Assessment EOR Techniques Used for the Egyptian Heavy Oil fieldsbottom of Form

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Abstract

Most of the current Egypt oil production comes from mature oil fields. Increasing oil recovery from these aging resources is one of the major concerns for the Egyptian oil industry in order to meet the growing energy demand in the coming years. To increase oil recovery from existing fields, operators in Egypt have started to pay more attention to heavy and extra heavy oil fields. Due to its high viscosity, different Enhanced Oil Recovery (EOR) techniques are considered and implemented appropriately. This paper will present the history and present applications of the different Enhanced Oil Recovery (EOR) techniques in Egyptian oil fields, covering the main problems encountered in the operation of each technique including the actions taken to overcome or eliminate these problems. The current study will cover fields located in in the Eastern and western Deserts of Egypt.

Enhanced oil recovery (EOR) processes are well known for their efficiency in incrementing oil production; however, the selection of the most suitable method to adopt for specific field applications is challenging. Hence, this chapter presents an overview of different EOR techniques currently applied in oil fields, the opportunities associated with these techniques, key technological advancements to guide the decision-making process for optimum applicability and productivity and a brief review of field applications. Oil recovery efficiency is greatly dependent on the microscopic and macroscopic displacement efficiency. Generally, microscopic displacement efficiency measures the extent to which the displacing fluid mobilises the residual oil once in contact with the oil, and it is greatly controlled by factors such as rock wettability, relative permeability, IFT and capillary pressure note that a decrease in oil viscosity, IFT or capillary pressure of the displacing fluid can increase the microscopic efficiency.

Macroscopic displacement efficiency, otherwise known as volumetric sweep efficiency, measures the extent to which the displacing fluid is in contact with the oil-bearing parts of the reservoir (metre to hectometre scale, and it is influenced by the rock matrix heterogeneities and anisotropy, displacing and displaced fluid mobility ratio and injection and production well(s) positioning. The product of microscopic (Ed) and macroscopic (EV) displacement efficiency yields the overall displacement efficiency (E) of any oil recovery displacement process. E=EdEvE4 And Ev=EiEaE5, where Ei is the vertical sweep efficiency and Ea is the areal sweep efficiency.

Natural drive mechanisms recover oil during the initial or primary production stage of a reservoir by means of the natural energy present in the reservoir without the need of supplying any additional energy. These natural mechanisms use the pressure difference between the reservoir and the producing well bottom. The total recoverable oil using this method is considered inefficient, as recovery is usually less than 25% of the original oil-in-place. Secondary recovery techniques are applied when the natural reservoir drive is depleted ineffectively and inadequately for augmenting production. This technique involves injection of either natural gas or water to stimulate oil wells and maintain reservoir pressure in the injection wells. The injected fluids act as an artificial drive to supplement the reservoir energy. Such fluids boost the flow of hydrocarbon towards the wellhead. If the injected fluid is water, the process is usually termed waterflooding; if the injected fluid is gas, the process usually involves pressure maintenance operations.

Gas-cap expansion into oil columns (wells) displaces oil immiscibly due to volumetric sweep-out. Diverse methods are used for fluid injection into oil reservoirs to support the natural forces. Recovery efficiencies in the secondary stage vary from 10 to 40% of the original oil-in-place. Other gas processes, whose mechanisms entail oil swelling and viscosity reduction, or favourable phase behaviour, are enhanced oil recovery (EOR) processes. Tertiary recovery techniques otherwise called enhanced oil recovery (EOR) processes demonstrate enormous potential in recovering stranded oil trapped at the pore scale after primary and secondary recovery techniques by capillary pressure-driven snap-off, which leaves behind in the reservoir about one-third of OOIP. The stranded oil is often located in regions considered inaccessible. EOR methods can extract more than half of the total OOIP and significantly more than the primary and secondary recovery methods. Notably, the impact of EOR on oil production is colossal as an increase in recovery factor by only 1% can yield 70 billion barrels of conventional oil reserves globally without the exploitation of unconventional resources. In comparison to primary and secondary recovery methods, EOR undeniably is a better alternative as its

contributions to global oil production entails a more economically feasible process.

Crude oil recovery takes place in three production stages primary, secondary and tertiary oil recovery processes. On average, oil recovery from the primary and secondary production stages is approximately one-third of the original oil-in-place (OOIP), while the remaining two-thirds of the oil, can be partially recovered through the application of tertiary processes also known as enhanced oil recovery (EOR) processes, which are key drivers for incremental oil recovery. EOR processes include thermal (TEOR), chemical (CEOR), gas flooding miscible and immiscible (GEOR) and microbial or MEOR processes. Thermal EOR techniques are applied for the recovery of heavy oils. In particular, steamflooding is the dominant thermal EOR technique worldwide. Increase in oil productivity is achieved through viscosity reduction, oil swelling, steamstripping and thermal cracking.