SAND CONTROL IN NIGER DELTA FORMATION

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ABSTRACT

In poorly consolidated sandstone formations, grain of sand that make up the sandstone are pulled loose from the formation and are carried off by the fluid flow. The sand causes a lot of problems that can mean a considerable decrease in productivity and adverse safety conditions. Costly work over operations may become necessary as a result. This paper, generally review the meaning of sand production, its causes, effects and control. TEGA Well 002 of SPDC in Niger Delta was used as a case study .The well was drilled and completed as a dual string produce on 21st November 1999 to a total depth of 6789ft. Sand production was influence by certain factors at the depth of 6660ft.Which include :Natural cause(un-consolidation producing) and failure of sand consolidation and the following were some of the effect of sand production:(i)The erosion of choke (ii)corrosion accelerated (iii)Deposits are laid down in the flowlines or in the process facilities equipment (iv) Loss of man-hour during the period of close-in in terms of wages, which add up to overhead cost. The method of sand control adopted in TEGA well 002 was discussed and also while sand consolidation (SCON) method failed, Internal gravel packing was chosen as the cost-effective method of sand control in the well.Finally,conclusion and recommendation were base on the benefits derived from the installation of internal gravel packing(IGP).

INTRODUCTION

Sand production and sand control are among some of the oldest problems of the oil industry. The Niger- Delta which constitutes the sand is also known as the "PAYZONE" in the country where gas and oil reserves characterized by loose and unconsolidation formation which has negative effects during production of oil and gas (DENSIS P., Michel .C. and Georges.G., 1995).

As a result, the paramount goal of the oil industry is to produce oil and gas at a minimum of economic cost. Therefore, the efficient management of petroleum reservoir requires adequate and proper well practice in order to have a sound knowledge of the performance and production changes of the reservoir. Hence, sand control can be defined as the means of reducing and preventing the influx of sand grain into the well bore to avoid the multitude of inconveniences and serious well damage, which could result to decline reservoir pressure coupled with drag force of the fluid flowing with high flow rate together with that of fluid velocity. Often sand production problems are created by less than adequate completion practices, which led to the challenge to complete wells and keep formation sand in place without unduly restricting productivity.

However, this paper we will review the causes of sand production, and how it can be predicted and controlled, some methods that will use in controlling this sand grain will be highlighted in this paper. The aim of this paper is review the problem of influx of sand production in the reservoir that lead to loss of productivity, causes and effects of sand production.

CASE STUDY

TEGA well 002 Owned and operated by the Shell Petroleum Development Company (SPDC) in Delta State is used as a case study for this paper.

BRIEF HISTORY OF TEGA WELL 002

TEGA well 002 was spudded on 21st November 1999 and was completed as a dual string producer and was drilled to a total depth of 6,789 ft. Since inception of the well, the producing interval had a high sand production though it produced for some time, sand free oil, despite that, the well was completed without sand control measure. Due to poor productivity and intolerable sand production, the well was shut-in and was later walked over, following a rapid decrease in production rate, a chemical sand control measure was adopted in the zone called sand consolidation (SCON). A resin treatment was pumped into the formation to hold the formation sand from entering the well bore. When the interval came on production, it produced initially at 3,511 Gross Production (661 day) with water cut of 0% (zero) with the beam choke size of 36/64.

The interval produce a high sand cut of 10ppth on 32/64 beam. On 16/3/2000 and by 17/4/2003 the interval was confirmed sanded up and the flow line was found corroded, after a bottom hole pressure hole pressure (BH.P) survey was carried out and as a result of this, the well was shut-in due to sand production. ISCON activities were repeated for improved production performance and were put back on production but eventually shut-in for poor production rate.

In order to increase productivity and minimum damage to equipment as a result of continue sand production, a mechanical sand control measure was further adopted which called gravel is packing. This method eventually proved good for that zone.

