

Case Study

Implementing Acid Breakdown Job Selection Technique Proved to be the key Drive down Cost of Gas Lift Completion and Maintaining to Improving Production in Amal Reservoir (B) of the Sirte Basin, Libya

ABSTRACT

Implemented a combination technique of the maximum economic , remove skin around the well bore , Gas Lift Analysis Based on the wellflo simulation and HCL stimulated by Halliburton Additives for Amal reservoir 'B'. Breakdown Acid Job, the process on this Issue is to Acid pumped through perforations to open more or increase effective diameter and the target is to Breakdown and open "all" perforations (pumped below fracture pressure). Amal reservoir 'B' was responded positively to the Acid treatment, Diversion was working well and gas injection rate despite of the recommended volumes were 22.1 gal / ft and the formation was vacuum. However, the Production increased by a ratio 299.4% by optimum gas injection rate 0.75 MMSCF/Day and fluid level increased by a ratio 57.1% which is much greater than Unstimulated. Therefore, this raises the importance of investigating the potential production increase and the treatment cost efficiency for this formation when carrying out stimulation campaign in order to rank in terms of stimulation preference.

Moreover, the estimated remaining reserves for each Amal reservoir 'B' and the ability of the production tubing and surface facilities to handle the extra fluids should be also considered. Previous field experience in similar fields is recommended when predicting production gain in order to minimize the risk associated with acidizing treatments.

Keywords: Stimulation; Gas Lift Completion; production Improving; Amal Reservoir (B); Sirte Basin; Libya.

1. INTRODUCTION

A vast amount of data is available for the Sirte Basin as a result of oil exploration activities extending over more than forty years. Thousands of wells have been drilled, gravity, magnetic and seismic data have been gathered, and as a result the basin is far better known than any other area in Libya, although it can fairly be claimed that the deep troughs are still imperfectly known. Studies on the subsidence history of the Sirt basin have been published by Gumati and Kanés, Gumati and Nairn, van der Meer and Cloetingh and Baird, et al. and the results of a gravity study of the Sirt Basin were presented by Suleiman,

et al [1]. The Sirte Basin covers an area of 600,000 km² in central Libya and contains a basin-fill which reaches a thickness of 7500m. The nature of the faults which control the Sirte Basin grabens is important, particularly in respect of oil migration. Basement in the Sirte basin has been penetrated in a number of deep oil wells and in general comprises parisian accreted oceanic terrace north of latitude 27 °N.[2,3]. The eastern Sirte Embayment contains the most complex petroleum systems in Libya. This is due to the presence of several potential source rocks, and evidence of considerable mixing of oils from different sources. The embayment contains the giant fields of Jalu, Sarir, Messiah and Abu Attifel, and the adjacent highs host the Amal and An Nafurah-Awjilah fields as shown in Fig. 1[11].

