BULETINUL Universităţii Petrol – Gaze din Ploieşti	Vol. LX No. 4A/2008	109 - 114	Seria Tehnică

Example of Well Abandonment with Non Conventional Bingham Plastic Fluids

Claudiu Pupezescu

Universitatea Petrol – Gaze din Ploieşti, Bd. Bucureşti, Nr. 39, Ploieşti
E-mail: cpupezescu@yahoo.com

Abstract

The scope of the paper work is to compare the traditional method of well suspension and abandonment, meaning using cement plugs, with a possible new method using a Bingham plastic fluid relatively new on the market – Sandaband. The study wants to highlights time reduction, cost reduction and the safety egress by using non traditional materials. The article will present a proposed programme on a well in Central North Sea area, including volumes calculation and the time and cost reduction compared with the classic operation.

Key words: *Central North Sea, well, suspension, abandonment, Sandaband*

Introduction

Sandaband is a Bingham plastic fluid and is a relatively new and patented product in the market to improve the efficiency in abandonment of wells. The product is based on special blend sand slurry, which through its low permeability and high specific gravity works as a plugging material. The product is protected by an international Patent, [4]. Sandaband Well Plugging AS from Norway is holding a licence to use this product.

There are three main applications for Sandaband:

- PM – Plugging Material, to be used for: Temporary and permanent plugging of wells (SAND for ABAND –onment); the abandonment status can be changed later, when decision has been reached. The paper will be focused on this issue.
- AM – Annulus Material: Fill behind casing during the drilling operation (primary cementing) or as the remedial treatment for (cement) barrier failure.
- LCM – Lost Circulation Material: Curing of ”thief zones” during drilling and hole reinforcement (formation fracture gradient improvement).

The paperwork will present the use of this product on a North Sea well. The main issues with this well are LSA scales in the tubing and control lines. Following UK regulations control lines cannot be a part of the cement plugs while abandoning the well. To remove the control lines, the tubing needs to be pulled and the LSA scale addressed accordingly. While using Sandaband, if the control lines will be part of the plug and they will corrode, the material being self – healing will fill the possible flow path.

Case Studies

BP Ula 7/12-A-15 Well

The Ula A-15 has been an oil producing well and it was shut in due to downhole safety valve (DHSV) problems. The objective of the operation was to temporary plug the tubing with Sandaband, in order to control the formation pressure, estimated to be 415bar. The well was successfully plugged with $22m^2$ of Sandaband on 02.02.2007. Sandaband was bull headed down the tubing and stopped as expected in the perforated interval. Sandaband filled the production tubing to 1800m RKB. Total duration of the operation (the time from when the materials and equipment arrived on the platform to when everything was packed up and shipped off after the well was confirmed dead) was 2 days. The well will be kept on observation for 1-1/2 years and will be re-entered and sidetracked at a future stage.

Statoil – Kristin Field, Well No. 6406/2-S-3HT3

The well was plugged with Sandaband in January 2004 to wait for completion equipment. The $2200kg/m^3$ plug was placed from 4917mMD to 5150 mMD in 30° - 35° deviated section. The plug was washed out in February 2006 and the well was completed, proven to be the best producer in the field.

ConocoPhillips – Albuskjell Field, Well 1/6 A-04

The well has been plugged permanently in December 2004, with $19.2m^3$ of $2200kg/m^3$ Sandaband from 368mMD to 247mMD or a length of the Sandaband Plug of 121m.

Sandaband is qualified for use in weak overburden

A StatoilHydro well in Norway has been plugged on June 27th 2007 in the uppermost 180 m section below sea bottom, using $2200kg/m^3$ Sandaband material showed that a full column could be placed in the un-cased test well without noticeable loss to the surrounding formation. This is in stark contrast to the previous well where cement could not be contained in the casing/formation annulus, but resulted in a leaking annulus without noticeable cement. Using Sandaband behind the casing, the annulus can be filled all the way and communication through the annulus is avoided.

Proposed Method

Well status

Depth reference is Mean Sea Level. Interpolated approximately based on data showing SSTVD and MD, with RKB 25,3m above MSL. The well data which are listed bellow are also shown in fig. 1.

- 13 3/8" casing is set @ 1404 m (1372m TVD).
- 9 5/8”" casing shoe = 2598m MD = 2499m TVD
- Calculated TOC behind 9 5/8” 2166m MD