CAUSES OF SAND PRODUCTION IN THE WELL

In TEGA well 002 sand production was influence by certain factors at the depth of 6660 ft. which include:

- Natural Cause -The failure of sand consolidation

NATURAL CAUSE

Unconsolidated formation is incompetent formation. The natural cause of sand production in TEGA well 002 was due to the un-consolidation producing formation, which is also known as incompetent formation in the Niger Delta basin loosely, weak reservoir formation has characterized sand stone reservoir therefore the inter-granular bond between the particles

are weak in which they could not withstand the fluid drag force and as a result sand was being produced.

THE FAILURE OF SAND CONSOLIDATION (SCON)

The second cause of sand production in TEGA well 002 was to the sand consolidation (SCON) failure, which was put in place after a work over on the well. The sand consolidation (SCON) must have failure due to poor injection of the resin into the reservoir, the sand grains at the producing interval was not strongly consolidated. The chemicals where not evenly distributed into the formation. The interval was still experiencing high sand production which now suggests that the (SCON) method used was not the best control measure for that formation.

SAND CONTROL MEASURE ADOPTED IN TEGA WELL 002

As a result of the failure of several consolidation (SCON) in TEGA well 002 a mechanical sand control measure was installed on the sand interval for effective control (George o. Sumar Jur ,1975). After several re-SCON jobs carried out in the well, the mechanical sand control method was installed called ***INTERNAL GRAVEL PACKING***. There after the well was made to flow with the beam size of 20/64 to 52/64 in this measure the gravel acts as an effective barrier to the movement of the formation sand while the wire wrap or screen liner stop the gravel from moving away in position. However, this method yields a good result that lead to consideration gain in oil production and sand is no longer produced till date.

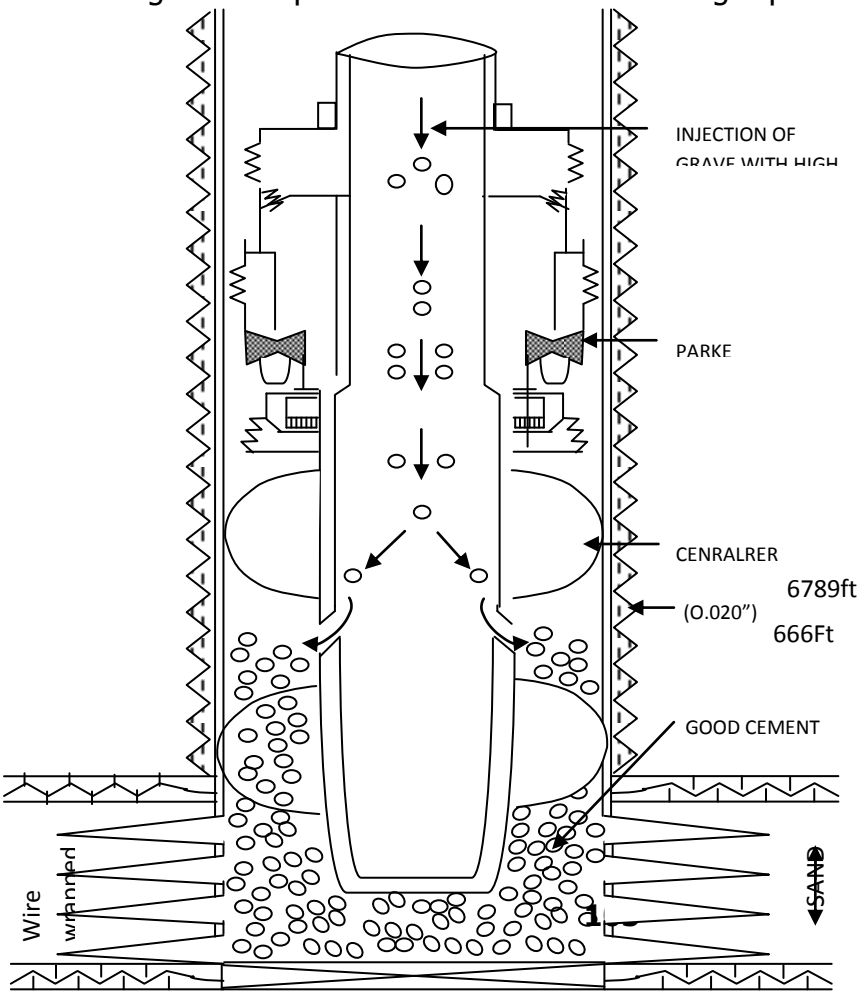


FIG.1.0 INTERNAL GRAVEL PACK (IGP)

