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Review Article

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Heavy Oil in Iraq: Review

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Abstract Iraqi heavy and extra heavy oils are estimated at 66.9 billion barrels in place but their reserves are 13.3 billion barrels. It essentially occurs in three regions of Iraq in 45 oil fields. The heavy and extra heavy oil in Iraq is substantial presently because of the worldwide technology enhancements in the last 10 years with relative to enhanced oil recovery (EOR). There are two main problems relating production and processing of heavy oils, they are high cost and environmental contests. Iraq's heavy oil can be appointed comparatively simple. It costs about US$10 per barrel to produce oil in Iraq, as against US$30-40 in countries such as Canada. Iraq is one of the top countries in the world on carbon production. Produced CO_2 from power plants might be used for gas injection projects for production of heavy oil in Iraq.

Keywords Heavy oil, Unconventional oil, Seepage, Iraq, Iraqi Law

1. Introduction

Heavy oil is liquid petroleum with API gravity of 10-20°or highly-viscous oil > 200 centipoise (cP) like honey at normal reservoir conditions. Oils with API gravity less than 10° are called extra heavy oils. Oil sands or oil shale, tar, and bitumen are categorized as extra heavy oil with a viscosity of > million cP. Both heavy and extra heavy oils are also called unconventional oil.

Heavy oil was used by the Elamites, Chaldeans, Akkadians, and Sumerians who quarried deposits of asphalt, or bitumen, for their identifiable need long time ago [1]. The roads of Baghdad were paved with tar in the 8th century. Although the Iraqi petroleum industry was recognized 14 centuries ago [2] but the role of heavy oil economically is still not satisfactory.

Thus, this study is trying to investigate obstacles that facing mining, producing, and manufacturing the heavy oil in Iraq.

2. Reputation of Heavy Oil Developments

The world has seen peak oil production from conventional oil reserves and the worldwide crude oil reserves from conventional petroleum systems has started to decrease. The global oil demand for oil remains to increase, in 2003 reached 80 million barrels a day (MMb/d) [3], in 2015 reached 98 MMb/d after strong global demand growth at 1.6 MMb/d, and expects to be 1.2 MMb/d in 2017 [4]. Heavy oil resources in the Middle East in general and in Iraq as well have been seriously miscalculated. Therefore, calculating and determining the amount and knowing the property of heavy oil will help to produce it economically and avoid shortage in energy supplies.

Oil prices stretched US$147 in July 2008 and decreased to US$34 succeeding the economic depression in 2009. Currently the crude price is about US$55. At the present oil price of more than US$50, production and processing of heavy oil is profitable. Heavy oil reserves are huge in Iraq and the cost of manufacture from these sources is about $10 per barrel, well under $30-40 production cost from Alberta oil shale [5].

3. Reserves and Occurrence

Iraqi heavy and extra heavy oils are estimated at 66.9 billion barrels in place but their reserves are 13.3 billion barrels. Insufficient heavy oil reserves were invested. Heavy oil essentially occurs in three regions of Iraq in 45 oil fields. The heavy oil fields are in: 24 oil fields in the northern part (Table 1); 5 oil fields in the central part; and 16 oil fields in the southern part of Iraq with API gravity: 12-22; 16-23; and 11-23 degrees, respectfully [6].

Table 1: Northern Iraqi heavy oil [6-7].

Oil field	Oil in place MM barrels	Oil reserves MM barrels	API	Sulfur wt. %
Qaiyarah	5423	813	16	7.3
Qasab	2318	347	17	6.7
Jawan	6716	1007	17	6
Najmah	5718	858	17	7.6
Makhmur	1263	189	12.7	6
Benenan	2000	70	10	6.8
Total	23438	3284		

4. Geological Setting of the Area

The heavy oils in the Cretaceous and Tertiary paleo reservoirs or as a seepages within these rock units in the area were originated from Jurassic argillaceous and carbonate source rocks, which accumulated in basins and were preserved under reducing environments [8]. Maturation, migration and accumulation have started since the late Cretaceous in different portions of the area; nevertheless, Upper Cretaceous and Tertiary sediments are still immature [9].