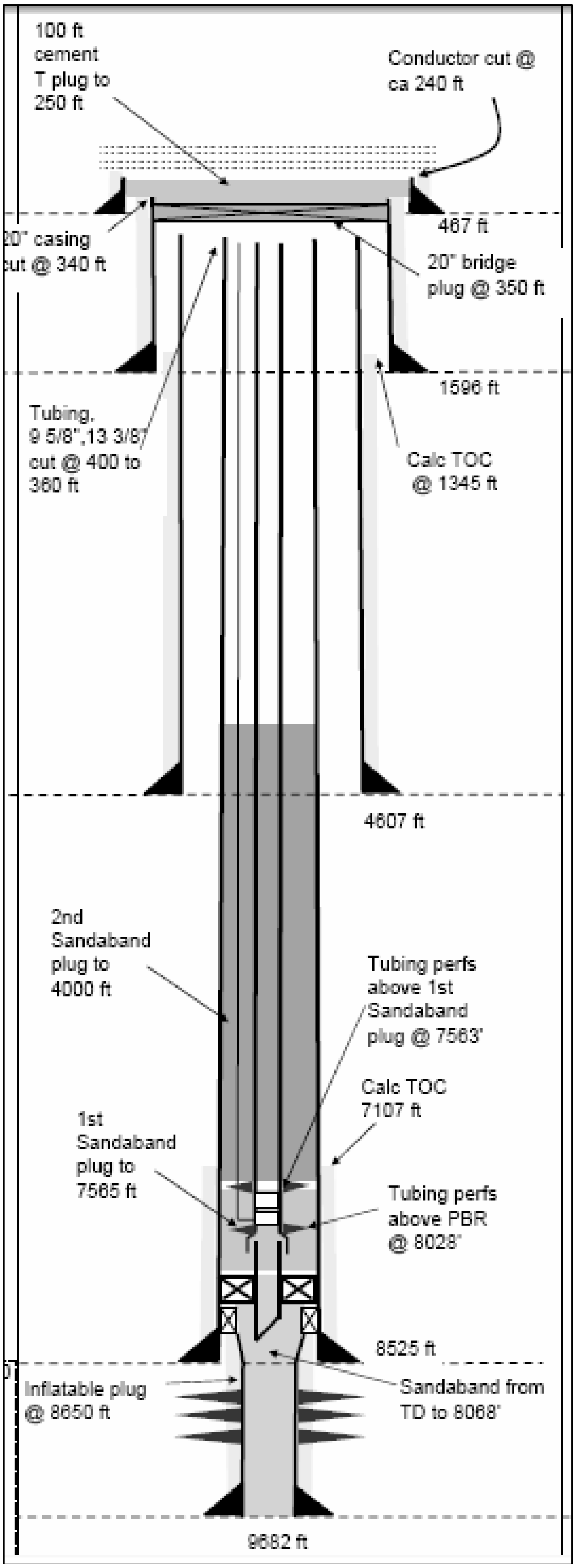

Fig. 1. Proposed Well status

- 5 ½" completion from 70+m down to PBR.
- PBR @ 2447m MD = 2360m TVD.
- Production Packer @ 2459m MD = 2368m TVD.

- Top 7" liner @ 2476m = 2388m TVD.
- Top 5" liner x-o @ 2521m MD = 2428m TVD.
- Perforations @ 2660 – 2769m MD. Top perforation = 2493m TVD
- TD 5" liner @ 2951m MD.
- Top reservoir 2639m MD - 2492 feet TVD.
- Original estimated reservoir pressure @ top perforations = 388bar.

The well will be plugged and abandoned with Sandaband. On top of Sandaband the well will be filled with sea water. As we can observe in fig. 1, the production liner will be filled with Sandaband up to bellow the packer. Then, a second Sandaband plug will be pumped from above the production packer to approximate 1219m. From 1219m to surfaces the well will be filled with sea water. The following section of the paperwork will explain how this depths will be obtained and how the hydrostatic pressure of the Sandaband and seawater must overcome the virgin reservoir pressure.

Capacities

13 3/8" x 9 5/8" annulus capacity (ID=12.415") = 31,14 l/m

9 5/8" Casing capacity (ID=8.535") = 36,93 l/m

9 5/8" x 5 ½" annulus capacity = 21,59 l/m

5 ½” Tubing capacity (18# ID= 4.83”) = 11,84 l/m

7” liner capacity (29#; ID=6.184”) =

. 19,35 l/m

5” liner capacity (18# ID= 4.83”) = 11,84 l/m

1psi=0,0689bar; 1foot=0,3048m.

Calculations

Estimated original formation pressure at TD = 5632 psi=388bar. Although the reservoir pressure has been depleted to slightly below 5000 psi=345bar, a permanent abandonment should anticipate a full pressure re-build in the future.

- Assuming minimum Sandaband weight 18.3 ppg (2200kg/m^3)
- Seawater at 8,59 ppg (1029kg/m^3)
- Requirement is to hold back 5632 psi (388bar) @ top perfs = 8177 feet (2492m)TVD, with a column of Sandaband + sea water to mean sea level.

Sandaband is a Bingham plastic that provides a hydrostatic head, plus a pressure gradient equivalent to the Yield strength between the Sandaband plug and the casing wall, along the well length.

The yield contribution to plugging back pressure has been tested on numerous occasions to give 0,65 psi/foot along tube with ID = 4.00”. The yield contribution is inversely proportional to the ID.

