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Evaluation of Stimulation Techniques for Oil Wells

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Abstract
The oil well stimulation is a technical measure which is by eliminating the damage of the near well-bore or building structures of high conductivity in the formation. The stimulation concludes Fill Layer Measures, Water Shutoff Measures, Separate Injection Measures, Sidetracking Drilling Measures, Fracturing, Sand Control Measures, Acidification Measures. Valid Measures, Measures to Increase the Amount of Oil, Measures Earnings, Measures of Investment Payback are the four indexes which analyze the effect of various measures. And compare the combined effect of these measures, achieve the effective increasing in the oilfield.

In this paper, By synthesizing measures for each increasing oil, to evaluate the effect of increasing oil after using a variety of measures in the economic aspects.

Key words: Stimulation; Effective of measures; Economic evaluation

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INTRODUCTION
With the deepening of the oil zone mining, oil production declines rapidly. I have become the main research content of oilfield development by using what measures to reduce oil production decline and improve development efficiency in the mining process (Thomas, 1982). In the oil exploration process, it can increase production, enhance oil recovery and ultimately achieve better development results through using certain measures.

1. STIMULATION
In the stimulation, there are seven main measures to increase production.

1.1 Fill Layer Measures (FLM)
According to the core analysis, electric log interpretation, drilling, testing, oil mining, gas production, etc. while in the secondary exploration of oil and gas fields, one can find undeveloped layers which show good or better bits and intervals. And the undeveloped layers are drilled and perforated, it is a measure that can enhance production in the oil and gas field (Ihaab, 2006).

Fill Layer Measures include the following steps: moving, wedge, sand washing, lower drift column, lift drift column, fill layer (the perforation is sorted by normal and transfer), down pump and completion.

1.2 Water Shutoff Measures (WSM)
In the oil field development process, the water out of the oil layer brings severely influence to the oilfield development, even to the extent that it will decrease the ultimate recovery. When the water is out, first, the water layers must be determined, and then using the shutoff measures to blank off the water(Phillips, 1984). The purpose of water shutoff is to control water producing layer, change the direction of water flow, improve the efficiency of water flooding. The method makes the water production fall or be stable over a period of time. It can maintain the oilfield production and enhance the oil recovery eventually.

1.3 Separate Flood (SFM)

There are a lot of oil layers in the well, as the different pressure in each oil layer and the diversity nature in crude oil, the oil layers will interfere with each other, Under the circumstance, the crude oil in some oil layers can not be exploited effectively (Stavlnad, 2001). Therefore, in order to reduce or eliminate the interference between the various reservoirs, separate flood and mining technology have been adopted in the most of extraction of oil.

The technology of separate flood refers to putting the packer into the injection well, the packers can separate the largely different layers, and using the water flow regular to distribute water in each layer, it can control the injection flow rate in the high permeability zone and enhance the injection flow rate in the mid-low permeable layer, making all kinds of oil can play a role (Li, 1999).

1.4 Sidetrack Drilling (SDM)

Sidetracking technology is fixing a whipstock in the certain depth in the oil wells. In the side of the window case with a milling cone under the function of angle build and deflector in the slant face, the new borehole drilled from the window, cemented the well by using the tail (Hwang & Yoon,1981).

1.5 Fracturing (FRM)

Reservoir fracturing is a process which squeezes high-pressure, high-volume and viscosity liquid into the oil layer (Einhorn, 1997). When many cracks merge in the layer, the proppant (such as quartz sand, etc.) are filled into the cracks. By this measure, it can improve reservoir penetration, water injection or oil production. The general fracturing fluids are water base fluid, oil base fluid, emulsion fluid, foam fracture fluid and acid base fracturing fluid.

1.6 Sand Control Measure (SCM)

In the process of mining oil, the sand control measure contains mechanical sand and chemical sand. Chemical sand can be divided into three categories: one is the resin cement formation sand. One can use the finished resin to inject into the formation, and it can also be cemented synthetic resin in the formation; the second category is artificial borehole. Artificial borehole has many types, such as pre-coat of gravel, resin mortar, with dry ash sand in water, cement mortar, resin walnut shell. These materials should be sent into zones through pump column, and squeezed into the hole outside the casing, the dense filling will be formed, so that can recover the primary stress of the formation. When the filling material solidified and forming a certain intensity sand retention barrier, the excess filling material will be milled, the well has enough condition to develop the gas and oil (Charnes, 1978).

The mechanical sand Currently can be divided into two categories which are column filter sand and mechanical filtration sand. The column filter sand takes measure on the production column or pack off column in the borehole, it usually takes pump or screen to control sand. The mechanical filtration sand puts sand control screen in borehole, and fills the material into annulus space between screen pipe and borehole wall, then squeeze part of gravel into formation around the near-well bore, it can prevent the sand from migrating. There are various kinds of filling material, the gravel is the most common used, and shuck, stone, plastic particles, glass beads or ceramic are also used in some way.

1.7 Acidification Measures (AFM)

The principle of measure is to dissolve or corrode the cementing material, formation hole and stemming in the cracks by the acid fluid. It can recover or enhance the permeability of the formation hole, and it is an effective measure in stimulating oil well and water well (Bowlin, 1987).

2. THE INDEX OF INCREASING OIL MEASURE

The index of increasing oil measure includes: measure valid, measure increase, measure earnings, measure input-payback. Indicators are defined as follows:

2.1 Valid Measures

It means that the oil production elapses the daily level before the measure taking, how long it takes when the measures have been implemented. It can be calculated when predict the law of diminishing basing on the increase production, it is a time indicator which weight the effect of measure (Palson, 2003). This article on a monthly basis.