PROCEDURE OF INTERNAL GRAVEL PACKING CARRIED OUT AT TEGA WELL002

The influx of sand production in the formation was prevented by the IGP sand control technique. It has a bottom hole temperature of 180^{o} f and the reservoir pressure at this time was 4520 psi at the specified depth. The procedure of IGP method are thus summarized below

i CLEAN OUT WELL: A brine of density 1511b/gal was injected into the well to remove junk debris, loose sand and to have enough weight to control the well. This was done to clean perforation.

ii. INSERTION OF SLECTED SCREEN:

A gravel pack wire wrapped screen of size 0.02 inches was then directly place opposite the perforation at the depth of 6660ft, a centralizer was used to hold the screen at the central position in the well bore **(**Penberthy W.L (Jr) and Shaughnessy, c.m ,1992).

iii. RIH slowly the gravel pack assembly which consists of the following: snap latch, seal assembly, welded screen, blank pipe, safety joint, cross-over sub and wash pipe (Shell international meatshappiz ,smip) (1995).

iv. INJECTION OF SELECTED GRAVEL

0.02 inches gravels were injected into the well bore using a high viscosity fluid (water pack of viscosity 240cps and pressure of 500psi). the pack of gravel was place in the annulus between the screen and the perforation. The gravel pack filled up to the depth interval of the reservoir.

v. The competence of gravel pack was tested and the remaining pressure bleed off.

iv. OPEN WELL TO PRODUCTION

The well was then put on production as soon as the gravel operation has finished. In this manner, the well was opened up gradually to promote perfect arrangement of formation sand on the gravel (Spsc sitp ,2006).

SAND CONSOLIDATION FAILURE

Sand production failure is as a result of incompetent formation or unconsolidation formation. In TEGA well 002, though the well drilled and completed initially without sand control measure in place. Therefore work over, SCON measure was installed in the perforation interval, but since the inception of the SCON, the well was still producing sand more than intolerable, which suggest that the SCON method is not best control method for the formation.

REASON FOR SAND CONTROL FAILURE

Several reasons were responsible for the sand control failure in TEGA Well 002 which includes:

1. Initially, the well was drilled without putting in place sand control measure.
2. The failure of SCON treatment after several re-SCON jobs, which lead to corrosion of the perforating intervals was due to the unconsolidated nature of the producing formation which characterized the Niger Delta basin (Suman, g.o (jr). ellis, r.c. suyder r.e ,1983).
3. Cost for stimulation (matrix acidizing).
4. Cost for sand control operation to bring the well back on production.
5. Cost for work-over operation carried out to repair the flow –line leakage bean/choke erosion.

PRODUCTION DATA OF THE WELL

The following data in table1.0 was used before mechanical method (IGP) was adopted to control sand production TEGA well 002.

TABLE 1.0 PRODUCTION DATA BEFORE MECHANICAL SAND CONTROL

Dates	Choke Size 1/64	Sand Production (pp+b)	J.H.P (PSI)	Water Cut %	GROSS Production BBLID	GOR Scf/bb1	Remark
9/03/00	36	19	960	0	5511	0	
10/03/00	40	357	N/A	0	4933	0	
23/03/00	40	5.7	1100	0	7121	690	
27/04/01	48	12	N/A	0	4092	760	
27/05/01	48	63	N/A	0	4174	430	
09/10/01	28	5.9	N/A	0	4000	677	
24/02/02	28	8.1	N/A	0	3600	1733	
09/11/02	28	20	N/A	3.35	3012	547	
22/02/03	28	2.8	N/A	3.35	4041	287	
25/02/03	28	5.4	N/A	4	6240	285	
24/05/03	32	105	N/A	4	6721	96	
24/03/03	32	8.7	N/A	5.6	6721	241	
02/04/04	32	142	N/A	10	6977	220	
02/5/03	32	146	405	10	6984	207	
17/11/03							SAND UP

