	44	100	380	95	90%	49%
Pinnacle-Alliance 06D	25	100	820	160	97%	62%
Pinnacle-Alliance 07C	38	37	1200	220	97%	86%
PanCanadian 00/02-09	13	164	428	239	97%	59%
Talisman Energy	6	39	629	21	99%	35%
Anderson 08-17	176	264	3648	264	95%	50%
Talisman Energy	113	277	2516	126	96%	31%
Chevron Fee 153X	45	32	1400	500	97%	94%
Wascana B7-27	76	0	2450	380	97%	100%
Talisman Energy	88	50	1700	189	95%	79%
Marathon Etah # 7	70	78	4000	320	98%	80%
Gulf Canada 02/12	21	117	1038	217	98%	65%
Tri-Link Res. Bender	35	35	976	227	97%	87%
TOTAL	769	1317	22965	3017	97%	68%

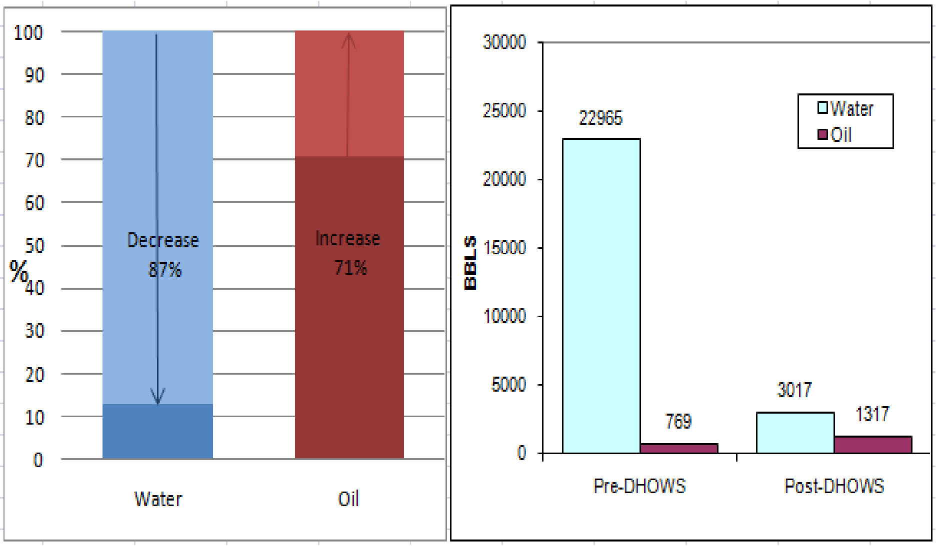

Figure (2). Downhole oil/water separation application.

4. Downhole oil/water separation threshold

The physical limitations of the liquid-liquid hydrocyclone separation process the minimum producing watercut required for efficient separation of the produced oil-water stream. In establishing a minimum 75% threshold watercut for consideration of DOWS application (single stage separation) in candidate wells producing from Jalo Eocene reservoir, and each of the following has been considered:

Expected hydrocyclone liners (and hence the velocity of flow through these liners);

A maximum allowable oil concentration of 500 ppm in the separator underflow (the water disposal/injection stream);

A well minimum liquid production rate of 1000BPD;

No known emulsion forming tendencies ;

The watercut of the hydrocyclone separation overflow, or the liquid produced to surface, it is assumed that a successful DOWS design will yield produced fluid with a 50 % watercut.

Staged DOWS (two stage separation) may be considered at a later date and should there be an interest in application for wells producing material water volumes at <75 % watercut. The watercut minimum could be decreased below the 75% threshold in the case of well with high liquid production rates.

5. Downhole oil/water separation Suitability for Jalo field:

It is provided that the field is uniformly depleted, to such a state that all remaining production will be derived at high watercuts, as it is understood, the reservoir drive mechanism is highly favorable for DOWS applications. Both the bottom and edge water drive contributions give some indications of two potential water disposal/injection options depending Of course on the suitability of other reservoir and well characteristics:

1. Into formerly oil producing sub-units that have watered out under the influence of the edge and bottom water drive;
2. Into reservoir sub-units which comprise a portion of the connected water aquifer responsible for the water influx.

In either cases, the within and near reservoir water disposal/injection will likely help to supplement the already strong natural water influx and resultant reservoir pressure.

