Abandonment of an Iraqi Well, justifications and feasibility study

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Abstract:

At the beginning of petroleum industry evolving the regulation did not focus on environmental issues, it was, mainly, looking to natural resources (oil and gas) production and protection. By the time, environmental and safety implications started to be the highest priority, as a result of undesirable impact of oil operations on plant. Huge numbers of dry wells were abandoned according to environmental regulations to prevent side effects which involved contamination of shallow water aquifers, surface seepage of hydrocarbon (whether oil or gas) or salty water, potential hazardous of explosion or soil contaminations, and water contamination at offshore unplugged wells. Based on the hazards above, the main objectives of plugging and abandonment operations is to achieve isolation and protection of all fresh and near fresh water zones, and all future commercial zones, as well as prevent leaks in perpetuity from or into the well and remove surface equipment and cut pipe to a mandated level below the surface.

In this paper, an Iraqi oil well was studied as a case study of abandonment processes. The well represents a danger to people, environment and subsurface fresh water; due to unusual raised pressure in different annuluses and copious surface leak from wellhead components while production. Worthily to say that, it is seldom in Iraq to abandon the wells in current time, according to good reservoirs situation. The reasons and justifications of this well plugging, depending on economic analysis and investigation were studied, and explained, according to international practices and procedures of such treatments. The workover option is most economic option, but it was eliminated due to failure in ensuring the well safety and severe environmental impact which expected. According to investigation, pressure and

laboratory tests were revealed that P&A is mandatory for this well as soon as possible.

1. Introduction:

As normal, production wells have limited economic life periods according to amount of oil in reservoir, their location in the reservoir, and the status of their components (casings, cement behind casings and wellhead). Sometimes, this limited life for a well is relatively short, because of the severe technical problems such as corrosion of casings which lead to connection between formations fluids, and might be leaking to the surface [1].

The well (wells) should be plugged after abandonment decision has been taken. For example, according to Schlumberger Plugging and Abandonment (P&A) definition: (To prepare a well to be closed permanently, usually after either logs determine there is insufficient hydrocarbon potential to complete the well, or after production operations have drained the reservoir) [2]. This procedure is to prevent migration of fluids whether hydrocarbon or contaminated water up hole after time later, which may contaminate fresh water, or to treat this technical issue according safety and environmental regulations [3].

Over 100 years, it seems there were no significant changes by abandonment treatments. Since 1919 there were regulations in Texas belong abandonment of oil wells issued by Railroad Commission (RRC). In Article 3 of these regulations, the followings were written: “dry or abandoned wells be plugged in such a way as to confine oil, gas, and water in the strata in which they are found and prevent them from escaping into other strata”[4]. The scenario of P&A been more complicated after reentered to antiquated of oilfields according to new technology which generally lead to increase the pressure of reservoirs and consequently increase the probability of contamination of fresh water aquifers. [4]

This process would cost a millions of US dollars because it needs to rent a daily workover rig and operation’s expenditure, which representing by materials, logs... etc.

This paper presents a case study of an Iraqi oil well which is in processes of abandonment including reasons of well abandonment decision, overview of methodology of work, technical justifications of plugging and the benefits of this abandonment.

2. Planning of Plugging and Abandonment (P&A) scenarios:

Depending on many factors, like location of well, complexity of original design and the type of well (onshore or offshore), the cost of P&A is different from well to other. It's clear that P&A of wells has no income to operators and owners companies. It's an environmental obligation of these companies to committing in terms of best international petroleum practice. Governments and legal authorities have to supervise the process of P&A to prevent impacting the environment negatively, and to keep people healthy and safe.

Many decisions of P&A were taken by operating companies itself, because of economic issues, which mean, if the cost to operate the well is less than the income of that well, it better to plug it[3]. On another hand, operating companies are looking to reduce P&A cost, so, some of them started to use rigless operations to perform the plugging operations to save the cost of daily rig and moving costs. But, rigless operations, always, take time loner than using the workover rig [4].

The cementing operation is the nerve of P&A plans, while, the logging to evaluate cement quality behind the casing and detect the top of cement (TOC) is needed as well. The milling tools are needed some times for P&A process.

Operationally, P&A starts by rigging up and pull out of hole all completion string (tubing, packers, Accessories), and, consequently setting the required cement plugs in specific depths. These cement plugs generate barriers facing and above production zones or water zones for complete isolation.