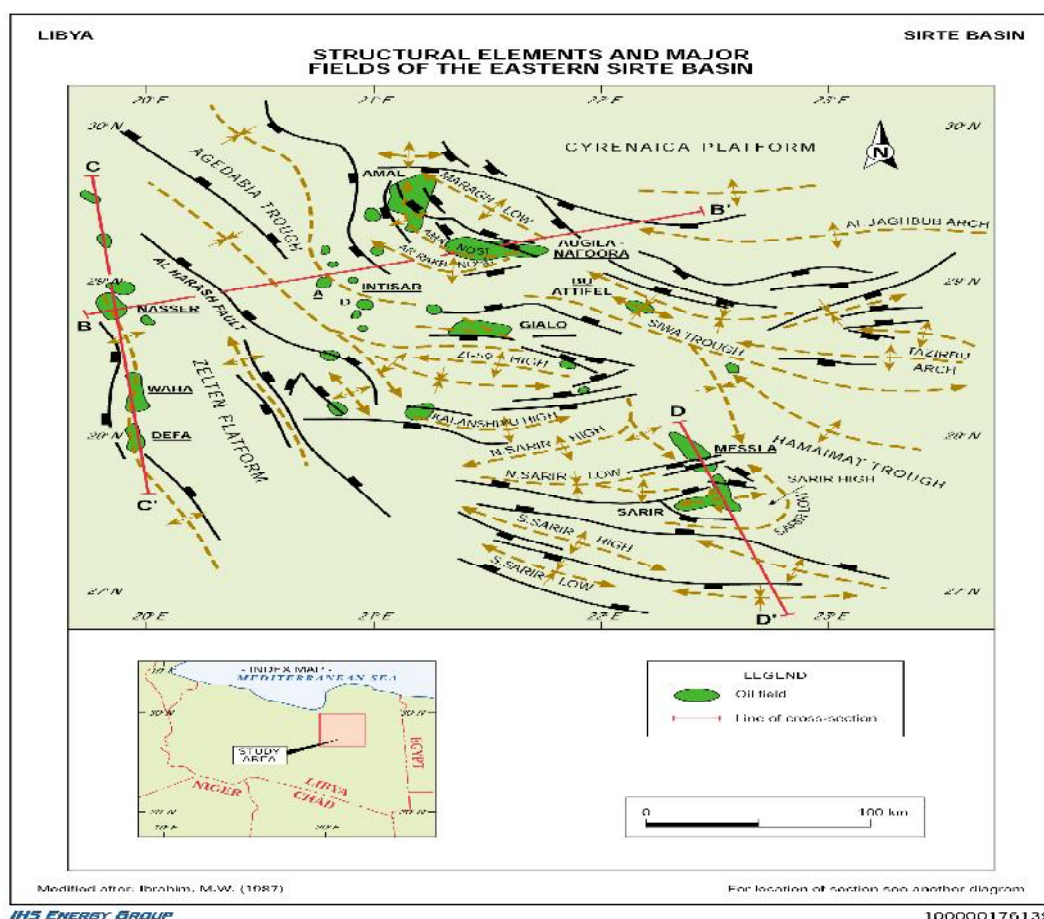


Fig.1 Structural Elements and major fields of the eastern sirte basin [11].

1.1 GEOLOGICAL SETTING

Sirte Basin is the youngest and most hydrocarbon prolific basin in Libya. Tectonically the Sirte basin is a Northwest elongated basin made of a series of Northwest-Southeast trending platforms (Horsts) and Troughs (Grabens) as shown in Fig 2. The basin has subsided slowly during Cretaceous and Tertiary, and particularly in the Eocene time when the maximum rate of Subsidence of the basin was reached (Berggren, 1964). After the opening of the Sirte Basin, the Sea transgressed Southward in the subsiding grabens and in the low-standing highs which were subsiding at a slow rate. The Sea transgression reached Latitude 22 during the late Cretaceous and Paleocene time and consequently, most of the major highs

were covered by the Sea. During the early Eocene, a partial regression of the sea occurred creating restricted conditions over the southwestern part of the basin. New marine transgression occurred in the middle Eocene eliminating those restricted conditions. The marine sedimentation prevailed and continued until the Quaternary, when the basin was covered by continental sediments. Sedimentation in the Basin varies from thick accumulations of organic-rich bituminous shale and deep marine carbonates to shallow marine carbonates and evaporates and returns to shale and so on. The Cycles may have resulted from changes in the sediment Supply, from reactivation of faults or from rapid subsidence (Conley, 1971). [8]. The Sirte Basin province is considered to be a holotype of a continental rift (extensional) area and is referred to as part of the Tethyan rift system (Futyan and Jawzi, 1996; [9]. Guiraud and Bosworth, 1997). [10].

1.2 LITHOLOGY

The Amal Formation is predominantly a sandstone sequence. It is heterogeneous in color, grain size and sorting. In color, the sandstones range from white to red, purple, tan and gray. The tan, white and gray colors are dominant. The grain size ranges from very fine sand to cobbles with the medium to coarser grain sizes being more common. Sorting is generally poor, and conglomerate beds are frequent. Quartz is the dominant detrital material as well as the most important cementing agent. Accessory constituents are feldspar, mica, pyrite, hematite and various dark minerals. Clays, sericite and rarely dolomite are found as cementing materials in much of the formation. Usually, the sandstones are firmly cemented, and orthoquartzites are common, particularly in the upper part of the formation. Interbedded with the sandstone, but comprising a much lesser part of the formation, are gray silty clays and gray, green and red, brittle, micaceous shales.

