APPLYING BI-LATERAL DRILLING FOR MAXIMIZING CRUDE OIL RESERVE

By : Hesham A.M. Abdou & M.Y.Bayoumi - Agiba Petroleum Company - Egypt

1. SUMMARY

Agiba is a joint venture company established between EGPC and IEOC and works in the exploration and production fields in Egypt on behalf of EGPC and IEOC, first ship of crude oil production delivered from Meleiha field to El-Hamra terminal (fig.1) in November 1986. By this date Agiba expanded its exploration activity and many areas were discovered such as: Ashrafi in Zeit Bay gulf of suez, each of Ras El-Hekma, Aghar, Zarif, El-Raml and El-Faras fields located in Western Desert. Present average daily production is ± 49 Mbopd and ± 30 MMSCFD of gas.

This paper presents Agiba experience in maximizing crude oil reserve by promotion a conventional way for exploration heavy oil in upper Bahariya formation interval and producing it from two lateral drain holes commingled with the light oil production from lower Bahariya interval exists in the vertical section of the well-bore.
Also, this paper presents reasons for selecting this way for enhancing heavy oil except other common ways, in addition to drilling and completion works aiming to put the subject well on production stream.

2. INTRODUCTION

Aghar field is located in Western Desert north Qattara depression, its average daily production rate is ± 5000 bopd produced from nine wells all equipped with different artificial lifting systems distributed as; ESP (four wells), sucker rod pumping system (two wells), PCP (two wells) and jet pumping system (one well). Some wells in this field produce heavy crude oils (± 15 ^{o}API) such as the multi-lateral well (AGH-8). The main objective of this completion is to develop the heavy oil reserves and produce it commingled with light oil.
This was realized by drilling the well multi laterally in the heavy oil interval and vertically in the light oil interval, the benefit obtained from drilling the well in these two ways is to minimize the risk of exploration for heavy oil
As AGH-8 is the first drilled well multi laterally in Egypt, there was fear of drilling the lateral hole in the direction of very thin sand layers with reservoir heterogeneity specially

3. WELL GEOLOGY, LOCATION AND RESERVOIR DATA

The well is located in west Razzak concession 270 meters south west of well (AGH-5) and 460 meters north east of well (AGH-6) as shown in (fig.2), upper Bahariya formation contains heavy oil and lower Bahariya contains light oil. The down hole logs showed that values of (h, ϕ, S_w) for upper and lower Bahariya intervals respectively are (5, 28, 18) and (18, 26, 12). RFT was performed in June 1998 (fig.3) and indicated that reservoir pressure is 2250 psi at 5000' SSL

4. DIFFERENT METHODS FOR ENHANCING HEAVY CRUDE OIL

Heavy crude oil is enhanced using either one of the following steam injection methods:

Steam flooding:

Where steam is injected continuously into the injectors, in this method reservoir temperature ranges from 200-300 ^{o} F. Steam generators with facilities are constructed and the process is continued, the steam generator uses either natural gas or oil to fire the generator and filtered water is used. Producing wells are completed using gravel packed and slotted liners

Cyclic steam injection:

Where steam is injected to heat up the well bore. This process is repeated at some future time depending upon the amount of steam that was injected previously. This method gets well bore temperature up to 500 ^{o}F, portable steam generators are used, producing wells are gravel packed and

slotted liners. Estimated cost for steam injection method is $ 9.5 / bbl. So, these methods were not taken into considerations while deciding enhancing recovery method because of their high cost

5. DISCUSSION OTHER POSSIBLE METHODS FOR ENHANCING HEAVY CRUDE OIL IN WELL AGH-8

The two methods may be applied to open windows in the heavy oil interval are:
- Hydraulic fracturing
- Bi-lateral drilling

The Bi-lateral method was suggested to be applied due to its low cost (1$ per barrel) if compared with that of hydraulic fracturing (7.6 $ per barrel), this method opened a window in the interval of heavy crude oil to produce the heavy oil with the aid of light crude oil produced from the lower interval, using such method achieved two purposes :

- Reduction of cost per barrel down to the minimum figure
- Increasing the formation capacity (Kh), subsequently increasing communication between formation and well-bore in the interval of heavy crude oil to ease its enhancing