Belong casings, there were two scenarios:

- Plug the well and leave all casing strings inside.
- Cut and pick up to surface non cemented casing, In order to set a permanent.

3. Iraqi oil well Plugged and Abandonment. (the case study):

This well drilled in 1979, but didn't produce from target reservoir according to extraordinary war situation at that time, so it buried by sand which led to fast corrosion of wellhead components. It recompleted in 2001 as a production well from Nahar Omar reservoir by using 3 ½" tubing (kill line) without packer. In 2011, a leakage from all side valves and tubing hanger was noticed for the first time. In the case of high production rate (64/64 chock size or higher), the leakage was observed even in the head of the surface casing (annulus C), Figure (1).

The well schematic is shown in Figure (1) and annuluses which named (A, B, C, and D). It can be noticed that, the 7” casing in Figure (1) was plugged by cement plug since 2001. And according to non-use of production packer to isolate the tubing from annulus A, So the whole of production casing was exposed to corrosive hydrocarbon for decades.

WHERE:

A= Annulus between CSG 9 5/8”and 3 ½ Tubing ”

B = Annulus between CSG 9 5/8” and CSG 13 3/8”

C = Annulus between CSG 13 3/8” and CSG 20”

D = Annulus between CSG 20” AND Conductor 30”

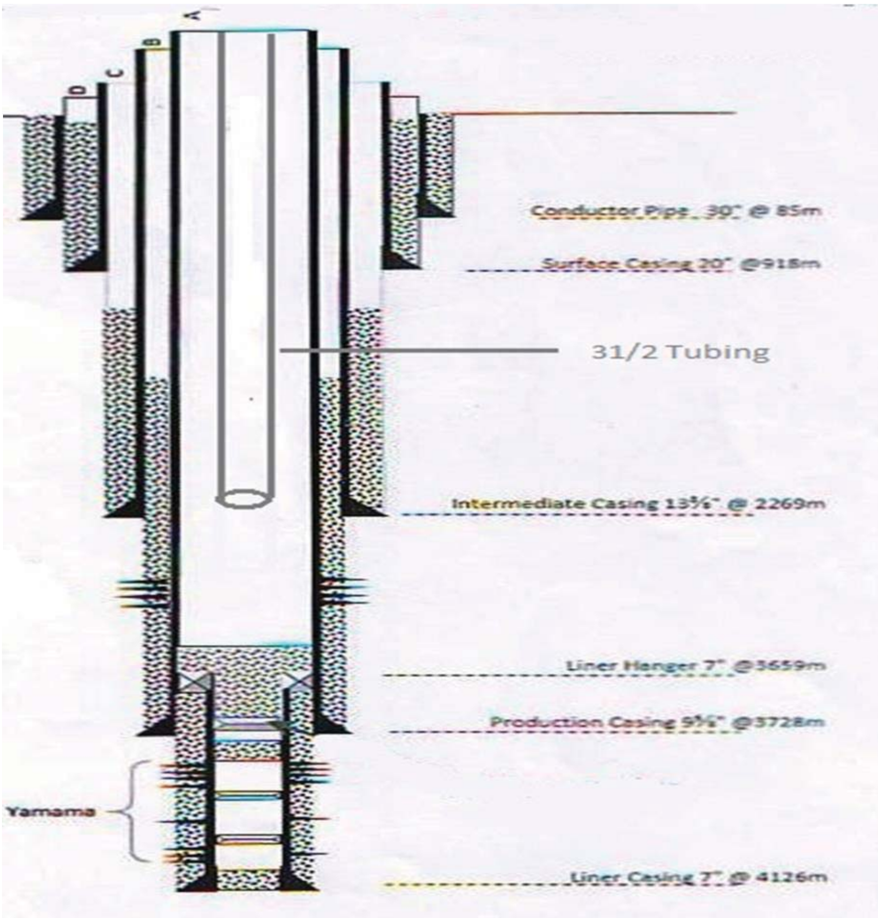

Fig. (1) X-Well schematic with mention to annuluses (A,B,C and D) [7]

4- Well pressure behavior:

A pressure gauge had been installed on side valve of wellhead (casing spool) to read the pressure in annulus B. The reading was (1100) psig in 2011, but, after bleeding off the pressure, the gauge reading started to reduce to 100 psig. After two days close in, gauge returned to read 1100 psig.