Reservoirs range in age from Cretaceous to Miocene. Paleozoic petroleum systems are known to exist possibly in parts of northwestern Iraq [10] and in the west as well [11]. Carbonates and sandstones are well characterized as reservoir rocks. Sandstones are generally more dominant as reservoirs outside the main part of the Zagros domain, while carbonates are substantial in the central portions of the Zagros. Miocene, Oligocene, and Eocene are most likely to be prolific southwest of the mountain front, where the Miocene evaporite (seal) is conserved [12].

Almost all the deposits of heavy oils are products of degraded conventional oils. Degradation arises when oil migrates on the way to the surface. The water of atmospheric origin, rainwater, containing oxygen and bacteria at temperatures below 93 °C reacts with migrated oil and degrades oil. Another process called “water washing” eliminates the more water-soluble small molecular hydrocarbons, mainly the aromatics. Heavy hydrocarbon denotes no more than 10 percent of the original conventional oil.

5. Oil Seepages

Seepages occur commonly in the area. Their ample connected to the existent of plate boundaries, African, Iranian, and Turkey plates [13]. Numerous oil and gas seepages are occur, either in the limestone or thoroughly allied with the main producing formation. Active seepages of oil and gas are found throughout the region.

6. Examples for Heavy Oil Fields

6.1. Qaiyarah Oil Field

The field (Fig. 1) discovered in 1928 by British Oilfield Development. The 800 million barrel Qayarah Field has 86 wells. Not yet refinable. Used for asphalt and other heavy residues [14]. The oil occurs 200 meters underground, is one of three anticlinal structures in the same fold-axis (Figs. 2, and 4) south of Mosul with latitude: 35° 48' 1" N and longitude: 43° 17' 23" E. The other two are Najmah and Qassab. All three comprise huge accumulations of highly sulfur content (6.5-8 wt. %) and low API gravity (11-18) degrees within Lower Miocene “Jeribe/Euphrates” limestone and in the Upper Cretaceous “Hartha” limestone (16-18 ºAPI). Qaiyarah heavy oil has high viscosity (659 centistockes at 20° C), high nitrogen content (0.23 wt. %), and high metals (Ni and V) content, 155 ppm [15]. German and Turkish engineers mined up to 240 barrels of oil a day from this area throughout World War I [16].

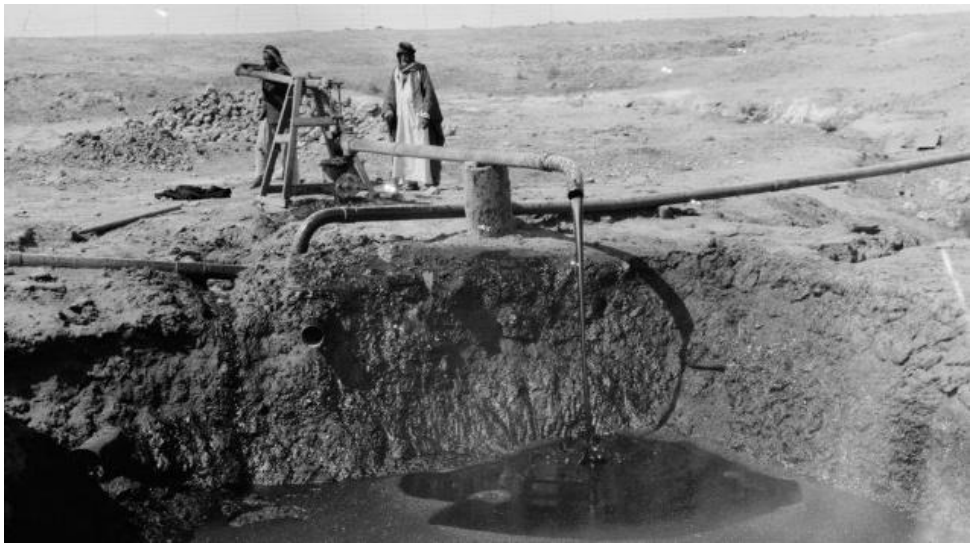

Figure 1: Qaiyarah, where original bitumen wells operated (Morton, 2017)

