

1.1 General Introduction

Enhanced Oil Recovery (EOR) is defined as the processes include all methods that use external sources of energy and/or material (chemical, thermal or miscible gas injection) into a reservoir to recover oil that cannot be produced economically by conventional means. Also refers to reservoir processes that recover oil not produced by primary or secondary processes and it may be initiated at any time during the history of oil reservoir and it includes all methods that use external sources of energy to recover oil (Abdulbasit, 2013).

There are four criteria which classify the oil reserves (Carcoana, 1992) these include:

1. *Recovery Possibilities*

The amount of oil recoverable from OIIP (oil initially in place) is limited by existing recovery mechanism efficiency of known reservoirs and economic conditions.

2. *Degree of proof*

$$E_R = \frac{\Delta N}{N} * 10 \text{ -----Eq. (1.2)}$$

Where

E_R = Oil recovery factor at certain time, percentage

ΔN = Cumulative oil produced, bbl

N = OOIP, bbl

It is a main interest for the petroleum engineer to obtain the ultimate oil recovery from a reservoir; which is equal to the product of $N \times E_{Rfinal}$, where E_{Rfinal} is the ultimate recovery factor.

The recoverable reserve ($\Delta N = N \times E_{Rfinal}$) should be estimated with high accuracy.

3. Development and Producing Status

The development status distinguishes between developed and undeveloped reserves.

The producing status is the highest status of reserves; because it differentiates between producing and the non-producing reserves from the existing wells, see figure 1.1.

4. Energy Source

It is classified into natural energy, which is responsible for the primary recovery mechanisms. Here the driving energy is inherent in the reservoir.

When the natural energy become unable or uneconomic to produce the well, a further energy is introduced into the reservoir by means of injection of water or gas under pressure which so-called the secondary recovery.

A substantial amount of OOIP (66%) remains unrecovered by the conventional means, which is the main target for the more expensive EOR or tertiary recovery (Carcoana, 1992).

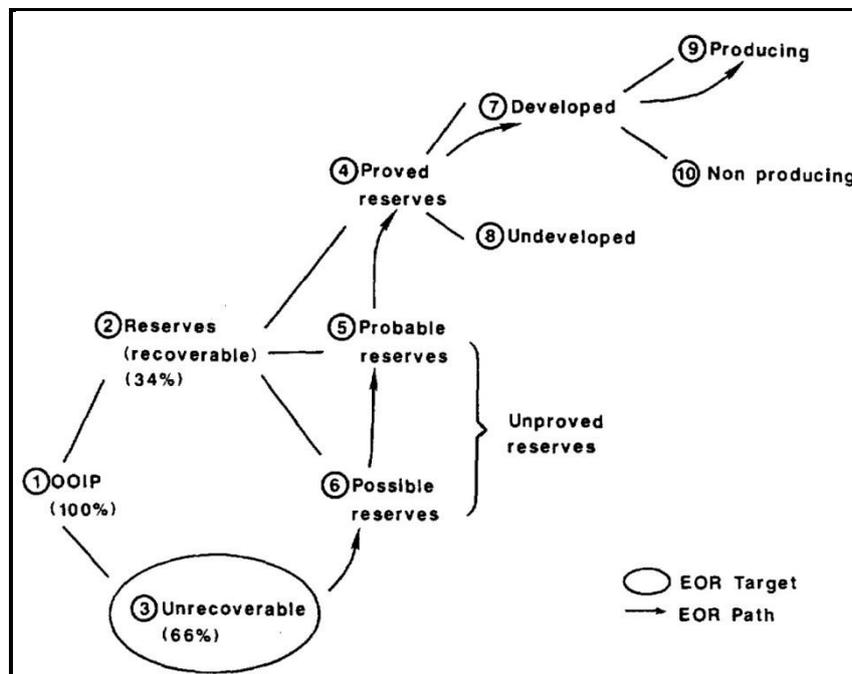


Fig. 1.1: Oil Reserves Classification and EOR Target and Path (Carcoana, 1992)

The legend for figure 1.1: is as follows:-

(1) Original oil in place, N

- (2) Estimated volumes of hydrocarbon anticipated to be commercially recoverable from known accumulations
- (3) 1-2
- (4) Are recoverable reserves under current economic conditions
- (5) Are less certain than proved reserves, more likely to be recovered than not
- (6) Are less certain than probable reserves and more likely not to be recovered
- (7) Are expected to be recovered from existing wells
- (8) 4-7
- (9) Are expected to be recovered from completion Intervals open at the time of the estimate and producing
- (10) 7-9

Oil Recovery Processes

Oil recovery processes are commonly subdivided into primary, Secondary, and Tertiary.

The primary Recovery

After been discovered, most of the oil reservoirs begin with a natural energy, which displaces the oil into wells. This driving energy comes generally from:

- Depletion drive
- Rock and liquid expansion drive.
- Gas-cap drive.
- Water drive.
- Gravity drainage drive.
- Combination drive.

Secondary Recovery

After the pressure in the reservoir decreases to the degree where the energy inherited in the reservoir is not enough to produce the oil or when the operation becomes not economic, water or gas is injected to displace the oil and maintain the pressure inside the reservoir. This method is so-called secondary recovery.