In February 2012, all valves been checked. They were in a good condition with no leak in all of them. The pressure reading in the head of annulus B while production was 700 psig.

In September 2012, the operating company took the decision to shut off the well according to the dangerous situation which represented by pressure build up in different annuluses and the surface leakage probability which will lead to contaminate shallow water sources.

After three months a leakage had observed from 20” casing (C annulus). Then, the well was killed in mid-2013 by circulation of (10) ppg brine through tubing.

Well pressure before and after killing had been taken for 7 days as shown in Table (1).

Table (1) Well Pressure behavior for 7 days before and after the killing of well [7]

Date	CIPHP/psi	Annulus’A’/psi	Annulus ‘B’/psi	Situation
7-7-2013	1740	1650	1100	Well is Shut down
8-7-2013	0	0	1100	Well was killed
9-7-2013	150	400	1100	Monitoring
10-7-2013	180	300	900	Monitoring
11-7-2013	180	300	750	Monitoring
12-7-2013	180	300	750	Monitoring
13-7-2013	180	300	750	Monitoring

It seems that, there is a communication between annuluses A & B even after killing the well. Production casing was damaged (corroded) to allow fluids to pass from annulus B to create the pressure in the top of annulus A.

5- Hydrocarbon analysis:

A sample of crude oil had been collected from leak place (annulus B) and second one from normal production place (Tubing/ annulus A). Chromatogram analysis was done for both samples investigate the source of annulus B sample. The matching of both samples means that, leakage oil is from the main reservoir (Nahar Omar) production through casing heads, while the un-matching means that this oil is from a different source. Results of analysis are shown in Figures (2 and 3).

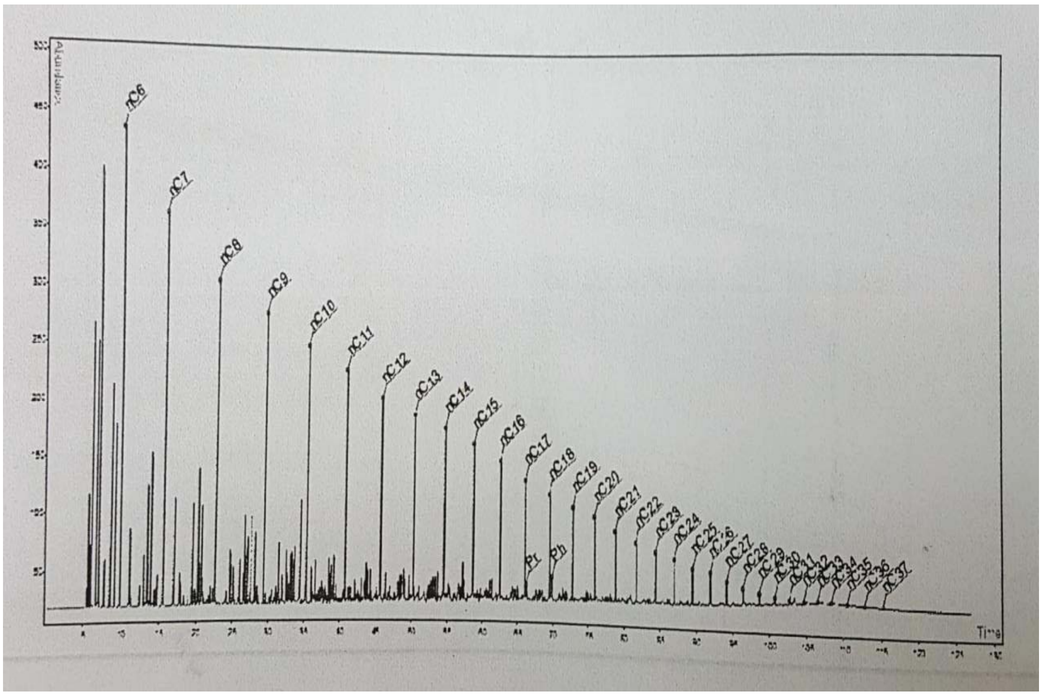

Fig. (2) Chromatogram analysis of Oil produced from annulus A [7]

