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Modeling the Economics for Oilfield Construction Projects

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Abstract: Oil and gas companies will face the problem of oilfield construction in the process of production. The economic evaluation for oilfield construction is the premise to ensure the successful implementation of construction projects. The purpose of this paper is to analyze economic evaluation method of oilfield construction project. After comprehensive analysis of the technical measures of oilfield construction, we establish a target economic evaluation model and discuss the parameter determination method in the model; According to the actual conditions of oilfield construction, we must measure how the overall economic benefits are affected by investment timing, we develop an investment timing selection method of the oilfield construction project; Through the application, the economic benefits of oilfield construction can be evaluated by the NPV method and investment timing selection can be combined with the boundary analysis method.

Keywords: *oilfield construction; economic evaluation; cash flow method; investment estimation; investment timing.*

1. Introduction

Through the changes in oil production and consumption between 1980 and 2014 in China, which can be seen in Fig.1, we discover that the growth of oil demand was fast [1].

With the steady growth of China's economy, the oil consumption will continue to rise. To solve the problem of oil supply, we should not only make up the shortages of domestic production by relying on imports, but we should also keep steadily developing domestic production. According to the onshore exploration results in recent years, most of the new discoveries belong to marginal oilfields of hypotonic, special hypotonic, low yield, poor quality, high viscosity which is difficult to exploit[2]. Therefore, we should still center on continued stable production of mature oilfields. The current situation of oilfield development [3] is that the majority of mature oilfields have entered the later stages of production which face high water cut, increased mining costs and production decline. With the reality of oil and gas exploitation, oilfields need to reconstruct to accommodate the new situation. A series of questions, including the amount of capital investment in construction, the time of construction, the ways to achieve optimal economic benefits, are worth being studied systematically. The study on the scale of financing is reasonable when projecting the amount of cash reserve for oilfield construction to avoid insufficient or excessive funds; inaccurate forecasting can cause either excessive investment or a low fund utilization ratio. The study on the economic impact of oilfield construction determines the value of an oilfield construction project. The study on the time allocated to oilfield construction is conducive to scheduling, funding plans and improve of the overall benefit of oilfield development.

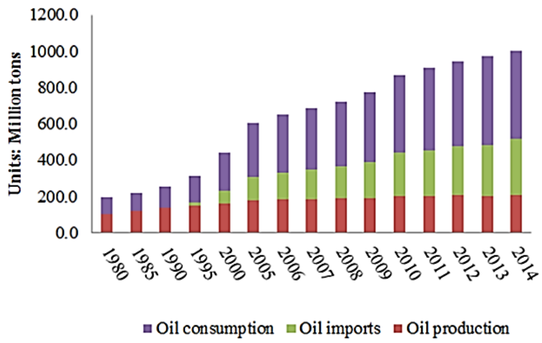

***Fig.1.** The trend chart of oil production and consumption in China*

In recent years, the research of oilfield mainly focus on overall development, especially production decline stage which includes the research of production variation forecast[4-13], the evaluation of recoverable reserves[14-19], the research of wells density adjustment[20-22], the research of EOR[21, 23-25], the research of evaluation methods[26-37], etc. From the earliest emergence of production decline concept (By R.Arnold and R.Anderson first proposed in 1908) to summarize the law of production decline into three descending curve by Arps J in 1945, the research on oil production decline officially kicked off. After that, Wenbo Weng proposed limited life system mathematical model for production forecast of non-renewable resources [4]. Xudong Zhao [6] predicted more than 150 oilfields' production using Weng model. N. Chithra Chakra et al.[13] forecast cumulative oil production from a petroleum reservoir employing higher-order neural networks. Yihua Zhong[12] proposed an oil production forecast model based on principal component analysis and support vector machine (SVM) for special high water cut stage. The evaluation methods, including real option theory [27-31], gray target theory[32], fuzzy hierarchy analysis[33, 34], cash flow evaluation[26, 35-38], and a series of evaluation method[39], have been applied in the evaluation of the project value.

