

# **Effect of the natural fracture reservoirs in the selection of the Enhanced Oil Recovery mechanism: Rhourde El Baguel reservoir-case.**

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Naturally fractured reservoirs are complex media and difficult to understand because of the peculiarity of the duality of matrix-crack media, cracks through which the fluid flows towards the well bottom have totally different characteristics to that of the matrix blocks in which the fluid is stored, the naturally fractured reservoirs are characterized by an enormous drop in production following a period of production with high flow rates..The detection of the presence of fractures in the reservoirs is done by several techniques or well testing is one such technique. The need for improved recovery techniques (EOR) is very necessary following the huge drop in production in fractured reservoirs, but the choice of which EOR mode to apply is very difficult.In Algeria the Rhourde El baguel reservoir (REB) is one of the naturally fractured reservoirs and its production has experienced a huge drop following the application of massive gas injection to achieve miscibility.The aim of this work is to do an analytical study to derive conclusions to aid in the selection of enhanced or enhanced recovery mode to increase the rate of oil recovery (the ultimate oil recovery).

First of all an enhanced oil recovery application principally targets to minimize the residual oil in the matrix once the primary and secondary recovery are both ineffective as for the EOR methods we have chemical flooding, thermal and miscibility Which is the one done in REB.

- ❖ REB is a fractured reservoir with an OOIP that exceeds 2 billion barrels it is situated in the North East part of the Algerian Sahara at about 90 km south-east of Hassi-Messaoud The producer tank of REB is a Cambrian age in a average depth 2845m from the levels of the sea. It's subdivided into 6 zones. After coring it was found out that REB has vertical and oblique fractures and horizontal fractures being nonexistent which was further confirmed by the imagery test results. In the year 1996 a redevelopment project initiated between SONATRACH and ARCO (BP).the redevelopment project was a high pressure (420 barg) miscible dry gas injection scheme to significantly increase the remaining reserves potential of the field it was predicted that the production will increase with the injection of the gas into the tank and achieve a maximum of 134000BOPD in the 9th year and an accumulation of 563

Million barrels during 25 years however these predictions couldn't be any further from the truth due to the failure of the project as it shows in the figure although we remark a slight increase in the oil production rate at the start of the gas injection it follows with major drop afterward no matter how much gas is injected now let's go to why the miscibility project failed well theoretically it failed due to three reasons : the lack of understanding and modeling the fractures as well as Efficiently USING the Wealth of the Acquired Data and lack of pilot tests which caused Wrong simulation results and Failure in the miscible gas injection in REB. AS for the practical diagnosis tracers were used in the injected gas and the results are as it shows in the tables the injected gas appeared very quickly in the production wells indicating a breakthrough of gas due to its high mobility and finding preferential paths through the fractures which resulted on the production of the injected gas after this failure the engineers didn't sit empty handed as some remedial actions were done to cope with the failure : gas shutoff , gas recycling , seasonal gas injection.

**In this study and after data analysis of the production we find that:**

- The density of fractures is the main reason for the gas breakthrough.
- The main reason behind the failure is the complete lack of understanding of the fractures and the inability to model them in 3D.
- The main causes of breakthrough are the high density of the natural fractures and the high MMP of the miscible gas injected (METHANE: 420 barg).
- After the breakthrough the injected gas traces its paths in the medium porous in addition to the higher mobility of gases refers to liquids, the oil gets trapped inside the matrix blocks.
- In one time the only solution after the failure of miscible injection project gas recycling was the only economical existing solution due to availability of the gas.
- Due to the increase of gas demand in winter, an economical recovery was adapted in similar high GOR NFRs to overcome this worldwide gas demand called by seasonal gas injection:
  - ✓ This kind of recovery is based off injecting the minimum optimum rates in winter and recycling all the produced associated gas in the rest of the year.

- ✓ A gain of oil production was registered after the winter in refers of what was predicted. This phenomenon is due to the draw down from the matrix to the fracture after decrease of fracture pressures
- Nowadays REB reservoirs it's a case study of chemical Enhanced oil recovery with polymers and surfactants (this project is at laboratory level), the pandemic, the low oilprices and the uncertainty of the results are the main reasons for the delay of this project.