6.2. Najmah Oil Field

The Najmah Oil Field (Fig. 2) is located in Nineveh Provenance with latitude: 36°00'00" and longitude: 43°13'0.02", 50 km south of Mosul City (Fig. 3). Founded in 1934, the field is 11 km long and 4.5 km wide. The estimate terrain elevation above sea level is 241 meters. The Najmah Oil Field is an anticlinal structure trending NW-SE. Important accumulations (oil reserves is 807 million barrels) of heavy oil (15 to 20 °API) have been founded in the Miocene Jeribe/Euphrates formations and the Upper Cretaceous Hartha Formation (Fig. 4). The oil field has 33 wells [17].

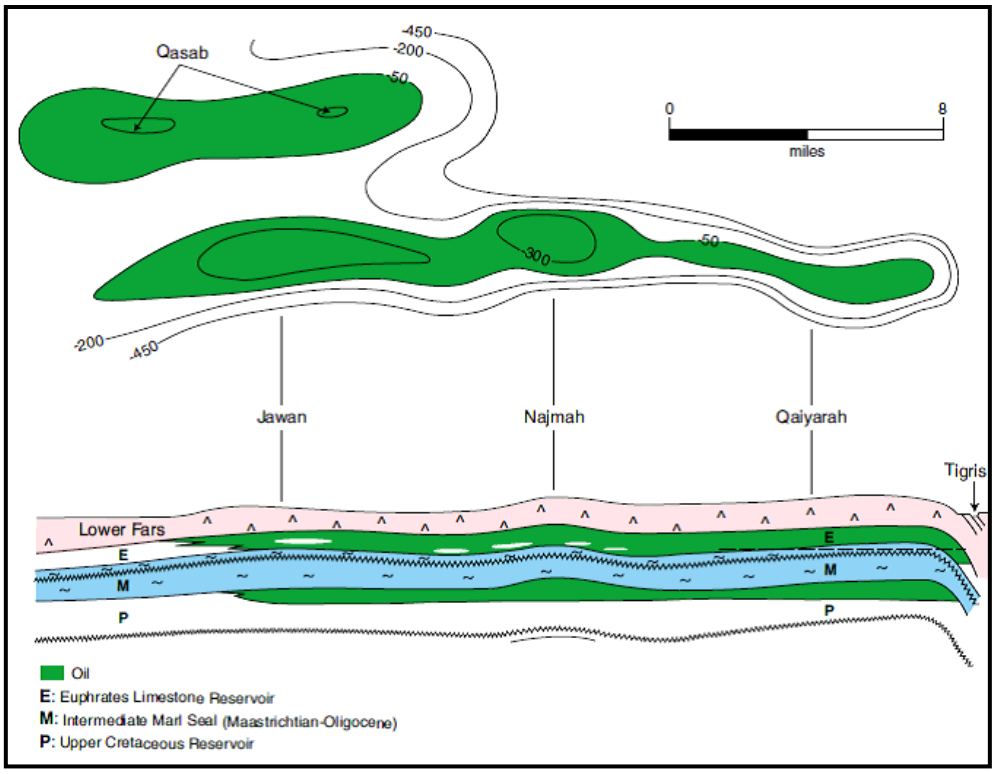

Figure 2: Schematic map and cross section of the fields, showing tilted oil-water contacts (Dunnington, 2005)