2.2 Measure Increase

Measure increase refers to the cumulative increase in oil production in the period of the measure valid. The accuracy of measure increasing affects the degree of economic evaluation measures (Gulick, 1998).

2.3 Measure Earnings

It refers to the incremental benefits which are bought by the measure after the implementation of this measure in the period. It is a main indicator to investigate the effect of the economic (Antonio, 1997). The formula is

$$ME = \sum_{i=1}^{n} \left(\Delta qi \left(P - T_{ax} \right) - \Delta C_i \right) - I \ .$$

Where ME is the short of measure earnings. $\triangle qi$ is the oil increase of the i-month in the individual measure within the validity period, the unit is ten thousand tons. P is crude oil price (excluding tax), yuan/ton. Tax is tons of oil taxes (additional education, urban construction tax, resource tax, mines compensation fee), yuan/ton. $\triangle C_i$ is The incremental cost of individual measures within the validity period of the i-month, ten thousand yuan. I

is Individual measures input, ten thousand yuan. *n* is the valid measure, month.

2.4 Measure Input-Payback

It is the time that the measure earnings compensate the measure input, namely it takes how much time for the net earnings of measure to set off the input of measure. It is a key indicator to examine the capacity of measure recover (Islam, 2001). Its expression is

$$\sum_{t=1}^{Pt}\left(\Delta q_t(P-T_{ax})-\Delta C_t\right)=I.$$

Where *Pt* is measure input-payback, month. It can be calculated by the cash flow statement. The formula is

$$P_t = \text{MCNCF} - 1 + \frac{\text{ACCF}}{\text{YNCF}}.$$

Where MCNCF is the month when the cumulative net cash flow is positive, ACCF is the absolute value of the cumulative cash flow last year and YNCF is the year of net cash flow.

3. CASE STUDY

This paper takes 2005 of S150-161 block measures as an example. The oil layer of S150-161 block is Es32 and Es33, the area of oil-bearing is 11.1km^2, geologic reserve is 1.441×104t. The buried depth of oil layer is from -2,230 m to -3,300 m, it is a lithology- structural reservoir. The relationship of profit is complex in the reservoir, and the reservoir is a fan delta fringe deposit which is dominated by the fine sandstone. The rock types are dominated by the fine-grained feldspar-porphyry sandstone. The degree of weathering is heavy, the reservoir nature is poor, the average porosity is from 11.5% to 14.3% and the mean permeability is from $3.08\times10^{-3}\mu m^2$ to $23.6\times10^{-3}\mu m^2$. The reservoir is a typical low permeability reservoirs.

3.1 Single measure of increasing oil

This article base on the seven measures above, 105 wells on the block are implemented by these measures. According to the feedback of measured data: 15 wells are implemented by fill layer measures, 15 wells are implemented by the water shutoff measures, 15 wells are implemented by the separate injection measures, 15 wells are implemented by the sidetracking measures, 15 wells are implemented by the fracturing, 15 wells are implemented by the sand control measures and 15 wells are implemented by the acidification measures. The increasing oil effect of each measure is shown in Table 1.

Where Valid measures of Single well is short for VMSW, Measure increase of single well is short for MISW, Measure earnings of single well is short for MESW and measure input-payback of single well is short for MIPSW.

In summary, during implementing stimulation of S150-161 block, the effect of fill layer measure is the best. The effect of water shutoff, fracturing and acidification are taken second place. The effect of separate injection, sidetracking and sand control are relatively poor. Thus, when develop the measures of next work, the fill layer measures must be thought firstly. Geology and economic should be argued from all parts before taking measures of water shutoff, fracturing and acidification. When the argument is effective, then the relevant measures are implemented.

Table 1
The Increasing Oil Effect of Each Measure in Single Well

Measures	VMSW (Month)	MISW (Ton)	MESW (Ten Thousand yuan)	MIPSW (Month)
FLM	9.2	93.24	50.25	2.1
WSM	8.6	88.62	48.5	1.9
SIM	8.2	69.22	29.45	2.5
SDM	8.9	81.51	30.54	2.6
FRM	9.3	85.64	42.68	1.4
SCM	8.4	78.53	29.57	1.7
AFM	9.05	82.66	41.55	1.6

3.2 Composite Measure of Increasing Oil

On the base of fill layer measure, when it is effective, 15 wells which are adopted fill layer measures are divided into three groups. The first group, based on the measure which is taken by the fill layer, water shutoff measure has been taken. The second group, based on the measure which is taken by the fill layer, separate injection measure has been taken. The third group, based on the measure which is taken by the fill layer, acidification and fracturing measures have been taken. The effect of these measures are shown in Table 2.

Table 2
The Increasing Oil Effect of Composite Measure in Single Well

Measures	VMSW (month)	MISW (ton)	MESW (ten thousand yuan)	MIPSW (month)
FL-WSM	22.7	150.68	82.54	3.4
FL-SIM	20.8	124.57	55.22	4.2
FL-FR-AFM	25.2	200.51	90.47	2.8

In summary, the total valid measure can be greatly enhanced by the composite measures. The union measure FL-FR-AFM makes measure earnings of single well to double revenue and greatly improve the incremental oil.

CONCLUSION

This paper introduces various measures of increasing oil, it includes fill layer measures, water shutoff measures, separate injection measures, sidetracking drilling measures, fracturing, sand control measures, acidification measures. The index of increasing oil measure includes:

measure valid, measure increase, measure earnings, measure input-payback. It discusses and compares the changes in various increasing oil measures corresponding indicators. S150-161 block case study shows that single measures can indeed improve increasing oil recovery, but a the effect of composite measure is more prominent. Therefore, when develop the increasing oil measure, in order to improve the recovery, the proposal is trying to select a composite measure.

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