From Top of Perforations at 8728feet (2660m) MDSS to WEG at 8137feet (2480m) MDSS:

Yield contribution = 0,65*(4,00/6,184) * (8728 – 8137) = 248,5 psi (17,3bar)

Hydrostatic head = (8728 – 8137)*cos(58) * 0,052 * 18,3 = 298,0 psi (20,5bar)

For the other section the calculation will be similar and they are summarised in table 1:

Table 1. Pressures.

Depths, m	Yield contribution, bar	Hydrostatic head, bar
Sandaband		
TOP 2660m – WEG 2480m	17,3	20,5
WEG 2480m – 2369m	7,7	20,5
2369m – 1823m	37,3	108,5
TOTAL = 208,9bar		
Seawater		
1823m – 0	N.A.	184,5
TOTAL = 393,4		

From table 1 we can observe the total hydrostatic pressure 393, 4bar is greater than virgin reservoir pressure 388,0bar. To be sure that no incidents will occur in the future a 30% safety factor must be employed. Bearing this fact in mind the second Sandaband plug will go up to

1219m and not only to 1823m. Using the same calculations we will obtain a total pressure (Sandaband and seawater) will be 504,9bar. This will give us a 31,2% safety factor

Using the capacities listed above the volumes of Sandaband to be used will be the following:

Underneath the packer = 4,7 m3

From 4000' down to packer = 40.8 m3

Total Volume = 46 m3

With this volume of Sandaband pumped in hole, a pressure safety factor of 31.2% would result.

The losses (left behind in the tanks, losses in hoses and pump) would amount to approximately 2 m3.

The volume of Sandaband should then add up to 48 m3.

Costs

If we compare the timings in the cost estimates in [5], at a glance it can be observed the 1.2 days operating time reduction when using Sandaband. This not only means that rig cost is cut down but also all the other costs are reduced. For the well the cost reduction value is £274,454. This cost reduction can be achieved just by switching from the use of classic methods of well suspension (cement plugs) to Sandaband.

Sandaband can be used with no risk in plugging wells with control lines left in place because the tests evaluated the case studies above demonstrate its self repairing properties. Not being necessary to pull out the completion tubing, probably contaminated with LSA scale, and not being necessary to dispose of the contaminated tubing will increase the safety of the operations and , nevertheless, will cut the costs even more.

The next table, table 2, summarise the costs of Sandaband operation for the well. 48m^3 of Sandaband slurry will be used, equipment turnaround is 7 days and employee turnaround, 4 days.

Table 2. Costs.

Sandaband Operation				
Item	**Price (£)**	**Quantity**	**Operational time needed (day)**	**Total Cost (£)**
Hose Package	450/day	1	11.1	4,987.5
12 m^3 Tanks	444/day	4	11.1	19,684.0
Diesel/Hydraulic Power Unit	729/day	1	11.1	8,079.8
HP Triplex Pump	1100/day	1	11.1	12,191.7
Supervisor on site	1162/day	1	8.1	9,392.8
Senior operator on site	1072/day	1	8.1	8,665.3
Sandaband	3487/m^3	48	N/A	167,376.0
Mobilisation Jaerbetong	1121	1	N/A	1,121.0
Engineering Planning	94/hour	50	N/A	4700.0
TOTAL				236,198.0

Conclusions

Looking at the 4 case studies we can see that all the previous experiences with Sandaband are successful. After a couple of years of observation no pressure build up was observed.

The second part of the article shows us how we can use a non-traditional material to replace a conventional one: cement. This not only means an innovative way of abandoning a well but can mean also great savings for the operator.

References

1. *** -A.N.R.M - *Instrucțiuni tehnice privind avizarea abandonării/ridicarea abandonării sondelor de petrol şi progamul de de asigurare a sondelor propuse spre abandonare şi abandonate.*
2. *** - Offshore Installations and Wells (Design and Construction, etc.) Regulations 1996 (Statutory Instrument 1996 No. 913)
3. ***- Oil and Gas UK *Guidelines for the suspension and Abandonment of Wells*, Issue 2 July 2005.
4. Svindland, A. - *Method and plugging material for reducing formation fluid migration in wells* ,Patent No. 6,715,543
5. ***- ADTI (Transocean), *Time and Cost Estimates*.

Exemplu de sondă abandonată cu un fluid neconvențional de tip Bingham plastic

Rezumat

Scopul lucarii este să compare metoda tradițională (cu dopuri de ciment) flosită în abandodonarea sondelor cu o nouă metodă, în care se utilizează un fluid de tip Bingham plastic, produs relativ nou apărutpe piață – Sandaband. Studiul vrea să sublinieze reducerea duratei operațiunilor, costului şi îmbunătătirea protecției muncii în utilizarea materialelor neconveționale. Articolul sudiază cele expuse anterior pe o sondă din Marea Nordului, incluzînd calculul volumelor de material necesare.