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OIL WELL STIMULATION USING ACIDIZING METHOD

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ABSTRACT

This research work is about the stimulation of oil well using matrix acidization method to improve the oil well's productivity. Matrix acidization method involves the placement of acid within the well bore at rates and pressure designed to attack an impediment to production without fracturing or damaging the reservoir (typically, hydrofluoric acid is used for sand stone silica based problems and hydrochloric acid or acetic acid is used for limestone/ carbonate based problem.) this operation when done correctly helps to improve a well's productivity particularly those well that are not producing to their full potentials so that the oil company can realize the highest price per barrel, and the consumer can get more oil circulating in supply to balance demand. The study revealed that it is possible to improve oil and gas production by introducing acids into oil wells that are not producing to their full potentials. Determination of the proper fluid placement is perhaps the most crucial factor in acid-treatment design in both carbonates and sandstones. When done correctly, have been shown to increase well productivity above that projected in both new and old wells. From an economic standpoint, oil produced today is more valuable than oil produced in the future.

INTRODUCTION

Oil well stimulation will involve the two main types of operation which are matrix acidization and hydraulic fracturing.

Stimulation operations can be focused solely on the wellbore or on the reservoir; it can be conducted on old wells and new wells alike.
Matrix acidization involves the placement of acid within the well bore at rates and pressures designed to attack an impediment to production without fracturing or damaging the reservoir (typically, hydrofluoric acid is used for sandstone/silica – based problems, and hydrotropic acid or acetic acid is used for limestone/carbonate-based problem).(1)

Hydraulic fracturing, which includes acid fracturing involves the injection of a variety of fluid and other materials into the well at rates that actually cause the cracking or fracturing of the reservoir formation. The fracturing of the reservoirs rack and the subsequent filling of the fractured voids with sand or the creation of acid channels allows for an enhanced conduit to the wellbore from distances in excess of a hundred feet.

Oil well stimulation is the general term describing a variety of operations performed on a well to improve its productivity. Oil well stimulation plays a vital role in the production operations. With oil prices at all-time high, it is imperative from an oil company's perspective that as much production as possible be safely extracted from the reservoirs, so that the oil company can realized the highest price per barrel and the consumer can get more oil circulating in supply to balance demand.[(2)]

SCOPE OF STUDY

In this study, we would limit our work on oil well stimulation by acidizing method .

AIMS/OBJECTIVES

The aim of oil well stimulation is to increase a well's productivity by restoring oil production to original rates less decline, or to boost production above normal predictions so that the oil company can realize the highest price per barrel, and the consumer can get move oil circulating in supply to balance demand.

TYPES OF TREATMENTS

Matrix Acidizing: In this category are treatments in which acid is injected into the pores and flow channels of carbonate rocks at a bottom-hole pressure considerably less than the fracturing pressure the purpose being to increase uniformly. The permeability of the formation, under these conditions, it is assumed that the acid enters only the natural pores and flow channels and react with the walls of the pores dissolving the rock and enlarging the pores. This reaction slows down as the acid is spent until finally additional radial penetration produces no additional benefit. The maximum radial penetration of unspent acid is a function of the acid velocity in the pore and it's spending time (which for a given acid depends on the acid volume and the rock porosity) since the spending time of acid does not change appreciably during a specific treatment, maximum penetration is attained when the first increment of injected acid is completely spent.

In evaluating this type of acidizing, the following basic adoptions are made:
(i)The formation is homogenous
(ii)The pores are of uniform size
(iii)The acid penetrates uniformly and radically
(iv)The reaction rates declines uniformly with decreasing acid concentration.
(v)The weight of limestone dissolved per increment of distance declines uniformly until the acid is completely spent.

Assuming a constant injection rate, and that the spending time remains constants for all increments of acid, later increments of acid entering the pore will penetrate no deeper before spending than the first increment i.e. instead of lengthening the treated flow channel additional acid will only enlarge the cross sectional area.