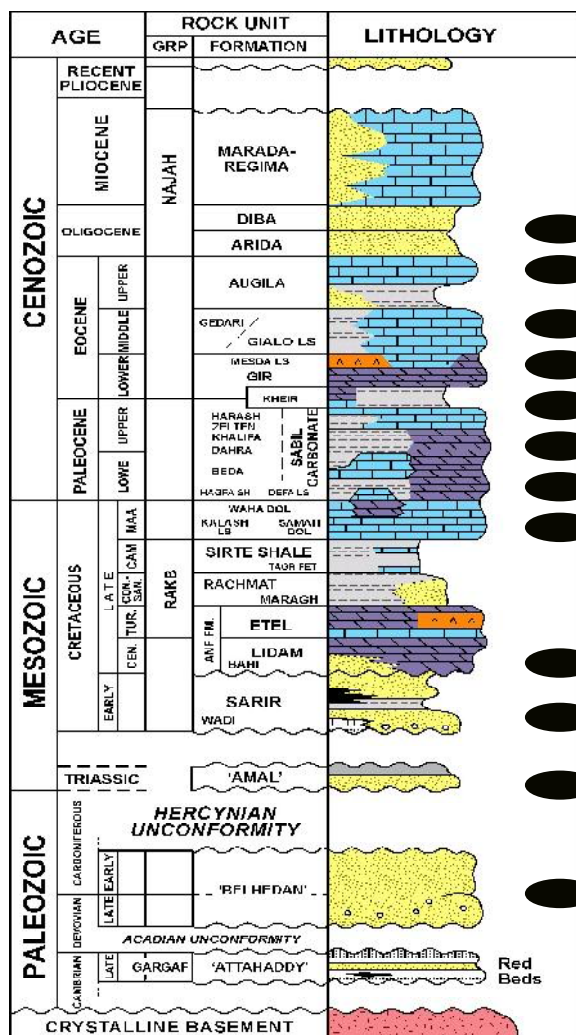
In addition to the sedimentary rocks, volcanic rocks in the form of dikes, sills or flows are found at a number of horizons in the upper part of the formation [1].

2. MATERIAL AND METHODS

As the formation to be treated is a sandstone reservoir, acid treatment should primarily increase the effective wellbore radius, thereby increasing the area of formation surface in direct communication with the wellbore. This goal can then be achieved by dissolving the matrix in the immediate vicinity of the wellbore and by opening the existing perforations. A secondary objective of the treatment is to remove drilling-induced or completion fluid-induced damage from the formation face and to clean drilling mud from natural or induced fractures for the producing wells and in addition to remove the completion fluid-induced damage for the well production.

Amal reservoir 'B' was responded positively to Halliburton treatment design despite of the recommended volumes were 22.1 gal / ft as shown in the table 1.

The name Amal Formation has recently been used for a formation in the subsurface of the Amal Field area (Roberts, 1970). However, it was not formally proposed as a new formation nor was a type section established. Therefore, the Amal Formation is here proposed as a new formation in the subsurface of the eastern Sirte Basin; however, it is identical to the rock unit used by Roberts. The type section is located in the Mobil B1-12 Well at a drill depth of 9829 to 11,290 feet (total depth), which corresponds to a subsea depth of 9688 to 11,149 feet. The base of the formation was not reached [4].



2.1 The proposed treatment for Stage 1 consisted of:

- 200 gal of Pickling Treatment.
- 12000 gal of Main Treatment 15% HCL Acid with Halliburton Additives
- 2500 gal of Guidon (Diverter). Halliburton produced
- 5000 gal of Displacement of Water (non-Corrosive Fluid).

2.2 The treatment actually pumped consisted of:

- 12200 gal of Main Treatment 15% HCL Acid with Halliburton Additives
- 2500 gal of Guidon (Diverter). Halliburton produced
- 6720 gal of Displacement of Water (non-Corrosive Fluid).

Fig.2 Stratigraphic section in central Sirte Basin (Sirte and Tibesti arms) (Ahibrandt, 2001).

Table 1. Amal 'B' Formation treatment design and recommended volumes. [12].

HALLIBURTON DESCRIPTION	WT - VOL	UNIT	Comments
PE ACID 15% Hydrochloric	12200	GAL	Main Treatment
WATER	4722	GAL	Fresh Water
HYDROCHLORIC, 22 BAUME, gals	6160	GAL	Raw Acid
HAFOS CRSN INHIB, gals	61	GAL	Corrosion Inhibitor
FE-1A ACETIC ACID - gals	122	GAL	pH Control
FE-2, lbs	330	LBS	Iron Chelating Agent
CLA-STA XP, gals	120	GAL	Clay and Fine Control
MUSOL®, gals	990	GAL	Mutual Solvent
Losurf-300M, gals	24	GAL	Surfactant
Guidon	2500	GAL	Diverter
WATER	2387	GAL	Fresh Water
HPT-1, gal	108	GAL	Polymer
BA-20, gals	5	GAL	pH Control
KCL, lbs	440	LBS	Salt

2.3 Data Acquisition and software's

2.3.1. In Site for Stimulation is Real Time Stimulation Data Acquisition System based on the InSite Core and InSite for Stimulation software products. For the Production Enhancement, InSite for Stimulation is the primary data acquisition module used in the workflow process. This workflow process is aligned with steps of the HMS (Halliburton Management System), which documents the processes that are involved. The workflow at this level is more detailed than the HMS processes, so more steps and processes are necessary than at the higher level view of HMS [5].