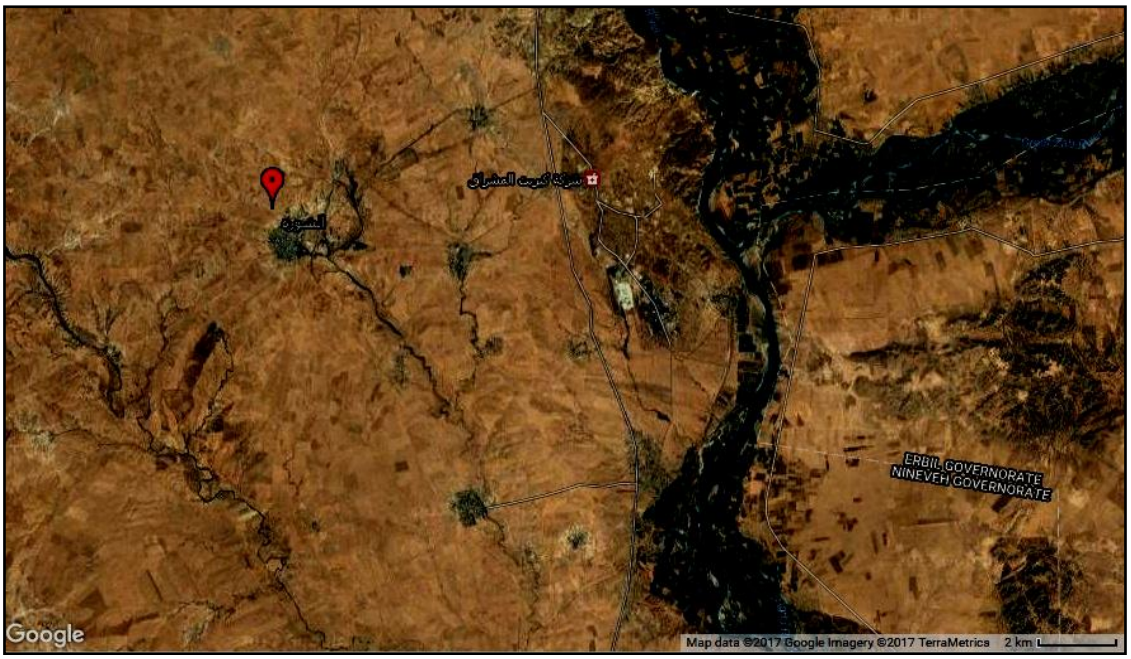

Figure 3: The satellite image showing the location of Najmah Oil Field

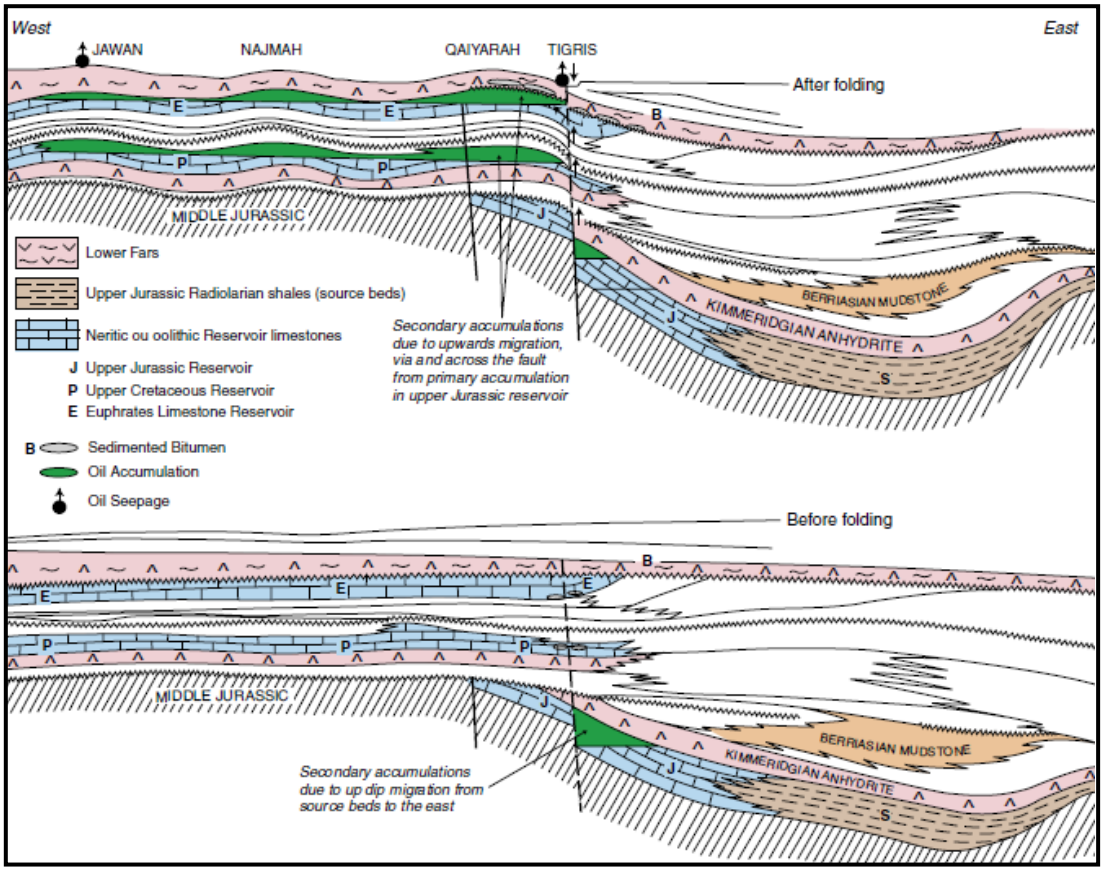

Figure 4: Representative cross sections showing a model of oil accumulation, Qaiyarah Area [18].

6.3. Tawki Oil Seep

Oil is flowing to the surface in several seeps; one of numerous oil seepages is in an area close to the 1st well being drilled with latitude: 37° 8' 8.9" and longitude: 42° 47' 52.7" (Fig. 5). The local residents has for generations used oil from these oil seepages for domestic necessities. The moderately mature oil seeps at surface within the Tawki area are correlated well in nature to oils connected with the Sargelu source rock [8].

Figure 5: Oil seep in Tawki near Tawki-1 Well

6.4. Benenan Oil Field

Extensive reserve potential in surplus of two billion barrels of oil-in-place at Benenan Heavy Oil Field (Fig. 6) in Erbil is exist (latitude: 36° 23' 59.1" and longitude: 43° 42' 46.3"). The field has several wells such as Hawler-1, Erbil-2, Benenan-3, and Benenan-4. The oil occurs within Upper Jurassic Najmah Formation (2010 m underground). An appraisal of commercialization of the field is ongoing [19].