Following the above assumptions, the radial distance the acid will penetrate before being totally spent depends on the equation.
Volume injected ft^3 = pore volume invaded ft^3,

or
$q_it = r\ Ø\ h\ (r^2_a - r^2_w)$ ------------------1

$$r_a = \frac{\sqrt{q_i t}}{\pi Ø h} + r^2 w \text{-------------------2}$$

Where r_a = radial distance acid will penetrate until it is spent
Ø= fractional porosity
qi = acid injection rate, barrels per minute
t = spending time, seconds
r_W = wellbore radius, feet
h = formation thickness, feet

The spending time for an acid depends upon the ratio of the area of the rock exposed to the acid to the volume of acid here denoted as specific surface area s0 (square centimeters per cubic centimeter). An acid will have the same specific area (at the same temperature and pressure).
For matrix acidizing, the specific surface area can be obtained from the kozeny equation as modified by pirson.

$$k = \frac{10^8}{2fs^2Ø} - - - - - - -3$$

Or

$$s_Ø = 10^4\sqrt{\frac{1}{2fk}} - - - - - - 4$$

Where k = permeability, darcies
S. = specific surface area, square centimeters per cubic centimeter
F = formation resistivity factor, dimensionless
The formation resistivity factor if is related to the porosity by
F = ▪^{m} ---------------5

ACIDIZING THROUGH PER-EXISTING FRACTURES

Treatments may be conducted in formations containing natural fractures. The purpose of this type of treatment is to remove secondary deposition or loose particles in the fracture and to dissolve rock from the fractures faces. The injection rate is controlled during such treatments so as to not exceed the formation fracturing pressure. The maximum penetration of the acid into the fracture is dependent on the spending time of the acid under reservoir temperature and pressure and on the injection rate. The evaluation of these treatments requires the following basic assumptions.

i) The fractures are horizontal and of uniform width and extend radially from the well bore.

ii) The acid leak – off into the formation is considered negligible.

iii) The rate of reaction of the acid is proportional to it's concentration and the quantity of rock dissolved from the fracture face decreases with increased acid penetration until the acid is spent. At constant injection rate, additional increments of acid passing through the fracture will not extend the acidized area but merely increase the fracture width.

At an injection rate qi, the radial distance the acid will penetrate a horizontal fracture until it is spent at time t is found from the equation.

Volume of fractures = volume of acid injected

or

$n \cdot w\, (r^2_a - r^2_w) = q_i t$-----------6

Solving for r_a

$$\frac{\sqrt{q_i t}}{\pi n w} + r^2 w \text{--------------------7}$$

Where qi = injection rate, barrels per minute.

t = spending time, seconds

w = fracture width, inches

n = number of factures

ra = distance acid will penetrate before being spent-feet.

r_w = wellbore radius, feet.

As earlier discussed in matrix acidizing, the spending time for an acid in a fracture is dependent on the specific surface area. In order to obtain s·, consider a fracture width wft with an area of one square feet. The area exposed to acid is 2 sq. ft. and the volume of acid is w cubic feet so that

$$s_{\emptyset} = \frac{2}{w}\frac{ft^2}{ft^2} - - - - - - 8$$

For natural fractures, it is safe to assume a fracture width of 0.1mm or less. [3]

ACID PLACEMENT

Matrix acid treatments, whether for sandstones or for carbonates, require similar methods to ensure optimum placement. Unless steps are taken to promote efficient acid placement, the stimulation fluids will tend to follow the path of least resistance, meaning the acid preferentially will pass into the interval with the highest conductivity. Often, this section of the well requires the least stimulation.

An acid stimulation that is placed solely into this already – productive interval (or already swept interval, for an injection well will have less effect than if the acid were placed into a less – conductive formation (assuming, of course that this second interval has potential for improvement).

MECHANICAL ISOLATION METHODS

Without doubt, mechanical methods are the surest way to place fluid in areas where they would not travel naturally. If the fluid is mechanically blocked from the path of least resistance, then it will have no alternative but to follow the only path presented to it. Various options exist such as bridge plugs, packers and a combination of packer and bridge plug. Ball sealers. The first recorded use of ball sealers was in 1956. In essence, their use has changes little since. Ball sealers are just what the name implies small ball that are pumped into the well with the stimulation fluids – intended to seat on perforations to create a temporary seal.
The first ball sealers were solid nitrile rubber. After that, other embodiments were introduced which included solid nylon balls, aluminum and rubber covered aluminum balls and plastic consolidated walnut shells.

COILED TUBING (C.T)

Coiled Tubing is a very useful tool for improving acid placement. CT strings now exists in many sizes (from 1 to 3½ in. in diameter) and maximum – allowable – depth ratings. The most common CT strings used in acidizing and wellbore cleanouts are 1¼ to 2 in. in diameter.Major advantages of coiled Tubing in acidizing includes;

1) Ease with which an acid injection can be terminated if it appears that continuing injection is not doing any further good. The total volume in the CT string is small and can be displaced quickly.
(2) Ease with which treatment displacement with nitrogen can be achieved, quickly pushing reactive fluids away from the will bore and thereby energizing the near – well bore fluid zone and enhancing flow back
(3) Ability to attach injection nozzles for full – interval treatment or for selective (hydrocarbon – producing) zone treatment such as in wells with high water cut.

