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Changyuan Periphery Oilfield Economic Evaluation Method of Waterflood Potential Exploitation Measures

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Abstract

Changyuan periphery oilfield stable form of 5.2 million production requires fine waterflood to reduce the amplitude of production decline and relieve pressure. However, the effiency of Potential Exploitation Measures were uneven, affecting oil production and economic benefits. So there need to economic evaluation for measures and make measures adjustment. Assessed two different blocks' economic through evaluated single oil and water well measures and the combined effect of blocks measures. Single well economic evaluation of oil and water wells measures include: measures validity, income, the incremental input-output ratio, payback period and efficiency 5 indicators. The combined effect of blocks measures evaluate by index *P*. In Changyuan periphery five demonstration area as an example, analysised of the best and worst economic effect of each blocks, and obtain a comprehensive evaluation results of the demonstration area. The evaluation results were consistent with actual situation, it should be widely applied.

Key words: Fine potential exploitation; Measure; Commercial efficiency; Effect evaluation

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INTRODUCTION

Changyuan periphery oilfield development adjustment of practice, technology research and application after 20 years. Adjustment technology of waterflooding has been continuous development and improvement. Initially formed the well pattern infilling adjustment, injection-production system adjustment, injection and production restructuring, unconventional adjustment techniques of waterflooding and a variety of new technological measures, such as chemical dialysis, microbes, and so forth. These adjustment techniques of waterflooding provide technical support to Changyuan periphery oilfield annual output of crude oil 500×10^4 t, but also for the fine tap the potential of water flooding provided a typical basis and guarantee. With further development of oilfields, Potential Exploitation Measures workload increasing year by year, average single well measures to increment oil reduced and measure investment efficiency is also reduced[1-3]. Therefore, need to optimized measures solution to improve the efficiency of the program of measures and improve investment efficiency[4-5]. The following measures will be evaluated by a single well and block measures the combined effect two aspects for the different measures[6].

1. EVALUATION OF ECONOMIC MEASURES FOR OIL WELLS

Applying measures validity, measures income, measures the incremental input-output ratio, measures efficiency indexes to evaluate oil wells measures economic[6-7].

1.1 Measures Validity

Measures validity refers to the duration of the effectiveness of measures, which reflect the impact of measures on the oil wells produce duration, and directly related to the economic[8]. It is generally considered to be from the beginning of time t_1 oil wells measures to yield decline and no longer implementing measures to terminate before time t_n (Figure 1).

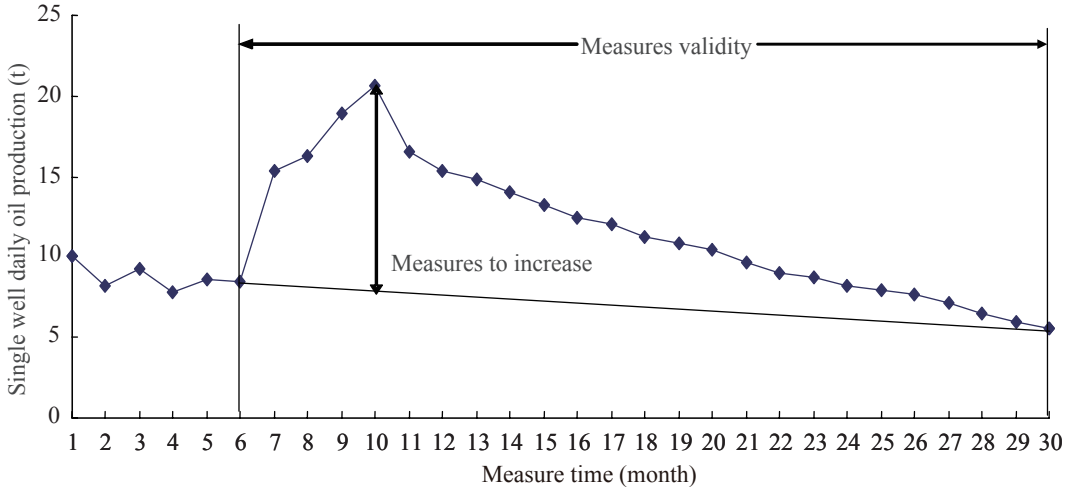

Figure 1
Well Measures Validity Evaluation Schematic

1.2 Measures Income

Measures income refers to the incremental economic measures in the period from measures to increase the yield generated[1]. It is an important criterion for evaluation of economic measures, is calculated as follows:

$$P_r = \sum_{t=1}^{n} (\Delta q_t (P - T_{ax}) - \Delta C_t) - I, \quad (1)$$

$$\Delta C_t = \Delta q_t (C_1 + C_2 + C_3 + C_4) + \Delta q_y (C_5 + C_6) + \Delta w \times C_7. \quad (2)$$

1.3 Measures the Incremental Input-Output Ratio

Measures increment input-output ratio refers to the measure input and output ratio of incremental measures[9]. Which measures the amount invested by liquid containing operating costs and investment measures. It is an important criteria for evaluating the economic benefits of the measure. Calculated as follows:

$$R = \frac{\sum_{t=1}^{n} \Delta q_t (P - T_{ax})}{I + \sum_{t=1}^{n} \Delta C_t}. \quad (3)$$

1.4 Measures Put in Payback Period

Measures put in payback period refers to the economic benefits of measures put in time brings. It is an important criteria for evaluating measures economic recovery capability. Its expression is:

$$\sum_{t=1}^{P_t} (\Delta q_t (P - T_{ax}) - \Delta C_t) = I. \quad (4)$$

1.5 Measures Efficiency

Efficiency measures include geological efficiency, increase economic efficiency and minimum fuel three indicators.