6. DRILLING WORK PROGRAM

- Drilled and completed 8 1/2" hole using 7" casing, L-80 & 23 IB/FT run to a total depth 6293'
- Using hydro-mechanical whipback whipstock opened first window inside 7" at depth from 5410' to 5423',
  kick-off the well at depth 5422' with an average inclination angle 22^{o}/100 ft to the end curve at 5899' MD (5700' TVD)
- Drilled 6" horizontal hole of length 581' to 6480' MD with a developed angle 85.2^{o} at the end
- 3 1/2" tubing, 9.2 IB/FT from the depth of 5507' to 6480' was run and dropped inside lateral hole using mechanical tubing release sub, the interval (5904-6480') as slotted tubing section .
- Unset hydro mechanical whipback whipstock and pull out of hole
- Run in hole with the second whipback whipstock to open second upper window from 5330' to 5343'
- Started kick off the well at depth 5343' with an average inclination angle 25^{o}/100 ft to the end of curve at 5772' MD (5588' TVD)
- Drilled 6" horizontal hole (5772'-6372') of length 600' to 5588' with a developed angle 91.2^{o} at the end
- 3 1/2" tubing, 9.2 IB/FT was run and dropped inside hole using mechanical tubing release sub from the depth (5409' to 6370'), the interval (5708'-6370') as slotted tubing section
- Unset hydro mechanical whipback whipstock and pulled out of hole

Fig.(4) is a sketch for the above implemented work.

7. WELL COMPLETION

The well was completed selectively with two packers (fig.5) to produce selectively either from light oil interval drilled vertically (under the lower packer) and / or produce from the Bi-lateral interval of heavy oil between the two packers.

8. WELL TESTING RESULTS

Productivity of the lateral interval checked by running a jet pump in the slide side door above the upper packer. To unload heavy oil and a plug was put in the F-nipple to isolate the vertical interval. Lower Bahariya it was tested at 2900 bopd before running jet pump, while upper Bahariya was tested at 160 bopd

9. CONCLUSIONS:

- Application of Bi-lateral drilling helped in increasing mobility to produce heavy oil which could not produced before

- Drilling of this well has increased the reserves more than preliminary estimated (lower Bahariya and upper Bahariya Bi-laterals) .
- By applying the Bi-lateral method in drilling well AGH-8, added new developed reserves that having heavy oil in addition to the light oil produced from another interval in the same well
- The multi-lateral technique is a good technical and economical approach for the development of heavy oil

10. NOMENCLATURES:

ϕ	:	Prosity
S_w	:	Water saturation
h	:	Net pay thickness, feet
K	:	Perneability, Darcy
MD	:	Measured depth
TVD	:	True Vertical Depth
IB/FT	:	Nominal weight, pound per foot
RFT	:	Repeat Formation Tester
SSL	:	Sub Sea Level

11. ACKNOLEDGEMENT:

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12. SI METRIC CONVERSION FACTORS

ft x 3.048•	E-01	= m
bbl x 5.615	E+00	= ft^3
141.5 / (131.5+^{o}API)		= g/cm^3
(^{o}F-32) / 1.8		= ^{o}C