Through the above literature analysis, it can be found that the research on evaluation of oilfield construction is diversified, with focus on certain aspects and lack of overall research. While the economic evaluation of an oilfield construction project is based on system engineering and needs concerted efforts. The most important issue of oilfield construction is input and output. As for the oilfield construction investment, the income and cost will fluctuate with the construction investment. So the problem of investment estimation, economic modeling, and optimal investment timing for oilfield construction is worth studying. Aiming at these problems, this paper examines a more in-depth research to make the economic evaluation of oilfield construction more scientific and objective.

2. Economic Evaluation Parameter Prediction:

The prediction of economic evaluation parameters is the basis for economic evaluation model of oilfield construction project. The accuracy of the predicted parameters directly affects the quality of the final assessment. By means of systemizing relevant literature and investigating actual situation of oil and gas production companies, this paper present the prediction method for natural production, investment, incremental yield, operating cost, etc. In addition, we make a detailed explanation for each parameter prediction method.

2.1. Natural Production Forecast

The forecast of oilfield natural production which maintain the natural decline play a significant role in oilfield development. For oilfield production forecast, there has been a lot of forecasting methods including mechanism forecast method, statistics forecast method, and information forecast method [28]. This paper adopts statistics forecast method, Arps production decline curve, which has been conducted numerous actual tests and widely applications [7]. According to the difference of decline index, Arps can be divided into three cases, exponential decline, harmonic decline and hyperbolic decline. Normally, practical oil productions obey hyperbolic decline [40]. The productions obtained by exponential decline, however, are generally close to hyperbolic decline and easy to solve, so the application of exponential decline is more widespread.

2.2. Incremental Production Forecast

Oilfield, after the production plateau and turned into decline period, productions and productivity will decline that wastes the production facilities and raise the production costs per barrel of oil. Taking some effective construction measures can slow down the oilfield decline speed and reduce the production cost. The degree of influence of oilfield stimulation measures including fracturing, acidizing, reperforating, plugging, on the production is random and limited. For oilfield construction, the effective methods to ease the production decline are well pattern infilling and inpouring polymer flooding [41]. Production calculation after well pattern infilling is denoted as:

$$Q_{t1} = Q_1\left(1 + nD_1t_1\right)^{-\frac{1}{n}} \tag{1}$$

$$N_{P1} = \frac{Q_1}{(1-n)D_1}[1-(1+nD_1t_1)^{\frac{n-1}{n}}] \tag{2}$$

The basic principle of production calculation after inpouring polymer flooding is similar with well pattern infilling, but parameter meaning is slightly different. Production calculation after inpouring polymer flooding can be denoted as:

$$Q_{t2} = Q_2\left(1 + nD_2t_2\right)^{-\frac{1}{n}} \tag{3}$$

$$N_{P2} = \frac{Q_2}{(n-1)D_2}[1-(1+nD_2t_2)^{\frac{n-1}{n}}] \tag{4}$$

2.3. Investment Forecast

2.3.1. The Content of the Investment Activity of Oilfield Construction

Oilfield construction process is a systematic engineering, which is involved in investment in all respects. The construction process can be seen as a process of re-investment. The investment related to oilfield construction includes several aspects like series of development strata adjustment, well pattern infilling, enhanced oil recovery, surface engineering adjustment. For conventional reservoirs, the most effective investments to raise oil productions are well pattern infilling and inpouring polymer flooding. The investment process is illustrated in Fig. 2.