2.3.2. Wellflo software for design and analyses of the artificial lift system as sensitivity that runs were conducted using Wellflo software package developed by Edinburgh Petroleum Services 2006 EPS Ltd. WellFlo is a single-well nodal analysis program which models natural producers, Injectors and (optionally), gas-lifted wells. Otherwise, flosystem is a suite of programs developed by *Edinburgh Petroleum Services Ltd.* to assist Petroleum Engineers in the design, optimization and diagnosis of oil wells and production systems [7].

2.4 Halliburton Pumping Unit & Fluid Transport trailers

Pump unit is capable of blending on pumping to the wellhead with maximum pressure and maximum rate. Since the control and data measurement is essential to Acidizing operation otherwise Halliburton Fluid transport Trailer each 6200 gal that it used in the job of Acid treatment with additives and diverter [6].

3. EXECUTIVE SUMMARY

Treatment timing is essential for natural or artificial lift wells as per routine and longtime of oil and gas production thus an estimate of the length of time that the well stimulation treatment will increase the well production is also required otherwise, well stimulation is only justified when the net (discounted) monetary of the resulting extra oil or gas production is greater than the cost of the stimulation treatment.

The purpose of Amal Reservoir 'B' treatment is to stimulate or effectively increase the flow capacity of Amal Formation thus the increase in flow capacity is accomplished by the Acid's ability to dissolve rock, certain scale, mud and other soluble material, which may be blocking the flow channels. Amal formation treatment is designed to increase the well's Productivity Index (PI). Matrix acidizing aims to increase PI by reducing Skin by dissolving formation damage and rock in the near wellbore region as shown the result in Fig.3

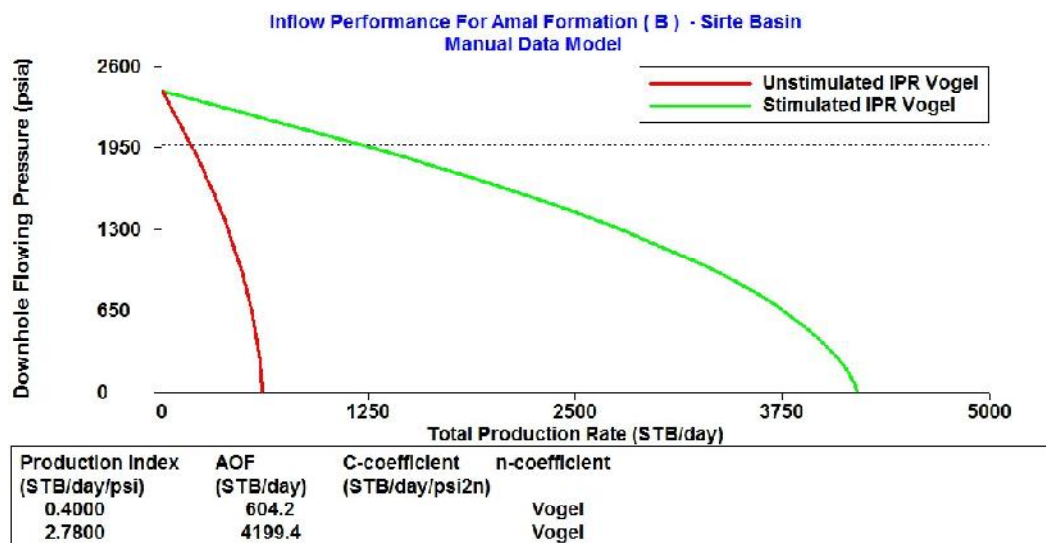


Fig.3 Improved Inflow performance Curve from a stimulated

When started pump non- corrosive fluid to Amal formation to make sure there is found return and never out so that the formation was vacuum and decided to cut pickling stage and injectivity test before Acid and going to main Main Treatment as shown in Fig.4 otherwise after Soaking agitation treatment that the diverter is working well In spite of this, the formation's vacuum as shown in Fig. 5. Therefore the Purpose of soaking – agitation treatment is to Remove scale, Open perforations and React with the formation face.