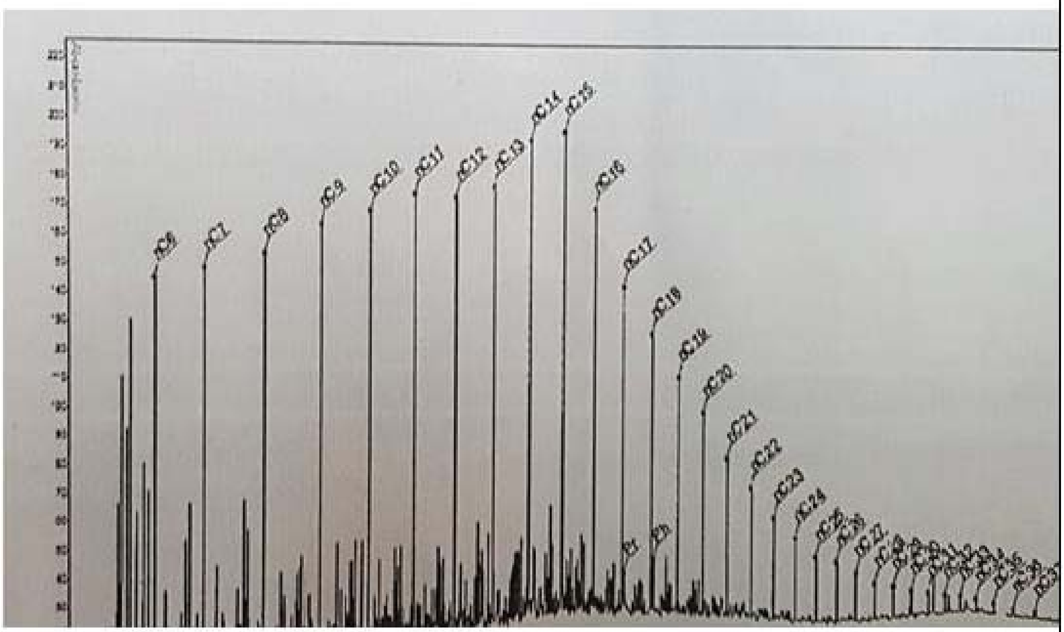

Fig. (3) Chromatography analysis of Oil leaked from B annulus [7]

From Figures (2 and 3), it's clear that both samples have different C-components. Sample in graph 3 (leakage oil) shows high concentration of nC (9-21), which means that, oil of annulus B is came from shallow reservoirs due to poor isolation of casing. From chromatography analysis and pressure behavior of well, it is confirmed that source of Pressure in B annulus is different reservoir despite of communication between A& B.

6- Workover operation choice:

According to good productivity of the well, till shut down the well in 2011, the workover choice was preferable to save the well. Workover plan included the following activities:

- Rigging up workover rig
- kills the well and pull out of hole completion string;
- Perform many squeezes jobs behind production casing 9 5/8” according to cement log interpretations.
- Run in hole 7 inch casing to the bottom of well
- Cement this casing in order to overcome the suspicion of corrosion and leaks which comes from other reservoirs to annulus A.

Unfortunately, the above program will not be able to solve the leak in annulus B (between 9 5/8" and 13 3/8") and C (between casing 13 3/8" and 20"), it means that the risk will be existing and the probability of contamination of shallow water formations still existing too. So the option of workover has been eliminated.

7- Abandonment procedures of the well:

Generally, Wells must be abandoned in a manner to ensure the following:

1. Adequate hydraulic isolation between porous zones.
2. Fluids will not leak from the well.
3. Excessive pressure will not build up in any portion of the well.
4. Long-term integrity of the wellbore is maintained.

So the plan of P&A process begins from bottom to top. For each casing string, it is important to be sure that, the depth down the casing shoe isn’t cased, and not cemented. The aim of that is to perform cement plug correctly. As specified in API 65-2, to set plugs in places and provide multiple barriers. Abandonment barriers installed during wellbore P&A treatments may include [5]:

— plug set across any exposed casing/liner shoe.

— Plugs set in open hole.

— Cement or mechanical plugs, or both, set above perforated intervals in cased hole;

— Plugs set at points where casing has been removed.

— Plugs set across liner tops.

— Plugs set above and below water bearing zones.