(a) Measures geological efficiency refers to the ratio of the total number of effective measures to measure the number of wells wells[6]. It is an important criteria for evaluating the effect of the implementation of comprehensive measures. Calculated as follows:

$$\eta_G = \frac{N_G}{N_T} \times 100\%. \quad (5)$$

(b) Measures of economic efficiency refers to the ratio of the total number of wells effective measures to measure the number of wells. It is an important indicator to measure the effect of integrated implementation of the measures. Calculated as follows:

$$\eta_E = \frac{N_E}{N_T} \times 100\%. \quad (6)$$

(c) Minimum measures to increase investment in oil refers to the minimum compensation measures increase the amount of oil[10]. Calculated as follows:

$$\Delta q_{\lim} = \frac{I + \sum_{t=1}^{n} \Delta C_t}{P - T_{ax}}. \quad (7)$$

2. BLOCK COMPREHENSIVE EVALUATION OF ECONOMIC BENEFITS

Measures with the highest cost-effective when there are two or more measures for the specified block technical indicators meet the requirement, they need out of the first preferred embodiment. However, oil usually only relatively simple quantitative indicators, which measure only consider measures to increase investment and is expected to fuel these two standards, the implementation of measures and increase investment in less large measure of oil. But not all the measures alone measures and measures to increase the amount of oil put into two indicators can evaluate the quality of the economic benefits. Therefore, we should consider the following five aspects, and adopt a comprehensive assessment index P, P larger the value, the better the effectiveness of measures for priority use[6]. Evaluation indexes (Table 1):

$$P = a \sum_{t=1}^{k} P_i. \quad (8)$$

Table 1
Changyuan Peripheral Oilfield Preferred List of Economic Indicators

Level	I	II	III	IV	V	Weights	Project code
Evaluation indexes (p_i)	0.8	0.6	0.4	0.2	0	a	k
Average income of single well measures (10^4 yuan)	≥10.5	7-10.5	3.5-7	0-3.5	≤0	0.3	1
Measures increment input-output ratio	≥2.5	2-2.5	1.5-2	1-1.5	≤1	0.3	2
Measures put in payback period (month)	0-2.5	2.5-5	5-7.5	≥7.5	U	0.2	3
Geology efficiency (%)	0.8-1	0.6-0.8	0.4-0.6	0.2-0.4	0-0.2	0.1	4
Economic efficiency (%)	0.8-1	0.6-0.8	0.4-0.6	0.2-0.4	0-0.2	0.1	5

Note. All kinds of measures ranging is determined according to 2012 statistic measures indicators.

3. APPLICATION EXAMPLES

3.1 Well Economic Performance Evaluation

Deadline to September 2012, an oil measure economic evaluation results for each demonstration area as shown in Table 2. Optimal economic measures chemical dialysis and oil fill holes, the average single well measures earnings were 101.02×10^4 and 22.53×10^4 yuan; the worst economic measures for the radial drilling, the average single well measures earnings -1.84×10^4 yuan.

Table 2
Changyuan Periphery Oil Well Measures Economic Evaluation Results

Evaluation project	Fracture	Reperf	Exchange pump	WSO	Microbe	Chemical dialysis	Radial drilling	Hot acid	Hydraulic perforation	Heater
Single well measures income (10^4 yuan)	73.01	101.02	50.08	65.36	6.6	22.53	-1.84	22.14	11.99	3.28
Input-output ratio	1:3.30	1:4.88	1:5.1	1:5.45	1:3.18	1:4.82	1:0.94	1:4.17	1:2.54	1:2.96
The payback period (month)	4.9	1.6	0.6	0.9	9.3	1.2	U	1.5	11.3	2.5
Geology efficiency (%)	95.4	96.2	69.3	83.7	100	100	100	50	82.7	100
Economic efficiency (%)	65.3	83.1	66.2	73.9	79.6	100	20.0	49.8	66.9	100

3.2 Economic Performance Evaluation of Wells

Deadline to September 2012, wells measure the results of the demonstration area of economic evaluation are shown in Table 3. Optimal economic measures subdivision, the average income of single well measures 20.17×10^4 yuan; the worst economic measures as well fracturing, the average single well measures earnings -19.79×10^4 yuan.

Summarized above analysis can be concluded that measures overall well on the evaluation results of the demonstration zone than wells Measures. Therefore, the traditional measures of each demonstration area to be assessed, given the various blocks oil wells the best and worst of the economic effects of the measures, they could then implement different measures for different blocks in order to achieve optimal production results (Table 4).