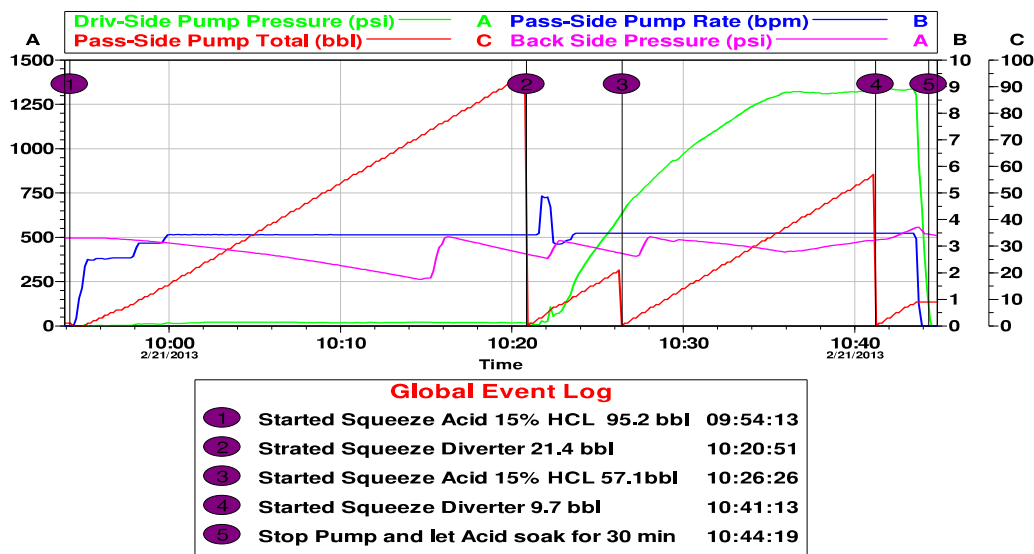


Fig. 4 Squeeze Acid and Diverter before Soaking – Agitation Treatment – Stage 1

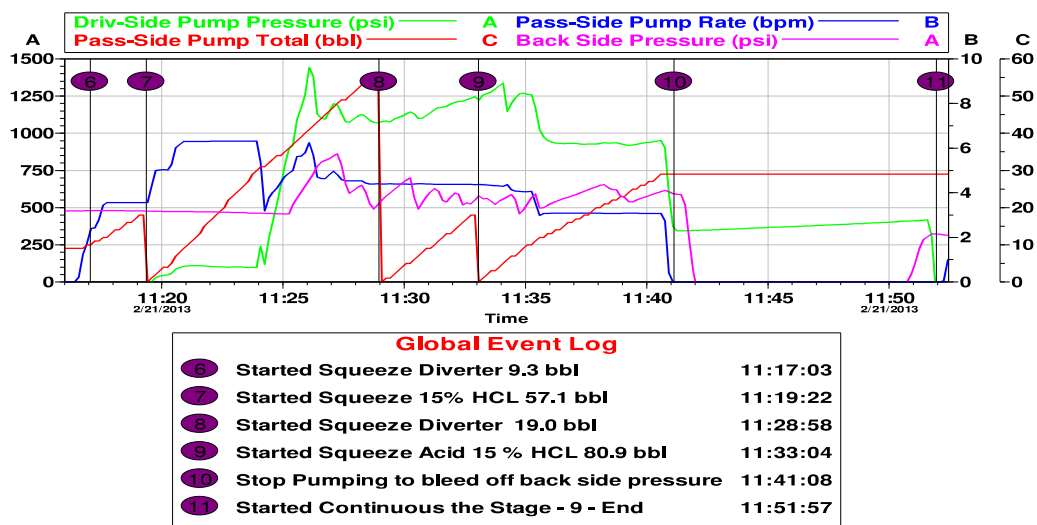


Fig.5 Squeeze Acid and Diverter after Soaking - Agitation Treatment - Stage 1

The final results of Squeeze at the last stage (Switch to water to displace) as following below and shown in the Fig 6.

- The pressure was 2104 psi and the rate was 5.136 bpm.
- The pressure was 1419 psi and the rate was 2.65 bpm.
- The pressure was 2032 psi and the rate was 3.26 bpm.
- The pressure was 2488 psi and the rate was 4.065 bpm.
- The pressure was 942.4 psi and the rate was 1.980 bpm.
- The pressure was 1194 psi and the rate was 1.960 bpm.