— Plugs set above or below hydrocarbon bearing zones or other potential flow zones;

— Plugs set at the surface or mud line.

The case study well has more than 8 reservoirs located in different depths between 2000 m to 3500 m. Some of these reservoirs consist from many production layers. In addition, this well has three strings of casings with high probability of corroded intervals of casing according to previous experience which came from offset wells. For that, P&A operation should be more accurate and specific. P& A procedure consists from the following steps:

- Remove X-mass tree and install BOP.
- Circulate to kill the well.
- Retrieve completion string and tubing.
- Carry out isolations by cement plugs 1,2,3,4 as shown in figure 4. The aim of these plugs is to isolate reservoirs each from other.
- Run CBL log to determine the top of cement of production casing 9 5/8” to cut and retrieve the free casing, accurately to surface.
- Carry out plug 5 to isolate the shallower hydrocarbon bearing zones from the deeper water bearing zones.
- Run CBL log again to detect the TOC of 13 3/8” to cut and retrieve the free casing to surface.
- Carry out plug 6 which located under the shoe of surface casing 20” to isolate shallow hydrocarbon bearing zones.
- Carry out shallow cement plug at 20 m depth.
- Cut 20” casing and the conductor 30” in about 3 m below ground level.
- Finally, filling the hole by sand.

The balanced-plug method involves pumping the slurry through drillpipe or tubing until the level outside is equal to that inside the string. The volume and hydrostatics of wellbore fluids, pre-flushes, spacers, and plugging fluids must be carefully calculated to ensure that the system is being correctly balanced in the hole. The pipe or tubing is then pulled slowly from the plugging material before it sets, leaving the plug in place.

After each plug, testing is required to ensure that the plug is a placed at the proper level and provides zonal isolation. The plug can be verified by tagging its top, pump pressure testing or swab testing [6].

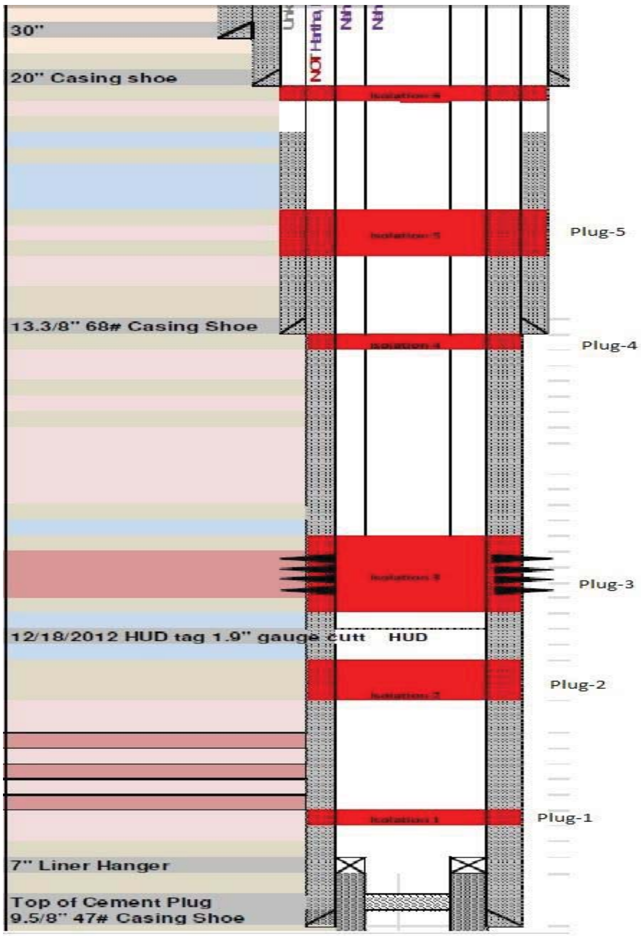

Fig. (4) X-Well plugs No. 1-2-3-4 [7]

8- Conclusions:

1. P&A was mandatory for this well according to investigation, pressure and laboratory tests.
2. The workover option of this well was the most economic option, but it was eliminated due to failure in ensuring and satisfying well safety.
3. High impact risks were expected to surface area, fresh water zones, populations and environment unless starting the P&A of this well.
4. The method of Cut and pick up to surface all non-cemented casings must be used (in this case) in order to set permanent plugs.

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