



A71 Well Productivity Enhancement by Perforation Extension and Re-Perforation in Abu-Attifel Oil Field- Libya

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Abstract: "Two million barrels of oil per day is the goal that the National Oil Corporation (NOC) in Libya aims to achieve as per its strategic plan announced at the beginning of 2023. The corporation instructed the companies within the sector to begin executing this plan to improve oil recovery from the fields they operate. Mellitah Oil and Gas B.V. Company Libya Branch began implementing the NOC plan in the Abu-Attifel Oil field, which aimed to enhance the productivity of well A71, where rates of oil and gas production from the well were declined due to scale accumulation caused by the high water rate associated with production. As a solution to this problem the company implemented the process of perforation extension and re-perforation as a well stimulation. In April 2024 the company succeeded to improve oil production from 560 STB/D to 2231 STB/D and increased the rate of gas production from 753 MSCF/D to 3376 MSCF/D. Additionally, the water cut (WC) decreased significantly from 63% to 28.5%.

Keywords: Productivity Enhancement, Perforation Extension, Reperforation Technique, Abu-Attifel Oil Field

1 Introduction

The National Oil Corporation NOC in Libya seeks to rehabilitate the oil fields in the country, as the Libyan state went through critical events that led to a decline in production levels as a result of the encroachment that affected oil facilities over the past decade during wartime. The NOC developed a strategic plan that it announced at the beginning of the year 2023, aiming to increase production of oil to two million barrels per day.

Companies operating in Libya's oil sector have initiated the required measures to execute this plan. Among these companies is Mellitah Oil and Gas B.V. Libya branch. Several measures have been implemented by the company to raise the level of

production from the Abu-Attifel oil field operated by it. Abu-Attifel field is located in the Sirte basin which has been discovered in March 1968 in Concession A100 about 300 kilometers southeast of city of Benghazi [1]. Water drive is the primary mechanism in the oil field [2].

One of the targeted wells in the field is the A71 well, producing from a sandstone reservoir, as it showed a low level of production despite the good reservoir properties. The company has implemented extended perforation and re-perforation process in the well in an effort to improve recovery.

2 Reservoir Characteristics

The main reservoirs in the A100 concession are two clastic units locally known as Lower Nubian Sandstone and Upper Nubian Sandstone, separated by Varicolored Shale[3]. The main petrophysical characteristics for the Upper Nubian Sandstone in the study area are presented in Table 1.

Table 1:Reservoir Characteristic

Gross ft	Net Pay ft	Av. Phi %	Av. Sw %	Av. Permeability K. md	Age
757	633	13	22	50	Early Cretaceous

3 Productivity Enhancement

Perforation extension involves targeting specific reservoir zones with the highest potential for oil and gas flow, while re-perforating entails creating new perforations in the existing well casing and cement behind it.[4], which is one method of well stimulation, where stimulation aims to enhance production from damaged wells. This damage obstructs fluid flow.

The precipitation of minerals (scale formation) is one of cause of reduces formation pores and clogging of the perforations in the well casing [5,6]. Associated water is the major source of all scales formation and when water is produced alongside oil and gas, as in the Abu Attifel oil field, various types of scale can form in the reservoir or within the production tubing. Scale can deposit as a thick layer in the wellbore tubing, reducing the tubing's production diameter Fig.1, which results in impairing of the flow, production equipment failure, emergency shutdown, and increased maintenance cost [7,8].

On the other hand, if the previous perforation, for instance, were within a watered-out region due to shifting of oil water contact OWC, therefore these holes can be closed and the hole can be extended into the zone that the analysis of well logs data indicated that it is an area with the highest porosity or natural fractures, which can be strategically perforated to enhance reservoir connectivity.

The aim of the paper is to assess the effectiveness of the perforation extension and re-perforation process in stimulating and enhancing the productivity of A71 well in the Abu-Attifel oil field.



Fig. 1. Scale formation in A71 well production tubing.

4 Well Background

The A71 Well is a vertical well, drilled and completed in January 1996 in the Upper Nubian Sandstone. In March of same year, the well was put into production. During the well's lifespan, several scale removal jobs were conducted, and more than one production logging test (PLT) was performed.

In November 2021, a PLT was conducted. Table 2 shows the test results.

Table 2:Reservoir Characteristic

14,150' – 14,166'	Producing 80% of oil inflow
14,194' – 14,200'	Producing 50% of water inflow
14,215' – 14,218'	Producing 50% of water inflow
14,236' – 14,246'	Producing 50% of water inflow
Based on results, water shut off WSO & Perforation extension were carried out	
1.Setting MBPT @	14,191'
TOC @	14,158'
	14,038' - 14065' 14,073' - 14078'
ext.	2.Perforation
	14,082' - 14087'
	14,146' - 14,150'

Another PLT was run in Mar. 2022, and the results showed:

- Higher outflow performance and higher infectivity in the 14,038'-14,067' interval, which is a sign of good permeability of this zone.
- Upper section 14,040'-14,055': Main source of oil inflow.
- Lower section 14,056'-14,067': Highest water production
- Gamma Ray (GR) sensor showed high readings across the entire logged interval, which may be a sign of radioactive scale accumulation.