2.3.2. The Investment of Well Pattern Infilling

Well pattern infilling is an essential construction investment activity in the process of oilfield development, the ways including development wells overall infilling, water injection wells infilling, drilling wells in inferior strata, EOR adjustment wells [42]. The investment of well pattern infilling mainly used in injection wells, production wells and supporting surface engineering. The calculation method of investments for development wells can be shown as:

$$I_k = I_z \cdot n_z + I_c \cdot n_c + I_g \cdot n_g \tag{5}$$

Estimation of surface engineering investment need to consider the basis of pre-existing conditions and combined with the existing facilities and the facilities need to add. If the existing surface facilities utilization rate of increased wells is ε, the surface engineering investment need to add can be computed by following equation:

$$I_d = n_t \cdot \left(1-\varepsilon\right) \cdot f \tag{6}$$

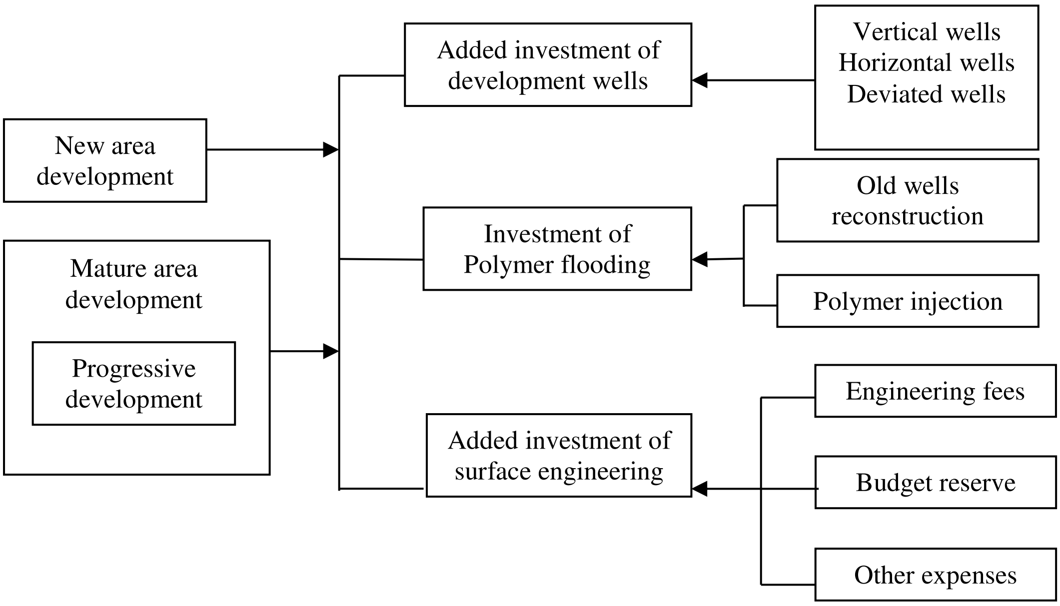

***Fig.2.** The flow chart of the investment for oilfield construction*

2.3.3. The Investment of Tertiary Oil Recovery

The technology of tertiary oil recovery includes chemical flooding, thermal flooding, miscible flooding, etc., which polymer flooding belongs to chemical flooding is currently the most widely used and most effective EOR technique in China [43]. The investments of polymer flooding are mainly related to injection wells and surface engineering. If infill injection wells, the investment can be calculated in accordance with the method mentioned in well pattern infilling. And if polymer injection by existing injection wells, the investment of injection wells does not occur. The investment of ground engineering is one of the major investments on polymer flooding. In the case of no wells infilling construction, the major investment for polymer injection is the surface engineering construction which includes injection equipment, infrastructure systems engineering, extraction separation process, etc. The usage of polymer injection facilities is generally not a one-off, and we can handle the surface engineering investment with allocation method in the process of repeated usage.

In the case of development plan completion and data available, added investment of surface engineering should adopt a detailed itemized quota estimation method. When development program is not complete or the data is difficult to obtain, we can adopt expansion index method or scale index estimation method which based on the investment of added drilling wells.