ACID PLACEMENT AND DIVERSION DISADVANTAGES INCLUDES

(1) Pump – rate limitations smaller diameters cause higher frictional pressure losses, which may limit treatment injection rates to lower than desirable levels. Acidizing through production tubing or drillpipe, for example, will allow higher rates.

(2) Socids (e.g. particulate diverters or ball sealers) are very difficult to place using coiled Tubing (C.T).

(3) Acid mixtures must be mixed very thoroughly and must remain that way before and during injection corrosion in a "CT" string is specially disastrous. Small pinholes or pits within the string can lead quickly to Tubing failure and a major fishing workover, not to mention the safety aspects of such a failure.

CHEMICAL DIVERSION

The first attempts at acid treatment placement used chemical "diverting" additives. In 1936, a soap solution that reacted with calcium chloride ($cacl_2$) to form water – insoluble, oil – soluble calcium soap was used in a hydrochloric acid treatment. This diversion idea led to the development or discovery of seemingly more sophisticated chemical diversion methods. These included $cacl_2$ solution (heauler than acid) to divert away from water and sulphuric acid to react with limestone or dolomite formation to form calcium soleplate in the formation to black and divert subsequent acid injection. Not surprisingly, the sulphuric acid method was widely accepted locust beam gum then was introduced to gel $cacl_2$ or sodium chloride solutions. Eventually, cellophane flakes in aqueous solution and oil – external emulsion (also gelled with locust – beam gum) were introduced commercially as diverting agents. The more commonly used chemical diverters today include the following (1)Salt granules (2)Benzoic acid(3)Waxes (4)Oil – Soluble resins (5)Gilsonite(6)Fibers (7)Foam (8)Viscous pills [(4)]

PROTECTIVE INJECTION

Protective injection involves the injection of an inert fluid into the most conductive interval, while at the same time injecting the acid system into a less conductive zone.

ACID FRACTURING TREATMENTS

Many of the techniques described in the preceding sections also can be applied to acid – fracturing operations. Mechanical isolation method work particularly well, although this often involves extra expense such as for a work over (or walkovers, which multiple intervals are involved) or for specialized completions.

However, what is really required for acid fracturing is a process or processes that can be applied without any interruption to the acid – fracturing treatments. This often is accomplished with the use of diversion stages programmed into the treatment schedule, effectively breaking up a large treatment into several smaller ones. Diverters such as ball sealers and particulates lend themselves readily to this technique and have been documented extensively.

These diverters are particularly effective because of the often high viscosity of the fracturing fluid (which helps to carry the diversion system) and the high rates experienced when fracturing (which enables the diversion technique to block perforation tunnels or plate off open hole sections more easily). Indeed, these techniques can be applied much more readily to acid fracturing than to prop pant fracturing because of the requirement of the latter for precise control of fluid placement.

CASE STUDY

In this paper we will use Middleton Well 30L as a case study.

BRIEF HISTORY OF MIDDLETON WELL 30L

The well was spudded on August 23rd 1981 and drilled to a depth (TD) of 8694ft MD (7260ft Total vertical depth). The well was drilled with a mud weight of 8.8ppg in the 26 inches trole and a maximum of 9.2ppg at total depth. Middleton well 30L was completed in three zones namely: Ewinti – 5, Ewinti – 7 and Ala – 3 reservoirs.

EWINTI – 5: This has 16ft net oil and 57ft net gas with gas oil contact and oil down to at 4956ft and 4972ft subsea respectively. After sand consolidation the tubing was found to be plugged with sand. No production was recorded.

EWINTI – 7: This has net gas oil and water of 8ft, 20ft and 20ft respectively. As at the end of 1982 the zone was making 60% water 720 BOPD on choke 20/64 inches. It made sand on 16/64 inches choke in July 1982. it was shut- in December 1982 to sand and water production.

ALA – 3: This encountered 29ft net oil in the upper member and 25ft net oil in the lower member. In July 1982 sand trace was observed on choke 14/64 inches. The well was shut in 1984 due to sand production. When the well was opened for trial test in December 1986 on choke 12/64 inches, it produced only 195 mscft day of gas.