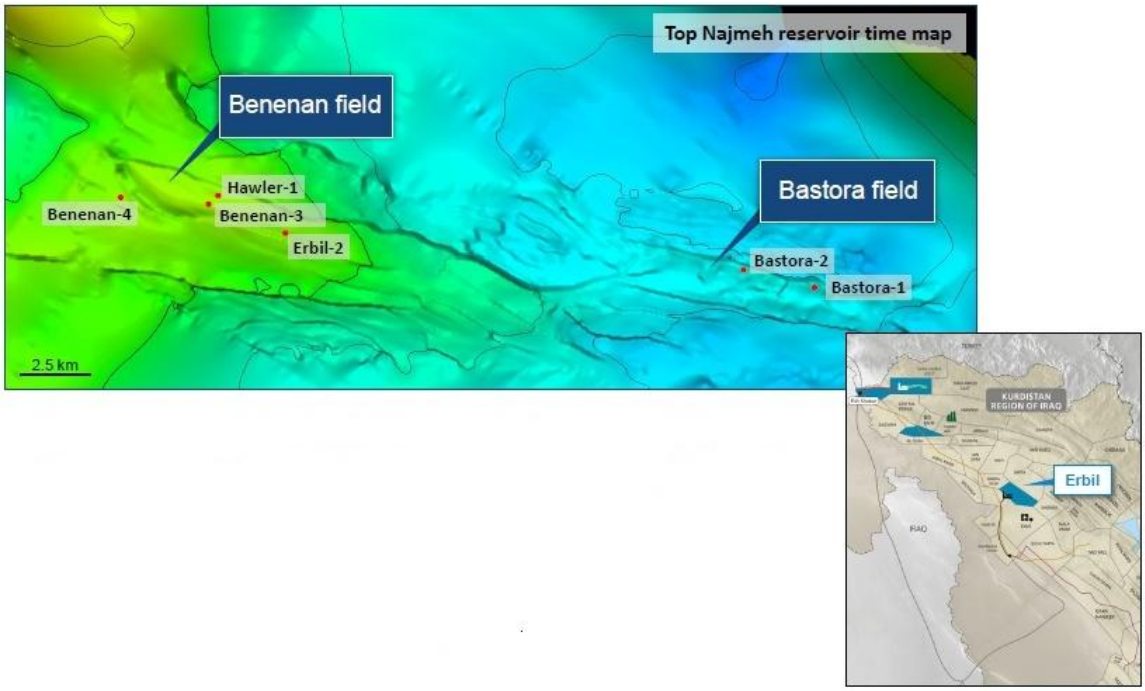

Figure 5: Top Najmah reservoir time map [20].

7. Iraqi Heavy Oil Production Cost Properties

More than a third of Iraq's oil lies in wells that are just 600 meters from the surface. They can be tapped relatively easily. It costs about US$10 per barrel to produce heavy oil in Iraq, as against US$30-40 in countries such as Canada [5, 21].

Moreover, industry leading finding and development cost of US$1.8 per bbl for Tawke field and 2014 average lifting cost in Kurdistan of only US$3.1 per bbl [20].

8. Iraqi Heavy Oil Properties

The northern Iraqi heavy oil has an API that ranges from 12.7 to 17 degrees and sulfur wt. % ranges between 6 and 7.6 (Table 1).

9. Production

Heavy oil has high viscosity therefore it is necessary to be faced to separation process and to blend process. To make heavy oil marketable, some procedures are needed such as vis-breaking, coking, thermal/hydro-cracking along with catalytic.

All lines from extraction to refining including production, storage, transportation, and processing need special technologies. The frequently used enhanced oil recovery systems for reducing viscosity of heavy oil are gas injection and thermal methods such as steam injection. On the processing side, elimination of sulfur and metals, and breaking of heavy compounds into lighter composites are other issues. Reproduction and scheme for this purpose need suitable process and pressure versus temperature simulations [5].

10. Recovery

Iraqi oil production overall was about 2.5 MMb/d including heavy oil (Table 2) before April 2003 and then fallen to nearly 1.4 MMb/d. Iraq's new goal is producing 6 MMb/d (2.2 billion barrels per year) but it is not assured that Iraq can accomplish this soon. The main reasons for the underperformance are: (1) the deprived municipal of the country's oil fields; (2) a rigid infrastructure; and (3) poor management and continuing rebellious attacks, mainly on pipelines [22].

Table 2: Heavy oil productions, 1977-1980 and stopped due to the eruption of Iran-Iraq war (Al-Zubaidi and Al-Zebari, 1998)

Year	Exported Heavy Oil (1000 Tons)
1977	19740
1978	30750
1979	41650
1980	38110
	130250

11. Problems and Challenges

Because of the nature of heavy oil and its molecular arrangement the following challenges will face the Iraqi authority:

- establish law and order along with security;
- loss the reports and destruction of rock core and seismic data after Gulf War;
- high viscosity of heavy oil makes it costly to produce, transport and to refine;
- more carbon, sulfur and metals in heavy oil than in light oils;
- sell price is much lower than that of light oils;
- the size of most reserves of heavy oil are small therefore, they are less attractive; and
- environmental concerns associated to processing and increase of carbon emission.

11. Conclusions

The heavy oil occurs in 45 fields with reserves of 13.3 billion barrels. Numerous challenges are facing the Iraqi government. When these problems are committed, Iraq will imaginably be the most stimulating area with respect to oil expansion and exploration. Iraq's heavy oil would be designated comparatively with no trouble. It costs about US$10 per barrel to produce Iraqi heavy oil.

12. Recommendation

These recommendations are suggested:

- Manufactured CO_2 from power plants may be used for gas injection missions; and
- solar energy may be used to produce steam for steam injection.

Therefore both CO_2 and solar may be an attractive environmentally approachable progressions for the manufacture of heavy oil in Iraq.

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