Heavy oil developments in the Middle East

The Middle East is not generally regarded as an area of high activity in the world of heavy oil extraction; however, it is estimated to contain 970 billion bbl of discovered heavy and extra-heavy oil resources, most of which are undeveloped (Source: Hart Energy Consulting).

Oman is currently a particular “hot spot” for investment in a range of EOR techniques to produce heavy oil, but is much less visible in industry statistics than countries such as Canada and Venezuela. Other countries in the Middle East are encouraged by Oman’s success and, with the additional impetus of increasing oil prices, are becoming more active in heavy oil production. For example, Iran and Iraq have plans to develop several heavy oil fields.

Oman

Four large projects are scheduled to be in progress by 2012, with at least another two expected to start soon after. Being a relatively mature exploration province, there are increasing efforts to improve recovery from known fields.

Occidental operates the Mukhaizna field in south-central Oman—a sandstone reservoir with high permeability, but containing oil of very high viscosity. The company has implemented a major steam flood project that utilizes a modified SAGD approach with vertical steam injectors around horizontal producers (Source: SPE 129248). At year-end 2009, the exit rate of gross daily production had grown to more than 10 times that of September 2005. (Source: Oxy website). Production recently exceeded 100,000 bopd for the first time.

Petroleum Directorate Oman (PDO)’s Marmul Field, in the south of the country, is characterized by heavy, 90cP crude oil that is difficult to extract using traditional methods such as pumping or water flood. A small-scale polymer flood pilot took place in this sandstone reservoir in the late 1980’s but the method was considered uneconomic. Today’s changed economic conditions make the higher cost of using polymers more feasible, and the project has expanded to revitalize this mature field.

At its Harweel field, PDO is injecting miscible sour gas to enhance recovery from some of the
oldest carbonate reservoirs in the world. Safety issues here are paramount. Gases—some of them toxic—are being injected at around 500 times atmospheric pressure, so the surface facilities have to be extremely robust and fail-safe. (Source: PDO website).

At Qarn Alam, facilities are close to being commissioned that will allow steam injection to be applied by PDO to improve production of 16 API oil with 200-300 cP viscosity. This is the world’s first commercial application of steam-assisted gas-oil gravity drainage in a fractured carbonate reservoir. The field is being developed using a full fracture steam flood. This takes advantage of the fractures to carry the steam through the low permeability (10 mD) reservoir. Fractures can represent a problem for cold production, providing high permeability conduits for early water breakthrough. By contrast, fractures can be a benefit for steam injection, which helps to hold back water in addition to heating the oil.

This concept reduces the well count significantly compared to other steam injection methods. The field lies beneath the gas-powered electricity generation station for the oil fields in the area. A waste heat recovery unit (WHRU) at the power plant is being used to create the steam being injected, significantly reducing the amount of energy and CO₂ that would normally be required for such an operation. The project will produce about 5 barrels of oil for the equivalent of every boe energy consumed, as the cost of steam generation is about 1/5th of what would be required for conventional boilers, so overall the development is extremely energy efficient. It is also one of the first cogeneration (“Cogen”) thermal oil production projects and the largest micro-seismic monitoring project for Shell—34% owner of PDO. (Source: SPE 105406).

Investment in the Qarn Alam field is estimated at USD 1.4 billion, and about USD 5 billion is being spent on the three largest fields in the country. In addition, pilot steam projects are being carried out at other large fields, such as Amal-West (sandstone) and Al Ghubrah South (carbonate). By 2012, Oman is expected to be producing between 250,000 and 300,000 bopd using EOR methods.

**Kuwait**

Kuwait Oil Company (KOC) has established a group focused on developing its extensive heavy oil resources in sandstones at Ratqa, in the north of the country. KOC will soon begin its first pilot steam soak wells, and plans to inject to its first 9 spot patterns by 2012. KOC plans to be producing heavy oil at 50,000 bopd by 2015 and more than 250,000 bopd by 2030. In addition, a steam pilot project is currently ongoing in the Wafra field in the Saudi-Kuwaiti neutral zone.