CANDIDATE SELECTION

Stimulation job can only be done on a well if it is not producing to its full potential, however it cannot produce oil from the reservoir if that oil is not in the reservoir. Consequently the proper selection of candidate well is of prime important to the over all success of any stimulation treatment, well is selected as candidate for stimulation if the reservoir permeability is low or if damage reduces the well productivity.

Middleton well 30L is considered for stimulation due to the high drawdown (DP) attributed to formation fines migration resulting from the shaly nature of the sand across the perforations.

RESERVOIR INFORMATION

The choice of many treatment operations is dependent on the type of damage and reservoir to be stimulated.

Middleton well 30L is an anticline structure tending North West–South east. The sediments across well 30L structure are the typical sandstone – shale sequence peculiar to the Niger Delta. It has an average porosity of 30.8% with an average permeability of 1300md with a sand thickness of 31ft net pay zone initial reservoir pressure was 3147 psia while the current reservoir pressure is 2162 psia.

The production started in 1981 at a rate of 1125 BOPD with a base sediment and water and gas oil rate (GOR) of 0.0% and 881 Scfl stb respectively. It was optimized on bean up (32/64) to a peak of 1706 BOPD in July 1982. The production declined in January 1992 to 453 BOPD on 14/64 inches choke. With the drop in production Middleton well 30L was qualified for acidization job.

RESERVOIR/WELL DATA FOR MIDDLETON WELL 30L

DATA	FORMATION ALA – 3	UNIT
Well status	Flowing	Status
Total depth	8,694	Ft
Maximum deviation	48 @ 6487	Deg @ ft bdf
Hole size	95/8 inches	Inches
Average thickness	31	Feet
Completion	1 GP	
Interval	7017 – 7055	Ftah Bdf
Permeability	1300	Md
Porosity	30.8	%
Water saturation	36	%
Initial reservoir pressure	3147	Psia
Present reservoir pressure	2126.2	Psia
Bubble point pressure	3050	Psia
Initial solution GOR	881	Scf/stb
Bottom hole temperature	222	Of
Oil gravity	42.1	Apl
Water specific gravity	1.04	$60/60^0$f
Tubing size	31/2	Inches
Present oil water content	7062	Ftah bdf
Present gas contant	Nil	
Oil viscosity	0.3230	CP
Flowline internal diameter	6	Inches

Area	964	Acres
Oil formation factor	1,47.90	bbl/stb
Ultimate recovery	46,579	MSTB
00IP	111,000	MSTB
Water viscosity	0.41	CP
Top of perforation depth	8750.0	MD
Bottom of perforation depth	8762.0	MD
Gas gravity	0.73	

Production Data for Middleton Well 30L before Stimulation

Date	**Bean**	**Cross BOPD**	**BWLPD**	**GOR**	**BSW %**	**THP Psia**	**Remark**
14/01/93	38	1632	0	405	0.06	450	PRE-TREATMENT
23/06/93	36	1588	0	36	0.0	330	
24/06/93	36	1588	0	635	0.0	330	
25/06/93	36	1888	0	638	0.0	330	
20/09/94	42	1776	0	426	0.0	250	
2 1/12/95	42	1122	10	692	0.9	200	
02/01/96	48	1147	9	483	0.8	170	
13/01/96	48	1200	12	325	1.0	180	
03/08/96	48	754	8	1457	1.1	120	
16/09/96	48	694	8	1316	1.1	120	
30/09/96	48	810	12	1257	1.5	100	

07/10/96	48	737	7	1671	1.0	120	
12/11/96	26	277	131	2939	32.0	140	
13/11/96	26	313	209	2587	40.0	120	
17/11/96	32	456	114	918	20.0	120	
24/04/96	32	313	209	4381	40.0	110	

Expected Producting Data for Middleton Well 30L

Date	Bean 164”	Gross BOPD	BWPD	GOR	BSW %	THP PSIG	Remark
25/04/97	32	750	0	1503	0	120	

STIMULATION PROCEDURE FOR MIDDLETON WELL 30L

In order to commence the stimulation of Middleton well 30L front end activities were carried out as follow:-

i. All well head pressure were checked and recorded.

ii. Wireline rig up: Blow out preventer and lubricator were installed on long string and the long string was tested to 100psi

iii. Otis downhole safety value (otis DHSV) was run in hole and retrieved in the Landing nipple and at 259 pull out of hole.

iv. A 1.80” gauge cutter was run in hole to 8630 feet and later pull out of hole before rig down.

v. Then coil tubing unit (CTU) was rigged up and all the treating lines were pressure tested to 500pis. The coil tubing was run to 2000 feet to circulate fitered seawater. And the coil tubing was pulled with 300gals of 15% HCl when the acid got to the end of coil tubing iot was reversed out and disposed off.

vi. A dummy run was made on the long string to check whether there was sand restriction in tubing.The run confirmed no restriction. The next stage was the stimulation treatments. To effectively carry out the stimulation the approximately fracture gradient of the formation to be acidized was determined using the relationship below.