TABLE 2.0 PRODUCTION DATA AFTER SAND CONTROL AGU WELL 001

Dates	Choke Size 1/64	Sand Production (pp+b)	J.H.P (PSI)	Water Cut%	GROSS Production BBLID	GOR Scf/bb1	Remark
11/12/03	20	1	0	0	2309	0	Flowing
11/01/04	32	1	4.13	0	4495	0	Flowing
21/02/04	36	4	4.01	0	5282	1210	Flowing
30/02/04	40	5.7	5.43	0	5818	1210	Flowing
5/03/04	44	1.7	4.01	0	7260	1210	Flowing
14/03/04	48	1.1	1.01	0	7140	1210	Flowing
30/04/04	52	1.2	1.04	0	8486	1210	Flowing

EFFECTS OF SAND PRODUCTION ON EQUIPMENT

The series of event continuous production imposed serous damage on production equipment of TEGA well 002. The effect as recorded in TEGA well 002 includes the following:

i) The erosion of choke (surface)
ii) Cuts production of flow line
iii) Loads of treating facilities
iv) Loss of production during work-over jobs
v) Loss of valuable man-hour during the period of close-in in terms of wages, which add up to overhead cost.

Thousand of dollars was spent to carry out work over operation as well as installation of sand control measure.

DATA RESULT AND ANALYSIS

Shell petroleum Development Company (SPDC) warri produced valued data on TEGA well 002. The data were obtained from well test record collected before and after sand control operation.

DATA ANALYSIS

The flow of oil from the reservoir into the well bore depends largely on the differential pressure between the producing formation and the bottom hole pressure. Sand production become more intolerable when the well was producing up to 10ppth of sand, to such extent the profitable production of oil from it, become impossible. This resulted in a drop flowing bottom hole pressure (PWF)

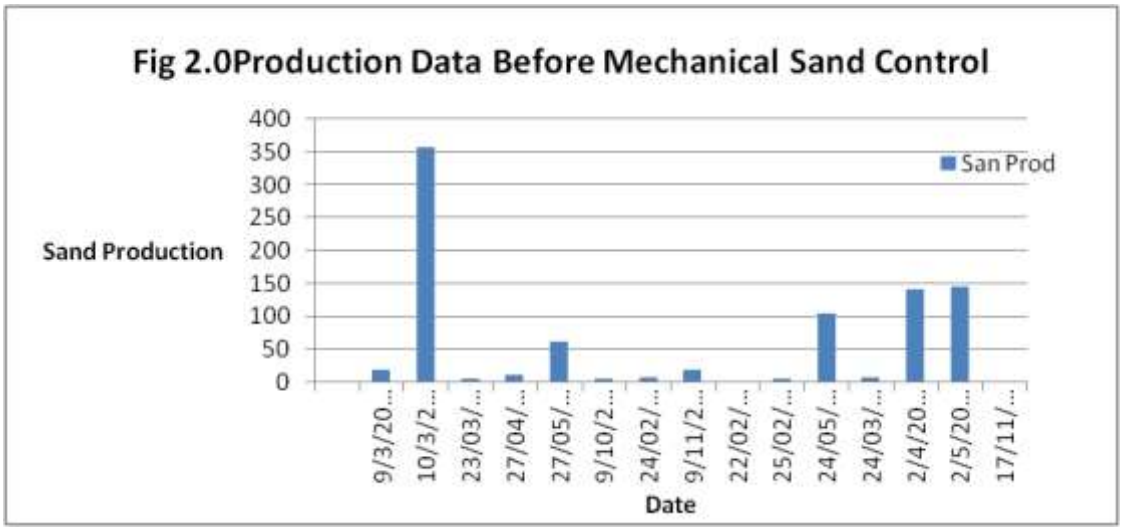
From the production data, it was discovered that an increase in the production of oil resulted in an increase in production of sand. The production data showed that on the 9th of March 2000 the production was 3,511 bbl/d on beams 36/64 with THP of 960 PSI with a sand production of 10pptb but increased production rate increased to 359pptb on the 16th March 2000 when the well was gradually beamed up from 28/64 "to 32/64" resulting in a peak