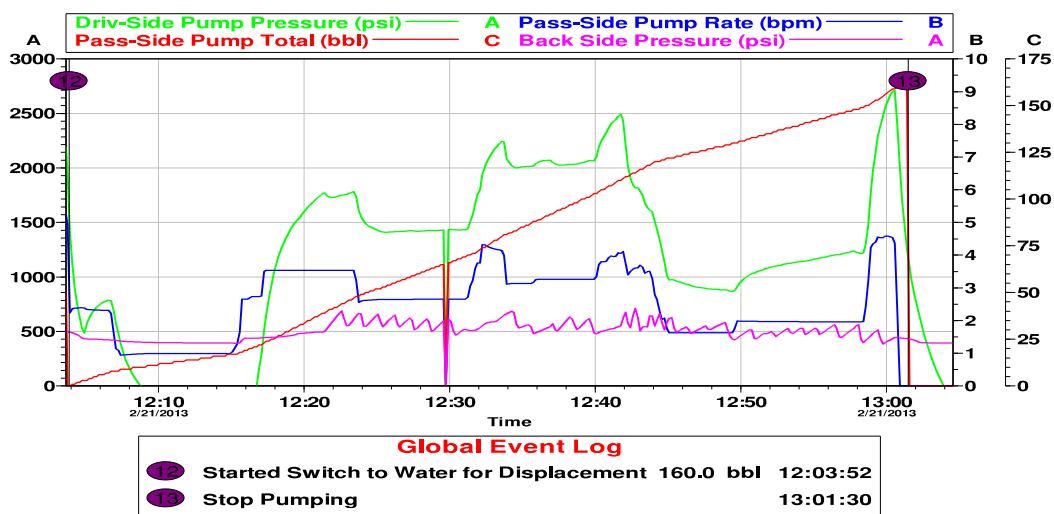


Fig. 6 Switch to Water to Displace and Continue Squeeze - Stage 1

The low producing which has high skin then its need to remove this Skin to increase the productivity index then we can increase the liquid rate production. Otherwise after running flowing gradient reservoir survey (FGS) that give me indication if there is some cause of damage and/ or not around the wellbore when compared with the last one on it. Alternatively, installation of gas lift design which allows an increase of the producing from Amal formation , less gas injection be the more effective methods of increasing the production when compared unstimulated and the target point of injection depends on PI after stimulated or unstimulated as show in Fig. 7 to Fig. 10.

When stimulated Amal Formation (B), Duns and Ros (Std) gave the best match with the real measurements of Pressure/depth survey data obtained from Running FGS, when compared with the other Correlations although unstimulated was Gray on it.