$g_f = \cdot + (g_{ob} - \cdot) * p_r/D$

Where

g_f = fracture gradient

$\cdot$= constant (0.33 to 0.5)

g_{ob} = overburden pressure gradient values rauges from about ipsi/ft at depth less than 10000ft and 10 to 1.2 depth deeper than 1000ft.
Pr = static reservoir pressure
D = Depth of the well
Also the maximum permissible injection rate that will not fracture the formation was derived from Darcy's radial flow equation.
$q_{imax} = 4.917 \times 10\text{-}^{6}(Kh\ (gf^{*}H) - \Delta P_{safe} - P)\ /\mu\beta\ (Inr_e/r_W+s)$
Where
q_{imax} = The injection rate in bbl/min
k = Effective permeability of undamaged formation in md
h =Net thickness of the formation in feet (ft)
g_f = fracture gradient in Psi/ft
H = Depth in feet
ΔP_{safe} = safety pressure margim (200 – 500psi)
P = The reservoir pressure in psi
μ = viscosity in centipoises (cp)
r_e = Reservoir drainage radius in feet
r_w =The well bore radius in feet
S= skin factor (dimensionless)
B = formation volume factor near unity
The value obtained from the above equation served as a guide when the acid was pumped in.

TREATMENT RECIPE FOR MIDDLETON WELL 30L
The acid treatment of middleton well 30L was mixed and pumped with the following chemicals into the perforation.
1. SPACER:-240 gals 3% NH_4 cl + 24 gals u66 solvent.
2. PREFOAM:-600 gals 3% NH_4cl + 6 gals + f78 surfactant
3. FOAM:-200 gals 3% NH_4cl + 4 gals + f78 surfactant + 1400scf/lbbl N_2.
4. PREFLUSH:-750 gals 3% HcL + 5 gals A260 inlubtor + 5 gals surfactant + 15 gals u42 Iron control.
5. MAINFLUSH: -1200 gals 8 – 1.5% mud acid (MA) + 8 gals A260 Inhibitor + 8gals f78 surfactant + 24 gals u24 Iron control.
6. SPACER:-100 gals 3% NH_4cL + 100 gals u66 solvent
7. OVERFLUSH: 1200 gals half strength clay acid (HSCA) + 6gals A260 Inhibitor + 4gals f78 surfactant + 24gals u42 Iron control.
8.3% NH_4CL was displaced with one coil tubing volume (care was taken not to over displace the half strength clay acid away from the wellbore.
9. All surface injection pumps were shut down and shut in pressure on coil tubing and annulus were recorded. Later the well was shut in for 12 hours to enable clay stabilization.
10. Wing value was opened for flow back. Then the rate per choke was slowly brought up (flow was started on choke 16/64").

11. Since the well did not flow unaided it was Nitrogen lifted via coil tubing until it continued to flow before pulling out of hole.
12. Producing fluid and tubing head pressure were monitored.

WIRELINE WORK AFTER STIMULATION
i) The wire line blowout preventer and lubricator were installed on long string and tested the same to 1000ps:
ii) The down hole safety value in landing nipple at 259 feet was re-installed.
iii) After the wire line was rigged down and the tubing head pressure was recorded.

FLOWBACK
The flowback of spent fluid from conventional mud acid treatment was accomplished as soon as possible. After the stimulation of middleton well 30L. The treatment fluid was immediately flowed back and the interval gradually beaned up to initial bean size (32/64) thus keeping the fines migration to minimum.

Date	Bean	Cross BOPD	NET BOPD	BSW %	THP PSI	GAIN BOPD	POST-TREATMENT
26/04/97	32	798	706	15.0	130	-45	
15/05/97	32	860	817	5.0	150	67	
25/03/97	32	892	891	0.1	150	141	
3/06/97	32	940	939	0.1	150	189	
12/06/97	32	983	983	0	150	233	
4/07/97	32	1017	1017	0	150	267	

RESULTS
WELL 30L POST AVID TEST
The matrix acidizing treatment was carries out smoothly. The well was left flowing with turbing head pressure (THP) of 150psig. After stimulation a production test was carries out on the newly stimulated middletokn well 30l. The result obtained from the test confirmed that the stimulation job was effective.