An additional PLT survey was conducted in Dec. 2022, which showed that water is coming from the lowermost intervals, indicating a potential leak in the MBPT."

In Jan. 2023 a gauge cutter (GC) tagged the depth at 14,195'. Subsequently, the MBPT was set at 14,140' and TOC at 14,118', followed by an extension perforation performed from 13,876' to 13,911'.

4.1 History of Routine Testes

Table 3 shows the well's routine tests conducted during the end of 2023 and the beginning of 2024.

Table 3: Well Routine Tests History

Date	FTHP psi	FTHT Deg F	Qo STB/D	Qg MSCF/D	Qw STB/D	GOR SCF/STB	WC %	Choke Size /64
25.Oct.2023	1680	204	1028	950	778	924	43	32
11.Nov.2023	1643	202	1650	2250	1212	1363	38	32
22.Feb.2024	1468	186	619	855	905	1386	42	16

5 Well Stimulation Decision

Based on the PLT tests results that showed the presence of scale and that some of the perforations do not contribute sufficiently to production, and the lowermost intervals produce the water by more than 50%. Also, considering the characteristics of the reservoir indicated in Table 1 and the well's history over 28 years, which showed an excellent response to improving the well by perforation extension to avoid shifting oilwater contact OWC, and re-perforation for blocked holes due to scale formation the decision was made to extend perforate and re-perforate the intervals referred to in Table 4.

Table 4: Required Extension perforation and Re-perforation interval

Interval No.	From ft	To ft	Height ft	Comments
1	14,038	14,045	7	Re-perforation
2	14,020	14,034	14	Re-perforation
3	13,988	14,005	17	Perforation Extension
4	13,955	13,965	10	Perforation Extension
5	13,835	13,864	29	Perforation Extension

6 Results

After completing the procedure of extension perforation and Re-perforation inunderbalance conditions, a routine test was conducted on April 17, 2024, and the results were as shown in Table 5 and Fig. 2.

Table 5: Well Routine Tests Results

Date	FTHP psi	FTHT Deg F	Qo STB/D	Qg MSCF/D	Qw STB/D	GOR SCF/STB	WC %	Choke Size
17.Apr.2024	2140	201	2231	3376	887	1806	28.5	32

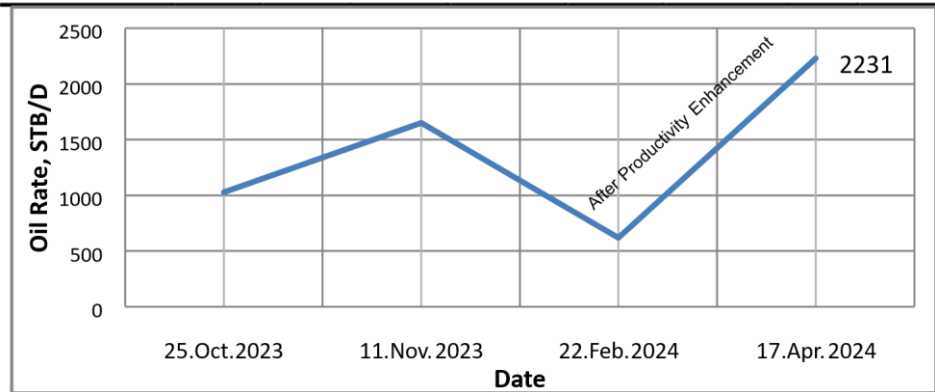


Fig. 2. A71 Well Oil Rate vs. Date

7 Discussion and Recommendations

The formation of scale is considered the main problem of the Abu-Attifel field. According to the history of the A71 well, the well has been exposed to a decrease in production due to the blockage of the perforations as a result of the formation of scale. Despite many operations to remove the scale, the large quantities of accompanying water were the main reason for reformation again.

It also clearly appears from the well's history that there was a shifting in OWC as the well's production area moved from a depth of 14384' to 14087', which naturally led to intervals of perforation contributing a large quantity of water and eventually resulted in the closure of these intervals..

PLT tests in the years 2019, 2021, and 2022 proved that, the deeper intervals have an increased percentage of water contributions, which made the decision to WSO, and those higher areas showed good potential for hydrocarbon contributions, which made the decision to extension perforations in it.

Periodic tests, Routine tests, to monitor the shifting of the OWC and monitor the formation of scale and remove it on quarterly basis is highly recommended It is also recommended to study the composition of these scales, conduct laboratory studies to treat them, and use the necessary inhibitors to prevent their formation.

Finally, this study proved that the pay zone contains large economically recoverable quantities, and that the success of the re-perforation and extension perforation process in well A71 will be an approach followed in other wells in the same field, as it is considered the least expensive process to enhance productivity.

8 Conclusion

- Success of the process of enhancing the productivity of wells A71 by extension perforation and re-perforate in the suggested intervals.
- The rate of oil production in Apr.2024 increased by 1671 STB/D i.e. from 560 STB/D to 2231 STB/D compared to March 2024.
- The rate of gas production in Apr.2024 increased by 2623MSCF/D i.e. from 753 MSCF/D to 3376 MSCF/D.
- The WC decreased from 63% to 28.5%.

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