Tertiary Recovery

The main objective of this level is to increase the recovery from the Reservoir depleted by secondary recovery when it becomes no more economical to inject water

or gas. The tertiary recovery or Enhanced Oil Recovery (EOR) is mainly divided into: chemical, thermal or miscible gas which will be discuss in details in chapter 2.

Differentiation between Enhanced Oil Recovery (EOR) and Improved Oil Recovery (IOR) is very important. IOR: refers any reservoir process to improve oil recovery, while EOR: refers to any reservoir process to change the existing rock /oil /brine interactions in the reservoir. In other words; IOR Includes EOR plus more other activities such as: Reservoir characterization, Improved reservoir management, Infill drilling, Horizontal well drilling, Sweep efficiency improvement, Work over, step-out drilling, Water injection cyclic water injection, and well stimulation (acidizing and fracturing). Figure 1.2 below shows the definition of IOR.

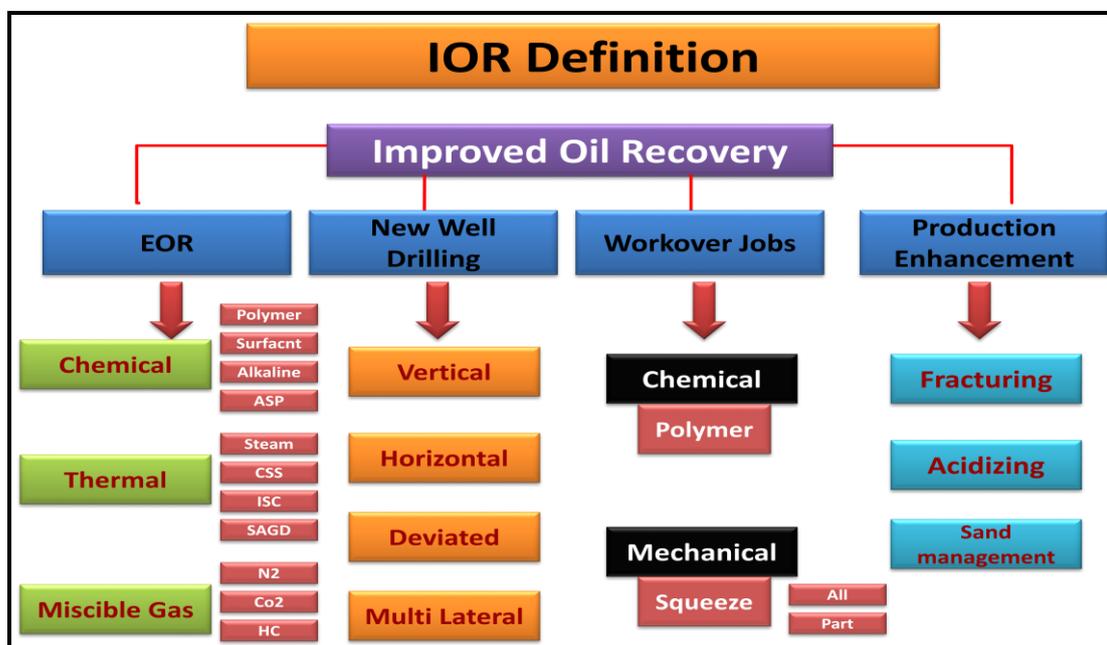


Fig.1.2: Improved Oil Recovery (IOR) Processes (Abdulbasit, 2013).

1.2 Problem Statement

Chemical EOR is one of the EOR types that cannot be successful unless a perfect design is done. To increase the recovery factor in Bamboo Oil Field by chemical (surfactant) Huff-n-Puff, the total injection rate, the concentration of surfactant, the total volume of water injected, and the injection and production period of Huff and Puff should be stated clearly.

1.3 Objectives of the Study

To find the optimum parameters for Huff and Puff for Bamboo Main Oil Field, Sudan, including injection flow rate, surfactant concentration, total volume injection, and duration of Huff and Puff.

1.4 Introduction to the Case Study

Greater Bamboo Field is located in block 2A Muglad Basin consist of four structures, Bamboo west , main, east and south and covers an area of about 144 km. It involves of multi-layered under-saturated sandstone reservoir of late cretaceous ages buried at depth ranging from 1000 m to 1500 m with crude oil viscosity ranges from 200 cp to 3000 cp. The total field STOIP and Recovery Factor (RF) is currently estimated at around 509 MMSTB, 16% respectively. To date the field had recovered more than 69% of the Ultimate Recovery (EUR).

The field initially produced around 20,000 STB/D with early water breakthrough and very minimal gas production rate until today. However, the production rate declined rapidly when the water production rate increased. Major factors that contributed to this problem are possibly due to the fingering and water conning. Currently the field is producing around 9000 STB/D with water cut around 75% and keeps increasing (Elamin S. Mohammed and Husham A. Ali, 2014).

1.5 Thesis out Lines

Chapter 2 in this thesis is including the literature review and theoretical background of the study, while chapter 3 is talking about the methodology. Chapter 4 is summarizing the results and discussion of the work and chapter 5 is conclusion and recommendations.