production of 6984 BOPD with low water cut. Due to the alarming rate of sand production the well was shut-in for sand control **(**Thomas o. allen andalan roberts ,1982).
Finally in December 2003 the well was completed with internal gravel packing in place with screen line across the existing perforation which ended sand production problem in that interval.

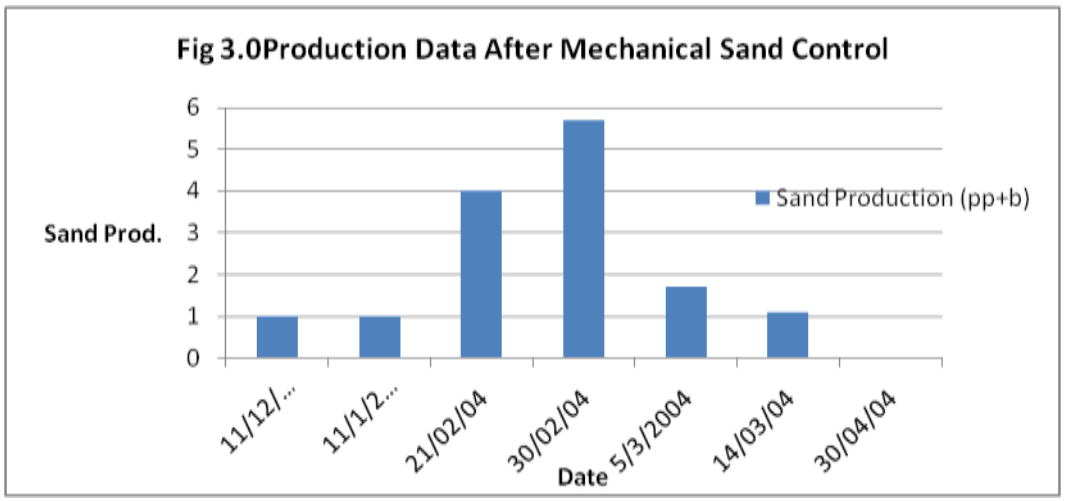
It is clear that after the method has been adopted in the interval, the well started flowing with improvement on the production data after sand control method was adopted as it is in table 2.0.

GRAPHICAL ANALYSIS BEFORE THE USE OF INTERNAL GRAVEL PACKING (IGP) ON THE WELL

Correlating data obtained before internal Gravel pack (IGP) production data on graph, it is shown that sand production kept with increase in production rate of 10pptb in March 2000 to 146pptb in May 2003 until November 2003 the well was closed for high sand production, Data after IGP showed a drastic reduction in sand production
from 146 pptb, which is quite satisfactory as show in the graph in fig 2.0.



From the graph above (fig. 2.0) it could be clearly seen that there was a rapid increase in sand production from September 2000 to 2003 (table 1.0) until internal gravel packing (IGP) was installed in the well.Fig.3.0 graphical presentation of production data after sand control in the well



ECONOMIC EVALUATION

In reality sand production has bounding effects on the economy of the operating company. It is expected that a well must produce the maximum profit, but once sand production occurs, the main objective of oil well drilling could hardly be reached.