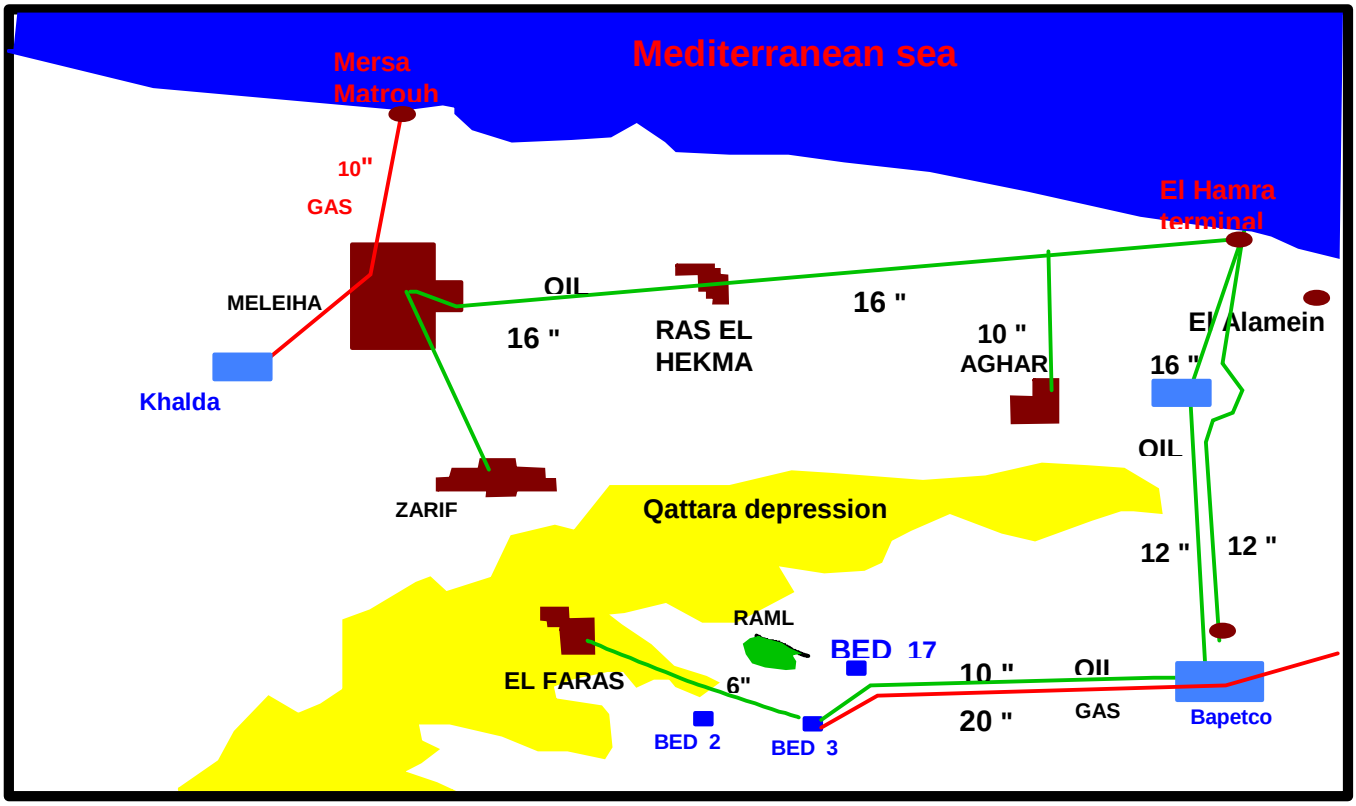


Fig.1 Fields location map

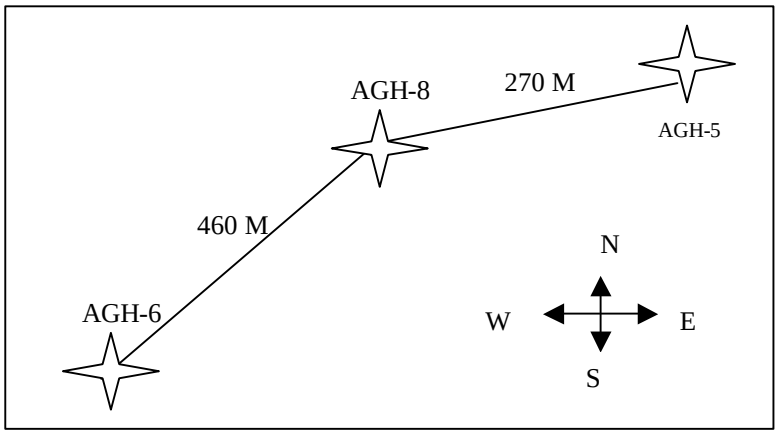


Fig.2 Well location sketch

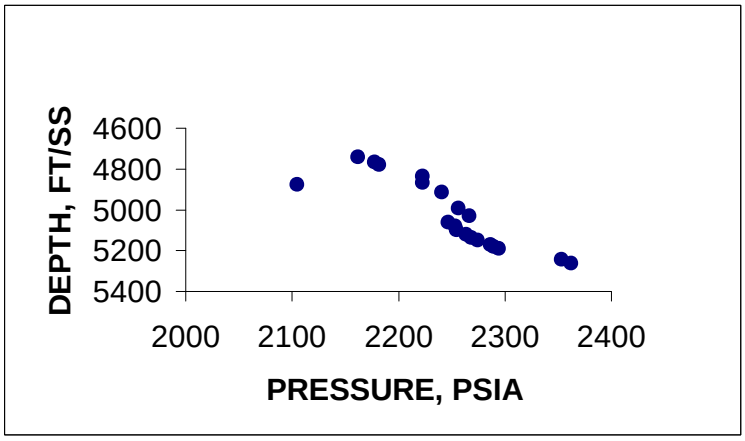


Fig.3 RFT of Well AGH-8

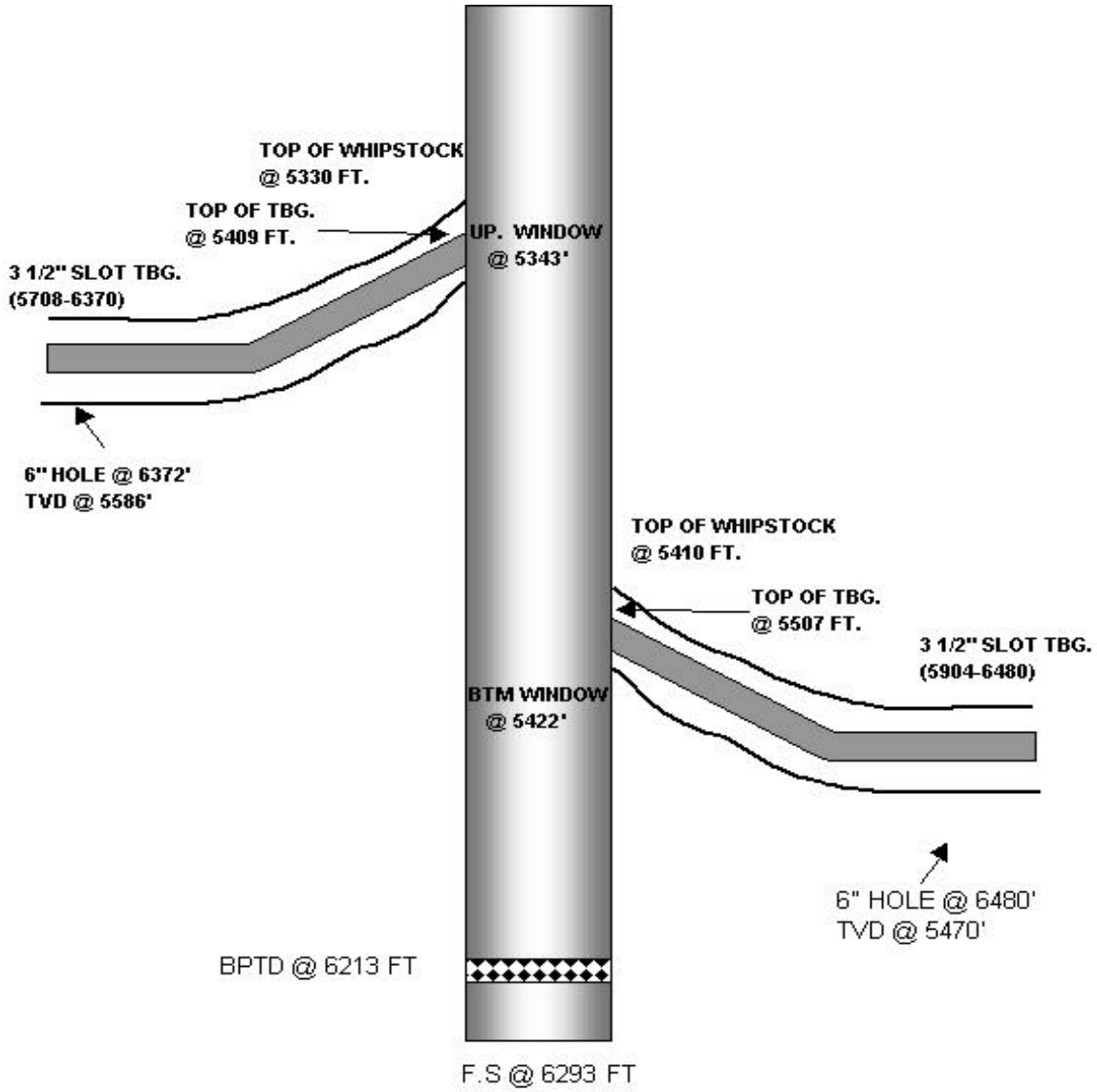