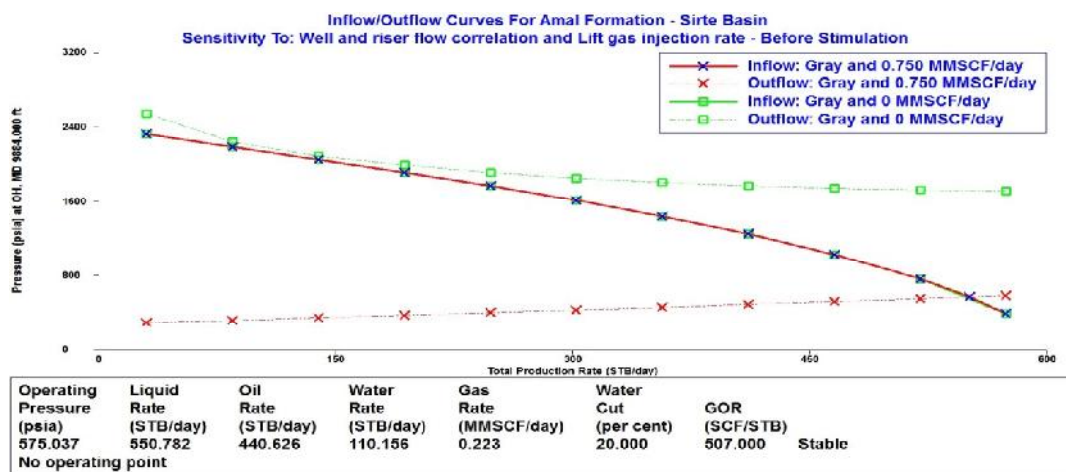


Fig.7 Inflow/Outflow curve unstimulated

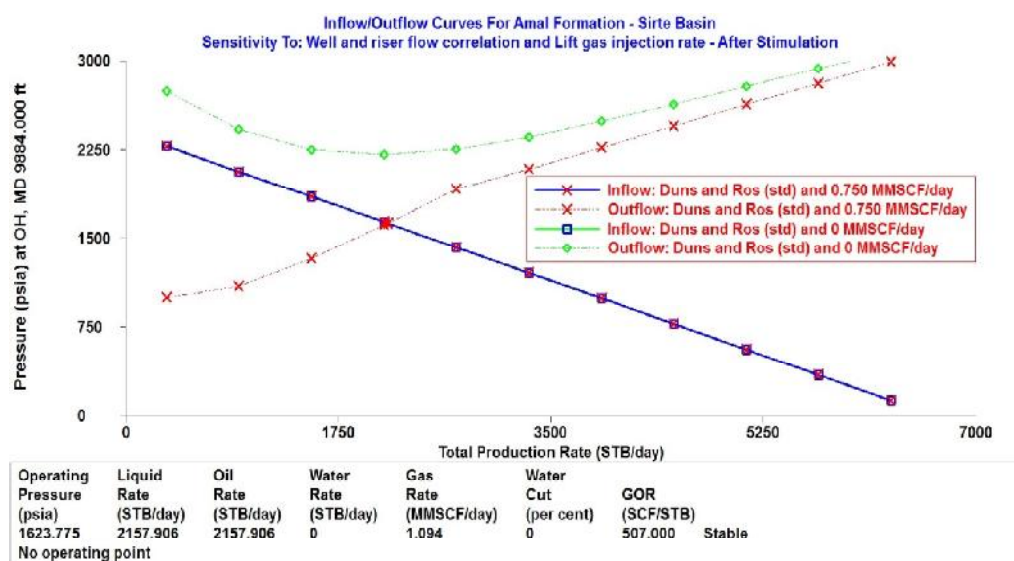


Fig. 8 Inflow/Outflow curve stimulated

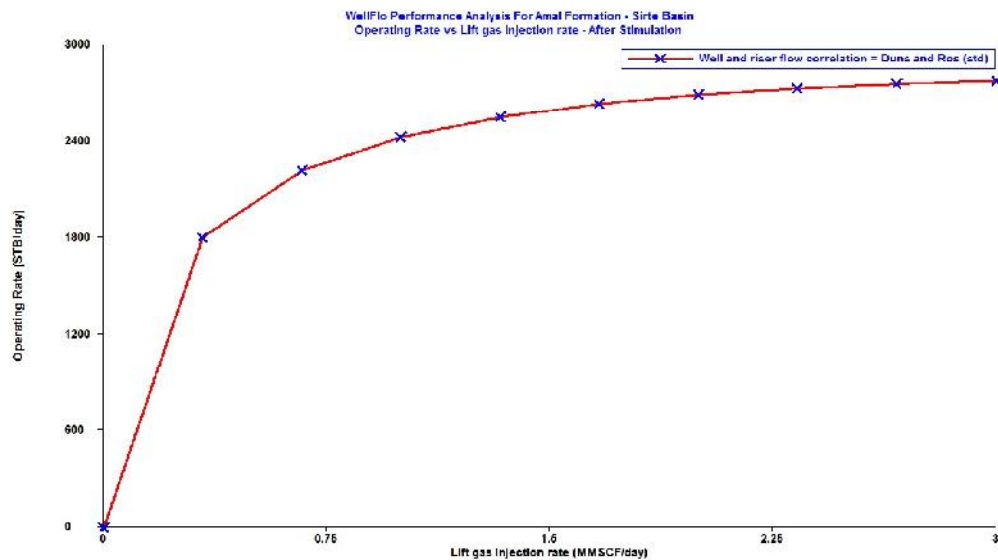


Fig.9 Lift gas injection rate after Acidizing

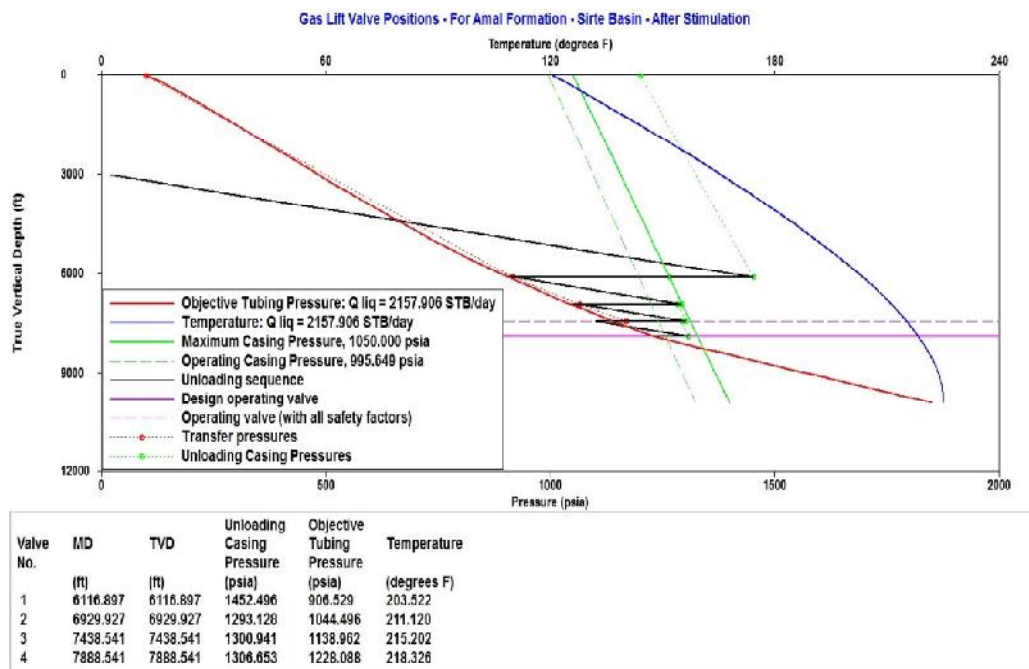


Fig. 10 Gas lift positions after acidizing

4. CONCLUSION

The resulting of the modification of Amal Formation that's meaning as the reservoir fluid properties near to the wellbore, gives lower near well-bore pressure losses, lower skin and an improvement in well productivity.

Two factors that affect the increase of this pressure drop are the amount of the permeability impairment, which is measured as a permeability reduction, and the radial thickness of the impaired or damage area. Otherwise, stimulation of Amal 'B' is to remove the skin damage near the well bore and to improve well influx (productivity) into well bore vicinity; this can be achieved by a 15% HCL acid with Halliburton additives and Guidon as diversion system.

When designing an acid job, the engineer must be aware the various types of damage that can occur and take the necessary steps to prevent them. The most common types of formation damage caused during acidizing as formation de-consolidation, fines mobilization reaction by-products, chemical incompatibilities, precipitation of iron compounds, emulsions and sludges.