POST ACID STIMULATION TEST RESULT
The production test datas on the performance of middleton well 30l are shown in the tables below.

Production Test Data after Stimulation of Middleton Well 3OL.

Post Stimulation	Survey Date	Production BOPD	BSW%	GOR SCF/bb1	Bean Size 64 inches
Date	26/04/97	706	15	1523	32

Production Test Data before Stimulation of Middleton Well 30L

Pre Stimulation	Survey Date	Production BOPD	BSW %	GOR SCF/bb1	Bean Size 64 inches
Date	26/04/97	313	40	4381	32

ANALYSIS OF RESULT

Well Performance Before Stimulation

Initially the well producing at a rate of 1776bopd on bean 42/64" with a BSW and GOR 0.0% and 426 scf/bbl respectively.

In December 1995 the well started producing water. The water production reached a peak of 40% on bean 26/64 inches in November 1996. However the interval productivity as at this time had declined to 313bopd on bean 32/64 inches and BSW peak of 40%. With the sudden drop in production it was suspected that the well productivity has been impaired by the movement of fines into the region of near well bore. A clay acid stimulation (preceded by half strength mud acid) treatment was carried out to remove the damage and boost production from 314bopd to 750bopd with bean-up potential.

Well Performance After Stimulation

Though for a normal evaluation of a post stimulation job bottom hole pressure survey is required to quantity the residual damage (skin). A production logging tool (PLT) is sometime run to evaluate the effectiveness of the treatment over perforated length.

For middleton well 30L evaluation job was carried out as post stimulation production test to gain insight into how effective the job was done. Pre stimulation, the well was producing 313 bopd gross 40% BSW on bean 32/64 inches.

However post stimulation result gave 798bopd gross 15% BSW on bean 32/64 inches. This showed a net oil gain of (798 - 313) = 485 bopd.

The post treatment production from the data above was 485BOPD net get gain while the expected production was 750 BOPD.

The result of the test carried out on the well shows that the drawdown that was formally 450psi reduced drastically which implies that the well productivity has been improved by stimulation. This is confirmed by the increase in production rate of the well to an average of 915BOPD which was formally 313BOPD when damaged. The production increase from 313BOPD to 798BOPD immediately after the stimulation job made the job to be more economical. Therefore the stimulation job is considered to be effective and successful and can be economically evaluated thus:-

ECONOMIC EVALUATION

MATERIAL REQUIREMENT

1 1800 gallons diesel
2 3150 gallons 32% HCl
3 27 gallons F78 surfactant
4 124 gallons U66 solvent
5 2040 gallons NH_{4cl}
6 1400 gallons Nitrogen (N_2)
7 9 gallons A260 inhibitor
8 63 gallons U42 Iron control

Cost estimated		$ = ₦80.00
Cost of Chemicals	=	₦ 601,720
Cost of equipment/personnel's		₦ 1, 45372
Total cost	=	₦ 2055441
Production rate after treatment	=	750bopd
Cost per barrel of crude oil	=	80 x 16 = 1280
		@ = $16 per barrel

Cost of crude produced after treatment = 1280 x 750= N960000

Therefore payout days = Total cost (of chemicals/equipments) / cost per bbl x production rate after treatment.

= 20, 55441 / 750 x 1280
= 2055441 / 960000
= 2.14 days = 2 days.

From the above evaluation it took a break even time of about 2 days to recover the sum spent on the total stimulation process.

This payback time is ideal and therefore justified the stimulation job. [5]

CONCLUSION

Stimulation job can only be done on a well if it is not producing to its full potential. Accordingly, the stimulation of oil wells using acid has created awareness to the fact that oil and gas production can be improved on by introducing acids into well that are not producing up to expectation.

Oil and gas are an integral part of a nation's economy most especially in Nigeria. Hence an increase in production of oil and gas can bring prosperity to the nation and subsequently improves the nation's foreign exchange position.

RECOMMENDATION

Since it has been tested and proven that oil and gas production c an be improved on by introducing acids into oil wells that are not producing to their full potentials, we hereby recommend this system of well stimulation using acidizing method to oil companies so that the oil company can realize the highest price per barrel, and the consumer can get more oil capitulating in supply to balance demand

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