2.4. Operating Costs Forecast

Operating cost is an important part in oil production cost. In accordance with the properties of operating costs, it can be divided into two categories: fixed operation costs and variable operation costs. Fixed operating costs are those not vary with the change of production. Oppositely, variable operation cost refers to the cost that varies with the change of production. Cost drivers are the reasons for change in cost. As the various stages of development, variable operating cost in practical production process of oilfield is constantly changing, which the indicators caused changing can be considered as cost variables. Such variables mainly include the number of injection and production wells, oilfield driver type, annual output of oil and liquid, and injection volume. According to different cost drivers, operating costs can be divided in Table 1.

***Table 1.** Operating costs*

Cost drivers	Operating Cost items	Calculation Method
Wells density (Wells number)	Fixed costs	c_F
	Material fee	c_m•n_t
	Logging well test fee	m_1•c_l•n_t
	Downhole fee	m_2•c_s•n_t
	Repair and maintenance costs	c_w•n_t
Driver type	Polymer flooding material Injection fee	c_v•q_{bt}
Liquid production	Power costs	c_e•q_{yt}
	Oil and gas processing fee	c_k•q_{yt}
	Fuel cost	c_b•q_{yt}
	Transportation costs	c_d•q_{yt}
Oil production	Light hydrocarbon recovery fees	c_h•q_t

Operating costs of oilfield construction can be calculated by following formula:

$$C_t = [c_F + (c_m + m_1 \cdot c_l + m_2 \cdot c_s + c_w) \times n_t + c_v \cdot q_{bt} + (c_e + c_k + c_b + c_d) \times q_{yt} + c_h \times q_t] \times (1 + r\%) \quad (7)$$

The operating costs prediction method developed above consider the costs change with variation of wells density and tertiary oil recovery. At the stage of oilfield construction, the operating costs will not change. However, the unit operation costs will rise with the production decline. The unit operation costs calculation formula can be expressed as:

$$c_t = \frac{C_t}{Q_t \cdot e^{-Dt}} \qquad (8)$$

This equation describes the law of unit costs increasing with production decreasing if there are no measures to increase production. For the purpose of make the utmost of the designed capacity and ensure a steady supply of oil, some measures should be taken. Under certain technical conditions the recovery is fixed, same as profit margins. If the unit cost of stimulation measures lower than no human intervention, oilfield construction will be stimulated; Oppositely, if the unit cost of stimulation measures higher than no human intervention, oilfield will not be reconstructed [44]. Unit operation costs of measures to increase production, however, should not exceed the unit operation costs which do not take measures. Thus, the operation costs of oilfield construction in each year can be shown as:

$$C_t' = Q_t \cdot D_R \cdot c_t \qquad (9)$$

3. Economic Evaluation Model:

According to the different demand of oilfield construction project, it can be divided into two cases including maximum benefit and maximum recovery. Therefore, this paper builds an economic evaluation model for oilfield construction from both aspects of maximum benefit and highest recovery to meet different decisions requirements. There are many economic evaluation methods for oil and gas project. Discounted cash flow (NPV) method, as a dynamic evaluation, not only reflects the time value of money but also has a relatively well rationality and operability. Therefore, this paper selects the discounted cash flow method as the economic evaluation method for oilfield construction project.

The basic idea of economic evaluation for oilfield construction project is shown as follows: firstly, oilfield annual production in lifetime before construction can be predicted by Arps production decline method, and then calculate the net present value (NPV1) on the basis of the estimated annual operation cost at the time of evaluation; secondly, predict the annual production of oilfield after reconstruction in lifetime, considering new investment (infill drilling, flooding material injection, surface engineering, etc.), and then calculate the net present value (NPV2) on the basis of the estimated annual operation cost at the time of evaluation; finally, comparing the calculated results, if NPV2> NPV1, we should reconstruct oilfield and vice versa. The flow chart of evaluation is illustrated in Fig. 3.