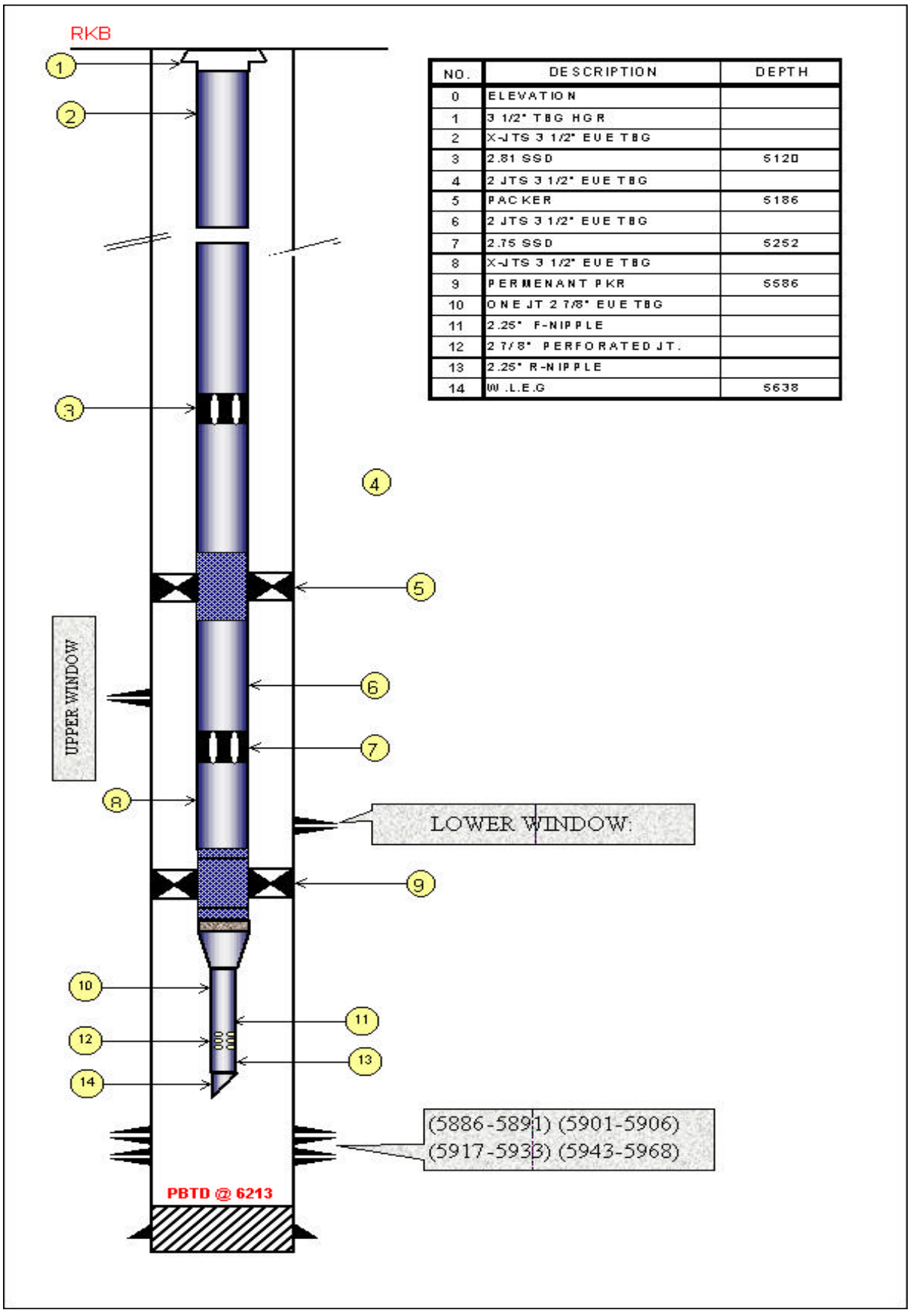


Fig.4 Well-bore sketch of well AGH-8



NO.	DESCRIPTION	DEPTH
0	ELEVATION	
1	3 1/2" TBG HGR	
2	X-JTS 3 1/2" EUE TBG	
3	2.81 SSD	5120
4	2 JTS 3 1/2" EUE TBG	
5	PACKER	5186
6	2 JTS 3 1/2" EUE TBG	
7	2.75 SSD	5252
8	X-JTS 3 1/2" EUE TBG	
9	PERMENANT PKR	5586
10	ONE JT 2 7/8" EUE TBG	
11	2.25" F-NIPPLE	
12	2 7/8" PERFORATED JT.	
13	2.25" R-NIPPLE	
14	W .L.E.G	5638

Fig.5 Well AGH-8 completion sketch