The criteria used to choose the optimum injection rate is basically called the technical optimum injection rate. However, the economic optimum gas injection rate will be somewhat lower, which is denoted as the gas injection rate at which the marginal cost of providing extra injection gas is equal to the marginal revenue from the extra well production gained from that extra gas. In addition, Down hole sampling, PVT, special core analysis to help better understand reservoir response to different plan scenarios , good reservoir and geological description like bed thicknesses, faults, fractures, rock type, geometry and structure through extra seismic acquisition if necessary.

COMPETING INTERESTS

Author has declared that no competing interests exist.

ABBREVIATIONS

AOF:	Absolute Open Flow
API:	America Petroleum Institute
Btm:	Bottom
D PC:	Differential pressure casing
EPSE:	Edinburgh Petroleum Services
FBHP:	Flowing Bottom Hole Pressure
FWHP:	Flowing well head pressure
G.O.R:	Gas Oil Ratio
G.L:	Gas Lift
IPR:	Inflow Performance Relationship
MMSCF/d :	Million standard cubic feet per day
MD :	Measured Depth
MPP :	Mid Perforation Point
OP :	Operating Pressure
Pt :	Tubing Pressure
Pso :	Surface Opening Pressure
Perf	Perforation

PI	Productivity Index
Pwf	Bottom hole Pressure
Pr	Reservoir Pressure
PI	Productivity Index
Tbg	Tubing
TD	Total Depth
TVD	True Vertical Depth
W.H	Well Head
WC	Water Cut
VLP	Vertical Lift Performance
HCL	Hydrochloric Acid
HMS:	Halliburton Mangment System
Md:	Milli Darcy
Kh:	Permeability Thickness
S:	Skin
Gal	Gallon
bbl/min	Barrel per Minute
Ft	Feet
PSI	Pounds Square Inch

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