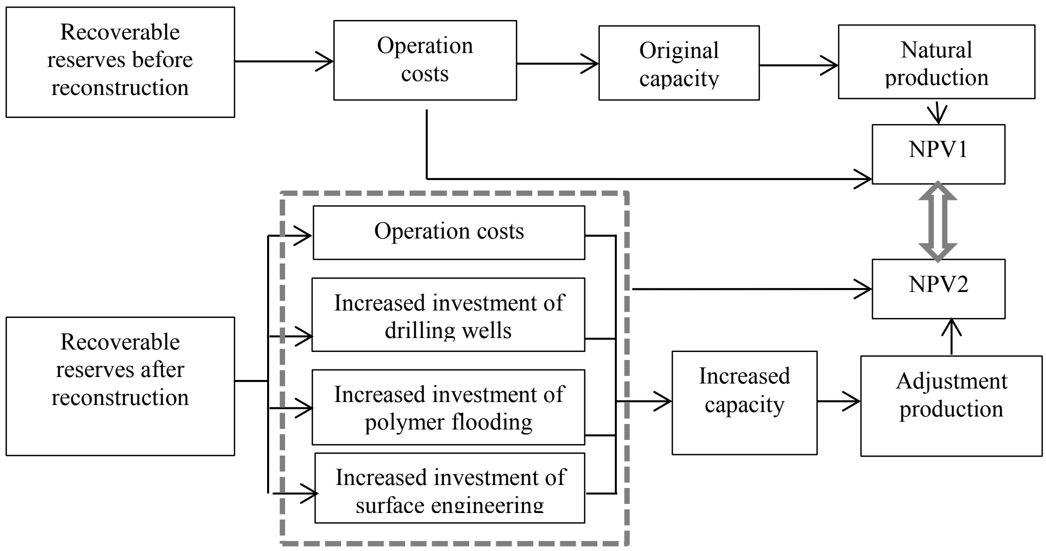

Fig.3. *The flow chart of economic evaluation for oilfield construction project*

3.1. Economic Evaluation With and Without Reconstruction

3.1.1. Oilfield Valuation under Natural Production

Oilfield production under natural production follows the natural decline rate. The oilfield valuation model under natural production which treats production decline method as calculating basis can be written as:

$$NPV_1 = \sum_{t=0}^{T} \left[Q_t \cdot f_s \cdot P(1-T_r) - C_j \right](1+i_0)^{-t} + I_l \left(1+i_0\right)^{-T} - I_c - I_l \qquad (10)$$

Using production decline method to assess the residual value of oilfield can only be applied when production decline law follows natural decline, and the production decline process should has nothing to do with human intervention. This model expresses the value of remaining recoverable reserves, which are the cumulative output value of production decline to economic limit production. Economic limit production is the oil production when sales revenue is just equal to operating costs of oilfield development.

3.1.2. Oilfield Valuation under Reconstruction

Oilfield reconstruction mainly refers to infill drilling and injection of polymer flooding, while corresponding surface engineering investment should also be considered in the valuation model. Therefore, the oilfield valuation model under reconstruction can be denoted as:

$$NPV_2 = \sum_{t=0}^{T}\left[f_s \cdot p \cdot \left(Q_t + Q_t'\right) \cdot (1-T_r)\right](1+i_0)^{-t} + I_l (1+i_0)^{-T} - I_c - I_l - \sum_{t=0}^{T}(I_k + I_d)(1+i_0)^{-t} - \sum_{t=0}^{T}\left(C_j\right)_t \cdot (1+i_0)^{-t} \quad (11)$$

According to the calculated net present value of natural production (NPV1) and adjustment production (NPV2), we can make a judgment whether we should reconstruct oilfield. If NPV2>NPV1>0, it is illustrate that oilfield has potential of value-added and can invest to construction; if NPV1>NPV2>0, it is illustrate that the economic benefit of construction is not well and can't bring excess returns, considering enhanced oil recovery, however, if higher degree of recovery under construction, we can invest it as well; if NPV1>0>NPV2, it is illustrate that we not only can't get excess returns but economic benefit of oilfield is negative, so even if it can improve recovery, we should not invest to reconstruct.