6. Water disposal/injection zone potential:

Little is known about the stratigraphy/lithology of most of the intervals located above the Jalo Eocene limestone, or for that matter those immediately below (or considerably deeper in the case of the coskinolina). Although water disposal/injection into uphole zones is possible with an appropriately plumbed DOWS configuration, no further attempt was made to identify this type of candidate water disposal/injection zone.

In respect of intervals beneath the main reservoir interval (like the sub Basal and below), a lack of data made it difficult to assess the potential of these candidate zones. The only exception was the coskinolina interval which has been the subject of recent Waha efforts to evaluate the water disposal/injection of this zone.

7. Watercut Analysis

Having established a minimum threshold watercut, all that remain is to determine which of the candidate wells meet/exceed this threshold. With respect to the evaluation of the DOWS candidate wells, the following observations have been noted:

1. a field average watercut of 86% was measured, with individual wells watercut ranging from 12 to 97 %;

2. some 88.7% of the candidate wells have a producing watercut >75% and are considered as potential DOWS candidates (based solely on a minimum watercut threshold);
3. with an average field watercut of 86% and assuming a DOWS producing liquid watercut of 50% , ~84% of the produced water could be re-injected subsurface were DOWS application deemed suitable for all of the candidate wells.

8. Candidate wells ranking

By considering the weighting scheme in table (3), 18 wells can be a candidate wells for DOWS application.

Rather than isolate the top 5 DOWS candidate wells for further examination, it is advised to select 3 wells from the remaining inventory of 18 wells that to some extent were representative of the range of circumstances/well characteristics present in the entire well inventory. The wells selected are as follows:

1. E-001;
2. E-038;
3. E-095.

Table (3). Candidate ranking scheme of Category "A" wells.

Ranking characteristics	Weight (%)
Current water-cut	10.0
Wellbore size and geometry	25.0
Water injection zone potential	15.0
Inflow potential	20.0
Offset distance	15.0
Oil reserves	7.5
Well history	7.5

Source: Waha Oil Company – Planning Department.

9. Conclusion

1- From the results of many trial applications around the world, Downhole separation is good technology to study and invest in.

2-The downhole separation is much more beneficial than conventional surface separation as it saves the cost of water handling, water production and water treatment.

3- According to the downhole separation threshold and Jalo reservoir and wells characterizations, many wells in Jalo (Eocene) field can be a candidate cases for downhole oil water separation (DOWS) and good results is expected.

10. Recommendations

1- Geological considerations must be deeply studied due to the effect of reservoir layers connectivity on production and injection.

2- Staged DOWS (two stage separation) may be considered at a later date, and should there be an interest in application for wells producing material water volumes at <75 % watercut. The watercut minimum could be decreased below the 75% threshold in the case of well with high liquid production rates.

3- Extend this study to consider downhole separation unit design (type, liquid capacity, …etc)

11. References

1- Baton Rouge, LA. (March 2000). Solutions from the field, Downhole water separation technologies, PTTC's central gulf region

2- Waha ompany. (March 2000). Downhole oil/water separation (DHOWS) Feasibility study. Final report, PanCanadian Energy Corporation.

3- John A. Veil. (January 1999). Argonne national Laboratory, Bruce G. Langhus, CH2M Hill, Stan Belieu – Nebraska oil and gas conservation commission. Feasibility evaluation of Downhole oil/water separator (DOWS) technology.

4- Waha Oil Company. (2002). Reservoir Engineering study, Gialo reservoir, Volume 1&2.

5- Lyle A. Johnson jr. (July 2001). Production well water shut-off treatment in a highly fractured sandstone reservoir, final report.

6- A. E. Blanco and D. R. Davies. (March, 2001).Technical & Economic Application Guidelines for Downhole Oil-Water Separation Technology, SPE Paper 67182 Production and operation Symposium Oklahoma 24-27.

7- Alhanati, F., T. Zahacy, and B. Peachey. (June 2002). Sharing the Risk in DHOWS Technology Development, presented at a meeting of the International Downhole Processing Group, Milan, Italy.

8- T. Kjos, A.S., S. Sangesland, J.F. Michelet and J. Kleppe. (1995). Down-Hole Water-Oil Separation and Water Reinjection through Well Branches, Presented at the SPE Annual Meeting held in Dallas.
9- Carlos Gomez, Juan Caldentey, Shoubo Wang, Luis Gomez, Ram Mohan and Ovadia Shoham. (30 Sept. 2001). Oil-Water Separation in Liquid-Liquid Hydro-cyclones, Experiment and Modeling, SPE Paper 71538, presented Annual Conf.