**Egypt**

Egypt has large resources of heavy oil. Issaran is one of the first heavy oil carbonate fields in which steam EOR has been successfully implemented. Its fractured reservoirs contain oil with 10-12 API gravity (Source: Petroleum Africa). Although they have good porosity and are highly saturated with heavy oil, the producing zones contain impermeable stringers that create breaks in vertical permeability. Favorable results have been obtained with CSS where sufficient fracturing exists to distribute the steam. To further optimize production, wells have been acid-fractured, some with proppant to stop natural healing of the fractures.

**Sudan**

Sudan has many fields containing heavy oil. Some of those with lighter oils (around 20 API) have been developed using cold production but are now in decline. Numerous resources of more viscous oil are still awaiting development. It is expected that heavy oil will represent about 50% of the country’s production by 2020. An operator in the country is performing reservoir studies and investigating techniques—including SAGD and in-situ combustion—focused on resources in excess of 1 billion barrels. A pilot project is currently being designed, scheduled to start operation in 2011.
A Chinese-led group tested a steam-assisted recovery project in 2009, but with limited success, due partly to the failure of elastomers in progressive cavity pumps (PCPs). The Sudanese oil exploration and production authority (OEPA) is currently actively encouraging more operators to consider EOR projects in the country.

**Syria**

Syria has considerable resources of heavy oil. Technical information required by Syrian Petroleum Company (SPC) for companies wanting to qualify for its 2010 onshore bid round includes full details of their experience in a broad range of EOR techniques.

**Bahrain**

In addition to its Mukhaizna project in Oman, Occidental is a partner in Tatweer, Bahrain. The fields in Bahrain have low permeability (2mD) unfractured carbonates with large volumes of heavy oil, and a trial of steam injection above the fracture gradient is being considered for 2011.

**India**

In-situ combustion has been used in Indian heavy oil fields for many years. In addition, Oil India is currently tendering for the design of a SAGD pilot project.

**The value of geomechanics**

Unlike the oil sands of Canada, heavy oil resources in the Middle East are often found in carbonate reservoirs. The heterogeneous nature of these rocks presents several challenges when designing production systems. Implementing heavy oil production strategies in carbonates requires a good understanding of the fracture network, which itself is a major challenge. In addition, the network can change as a result of production, such as the closing of fractures. Geomechanical studies can measure and predict some of these changes, enabling mitigation strategies to be implemented.

In very shallow fields, steam can break through to the surface, representing HSE issues. In deeper fields, such as in Oman (600-ft) and Kuwait (500-ft), pressure changes in the reservoir can change elevations, potentially impacting surface facilities. These facilities are not limited to oil production equipment—for example there is a gas power station above the Qarn Alam field in Oman. Development decisions therefore need to take into account possible effects above the reservoir.

**Using solar heat to generate steam**

In the sun-drenched Middle East, generating steam through solar heat has been shown to be technically feasible. Plants in California and elsewhere are successfully using solar “dishes” or parabolic “troughs” to heat water and drive steam turbines for electricity, but as yet this steam has not been used for thermal EOR. A demonstrator project is being tendered in Oman (Source: MEED article 2010) for a small solar trough, designed to deliver 300 b/d of steam, to confirm its operability and feasibility for thermal recovery.

**Sharing experience**

A common feature of EOR projects for heavy oil around the world is the quest to share the limited available global knowledge and experience. International oil companies and oilfield service companies can facilitate the sharing of experience, which is of particular valuable to national oil companies (NOCs), many of which currently have little exposure to EOR technology.

A robust screening process will help to determine which EOR method is likely to deliver the best results for improving the properties and flow characteristics of heavy oils on a case by case basis. The development of new recovery technologies, and the increasing scarcity of conventional hydrocarbon resources, will create an ever growing market for efficient EOR related to heavy oil.

**Some related links:**

- Petroleum Africa, May 2010: Reservoir Characterization of the Issaran Heavy Oil Field, Samir et al.
- PDO website enhanced oil recovery (EOR) pages PDO website “Fact File”
- Occidental Petroleum Corporation (OXY) website – Oman page.
- MEED article about Oman solar project (2010).