Table 3
Changyuan Periphery Well Measures Economic Evaluation Results

Evaluation project	Fracture	Acidify	Reperf	Subdivide	Shallow profile	Recombination	Conversion
Single well measures income (10^4 yuan)	-19.79	9.1	18.73	20.17	13.39	29.6	46.58
Input-output ratio	1:0.89	1:3.48	1:2.93	1:4.46	1:3.28	1:4.73	1:3.42
The payback period (month)	U	2.1	1.9	0.8	2.6	0.4	1.6
Geology efficiency (%)	78.6	75.3	82.9	80.0	83.8	66.7	85.9
Economic efficiency (%)	32.0	48.7	66.7	62.7	68.2	66.7	72.0

Table 4
Changyuan Periphery Demonstration Area Wells Measures Evaluation Results

Demonstration area	Production well		Downflow well	
	Best economic measures	Worst economic measures	Best economic measures	Worst economic measures
Shengping oilfield	WSO	Hydraulic perforation	Shallow profile	Fracture / reperf
Longhupao oilfield Sagao commingled production area	Reperf	Fracture	Recombination	Reperf
Chao 55	WSO	Heater	Fracture / Shallow profile	Acidify
Dong 18	Reperf	Microbe	Subdivide	Conversion
Mao 11	Chemical dialysis	Radial drilling	—	

3.3 Demonstration Area Overall Economic Benefits

Deadline to September 2012, Changyuan periphery five demonstration area aggregate measures 635 oil wells, the cumulative increase of oil 14.07 × 10^4 t, single well measures income 30.06 × 10^4 yuan, payback period of 3.96 months, the effective rate was 91.3% geology effective, the economic rate of 73.6%, with a total investment of 9,015.1 × 10^4 yuan, the total output of 41,997.53 × 10^4 yuan, the input-output ratio of 1:4.67, the total profit of 19,089.57 × 10^4 yuan (Table 5).

Table 5
Comprehensive Evaluation Results of Changyuan Periphery Demonstration Area

Demonstration area	Total wells of measures	Cumulative oil (10^4t)	Single well measures income (10^4 yuan)	The payback period (month)	Geology efficiency (%)	Economic efficiency (%)	Total investment (10^4 yuan)	Total output (10^4 yuan)	Input-output ratio	Total profit (10^4 yuan)
	203	4.57	37.33	2.5	81	66	2,249.8	13,632.4	1:6.1	7,577.8
Shengping oilfield	257	6.96	34.39	1.9	97.5	78	4,116.8	20,761.8	1:5.0	8,840.35
Longhupao oilfield Sagao commingled production area	86	1.03	8.73	7.8	94.1	79.4	1,292	3,085.8	1:2.4	750.88
Chao 55	43	0.87	25.33	4.2	93.7	62.5	708.5	2,608.4	1:3.7	1,089.38
Dong 18	46	0.64	18.06	3.4	90.2	79.3	648.0	1,909.13	1:3.0	831.16
Total	635	14.07	30.06	3.96	91.3	73.6	9,015.1	41,997.53	1:4.67	19,089.57

CONCLUSION

(a) Measures from a single well, the wells optimal economic measures chemical dialysis and oil fill hole, the worst economic measures for the radial drilling; optimal economic measures for wells is broken down, the worst economic measures is well fracturing; and show entire demonstration area better than oil wells measures measures.

(b) Measures overall block effect, demonstration area Longhupao high oil Sa commingled area measures the best economic results, towards Block 55 measures the worst economic effect; however, after adjustment measures, and achieved good on the whole economic effect.

(c) After the demonstration area measures for economic evaluation, screened out of the blocks for tapping the potential of the measures, as a guide and constantly deepen the understanding of the blocks in the development process of practice repeatedly adjusted through practice, knowledge, practice, and then the process of cognition , firmly grasp the initiative in oilfield development, achieve high and stable yield long time.

NOMENCLATURE

P_r—Measures earning, yuan

P—Crude oil price (excluding tax), yuan/t

Δq_t—Months increase oil, t

I—Measures direct cost, yuan

T_{ax}—Tons of oil taxes (additional education, urban construction tax, resource tax, mineral resource compensation), yuan/t

n—Measures validity, months

ΔC_t—The first Months within the validity period t incremental costs of individual measure, yuan

C_1—Fuel cost, yuan/t

C_2—Transport operation, yuan/t

C_3—Factories and mines management fee, yuan/t
C_4—Other fee, yuan/t
C_5—Power cost, yuan/t
C_6—Oil and gas processing fee, yuan/t
C_7—Water injection cost, yuan/t
Δq_y—Months increase the amount of fluid, t
Δw—Months increase water injection volume, t
N_G—Geological effective measures wells
N_T—Measures total wells
N_E—Measures for cost-effective wells
$\Delta q_{\lim}$—Measures to increase the minimum amount of oil, t
P—Evaluation index
a—Weight value
P_i—The value of the Evaluation index
k—Item code

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