COST ANALYSIS

The estimated cost of installation of internal gravel packing with sand screen liner which amounted to a whooping sum of five hundred and eight thousand dollars ($508,000) an equivalent of sixty-six million and forty thousand naira (660,40,000) at rate of N30 per dollar. This include cost for

1. Equipment $488,000 equivalent to (N63,440,000).
2. Personal $20,000 equivalent to (N2,600,000).

PAY BACK TIME (PAY OUT DAYS)

Observation showed that expected oil gain was 1602 (bbl) gross production per day. The cost per barrel of crude oil at the prevailing oil market rate was ($40) forty dollar per barrel as at may 2004. From the data the pay back time can be estimated. The pay back or pay out days is defined as the number of days required to compensate or offset the total cost of the job.

- Average production rate before internal gravel pack sand control measure was 6984 (bbl/d) gross production per day.
- Average production rate after the sand control measure was 8486 (bbl/d).
- Production gain = 8586-6984 = 1502bbl.
- Gain per day = 1502 x $40 = 60,080.

$$Pay\ out\ day = \frac{Total\ investment\ Cost}{Gain\ per\ day}$$

$$Pay\ out\ day = \frac{\$50,8000}{\$60,080}$$

= 8.455 days approximately 8 days

From the analysis , it is noted that the company has to wait for 8 days to recover the total investment made on the sand control job.It is important to note also that the installation of internal gravel packing paid off effectively Williams b.b, elliot l.s, weaver r.h(april 1972), as there was a substantial in oil production which indicates that production of the formation sand was properly monitored and checked.

CONCLUSION

The reservoir rock that contains crude oil accumulation is mostly sandstone, which lacks good cementation i.e. the sand stone are poorly consolidated with emphasis on the Niger Delta formation. TEGA well 002 was completed and produce from unconsolidated formation which produce sand along side with crude oil. The restriction of production rate can be used to prevent sand production by reducing the drag force on the sand grains.

Sand production in an oil and gas well is not profitable; problems associated with sand production include damage of both surface and bottom producing equipment, therefore evidence that sand control method in the reservoir required good sand control method to maintain good productivity of the well. It is from this that its necessary to install a good sand control technique early in the production life of the well. Hence, internal gravel packing had proved to be the good method of sand control in TEGA well 002.

RECOMMENDATION

Based on the above conclusion, it is recommended that, internal gravel packing can be of help where the SCON method failed due to the nature of the formation. If properly applied

under the right condition for control of sand production across with sand characteristics as TEGA well 002.

NOMENCLATURE

BOPD Barrel of Oil Per Day
EGP External Gravel Pack
IGP Internal Gravel Pack
SPDC Shell Petroleum Development Company
PPTB Pounds Per Thousand Barrels
SCON Sand Consolidation
THP Tubing Head Pressure
ESS Expandable Sand Screen
FT Feet
Ft. ah Feet of Average Height
GOR Gas Oil Ratio
PSI Pounds Per Square Inch
TSO Tip of Screen Out
BHT Bottom Hole Temperature
BHP Bottom Hole Pressure
RIH Run in Hole

REFERENCE

Densis P., Michel .C. and Georges.G.(1995)Well completion and servicing

GEORGE O. SUMAR JUR (1975): World sand control Hand Bock, Vol.1 House Tx

Penberthy W.L (JR) and Shaughnessy, C.M (1992) Sand control Spe series on special topics Vol; 1, R Chardon Tx.

Shell International Meatshappiz (SMIP) (1995) "Production Operation" Hand Book volume 5 Edition page 21.

SPSC SITP (2006) "Petroleum Production technology process sand control completion".

Suman, G.O (JR). Ellis, R.C. Suyder R.E (1983) "Sand control Hand Book" (second Edition). Gulf Publishing

Thomas O. Allen and Alan Roberts (1982) "Production Operation" volume 2 oil and gas consultant Int. Inc. Tusla Oklahoma.

Williams B.B, Elliot L.S, Weaver R.H(April 1972) "Productivity of inside casing gravel pack completion" journal of production Technology.