3.2. Investment Timing of Oilfield Construction

The problem of investment timing of oilfield construction which is different from the general construction project is rarely serious consideration [45]. The uncertainty of oilfield construction project is relatively low. The investment objective is mainly to maximize the net present value (NPV), but sometimes, for the purpose of access to oil resources, we will also through construction to enhance oil recovery.

If the purpose of construction is to enhance oil recovery, regardless of the economic value, we can carry out when the production is falling. Normally, the purpose of oilfield production is to maximize economic benefits, so the investment timing should base on the construction project value which varies with different construction timing. The best point to construct is the first year when increased profit equals to increased costs.

4. Application:

Oilfield K located in Xin Jiang, China, which border on Kazakhstan. Basic proven oil-bearing areas of the fault block are $28.62km^2$ and oil reserves are 2667.58×10^4t. Oil and gas exploration right was obtained at the end of 2006. Geophysical exploration work initiated at 2007. Drilling was implemented at 2008. In the construction period of 2011, the total numbers of wells were 198 which included 11 available oil wells and 187 new drilling wells of drilling footage of 46.91×10^4. The rate of production is 1.46% and production capacity is 30.3×10^4t per year.

4.1. Economic Value Assessment

The economic evaluation period of oilfield K is twenty years (2011-2030), and construction period is one year. According to industry standards, public economic parameters can be seen as follows;

Table 2. *Public economic parameters*

Basic parameters	Units	Value of number	Basic parameters	Units	Value of number
Project calculation period	year	20	Discount rate	%	12
Project construction period	year	1	Commodity rate	%	95
Project operation period	year	19	Added value tax	%	17
Liquidity proportion in construction investment	%	5	Urban maintenance and construction tax	%	7
Depreciation and amortization period	year	10	Resource tax	$/t	4.52
Oil price	$/bbl	80	Educational Surtax	%	3
Tonne/barrel conversion factor		7.146	Income tax rate	%	25

4.1.1. Production Forecast

Natural production forecast of oilfield K in development period using production decline curve is listed in Table 3.

Through the analysis of table 3, an obvious production decline can be found at 2014, when should consider to reconstruct oilfield to maintain production. According to composite decline rate under construction, the production forecast is shown in Table 4.

Table 3. *Natural production forecast*

Year	2011	2012	2013	2014	2015	2016	2017
Annual output (10^4t)	12.12	30.90	29.89	27.05	24.47	22.14	20.04
Year	2018	2019	2020	2021	2022	2023	2024
Annual output (10^4t)	18.13	16.40	14.84	13.43	12.15	11.00	9.95
Year	2025	2026	2027	2028	2029	2030	
Annual output (10^4t)	9.00	8.15	7.37	6.67	6.03	5.46	

Table 4. Production forecasts under construction

Year	2011	2012	2013	2014	2015	2016	2017
Annual output (10^4t)	12.12	30.90	29.89	30.51	30.67	30.88	30.36
Years	2018	2019	2020	2021	2022	2023	2024
Annual output (10^4t)	30.257	28.206	25.27	22.64	20.28	18.17	16.27
Years	2025	2026	2027	2028	2029	2030	
Annual output (10^4t)	14.58	13.06	11.70	10.48	9.39	8.41	

4.1.2. Investment forecast

According to the development program deployment of oilfield K, the numbers of designed development wells were 187 and drilling footage was 46.91×10^4; the numbers of designed production wells were 126 (including 19 horizontal wells) and injection wells were 67. The total investment of the project in construction period was 291.1 million dollars, which includes development wells investment 206.95 million dollars, production engineering investment 14.7 million dollars, and ground engineering investment 69.4 million dollars.

Oilfield K starts construction since 2014 and end in 2018. The construction engineering expected to cost 78.3 million dollars on drilling engineering, 6.5 million dollars on production engineering, and 29.8 million dollars on surface engineering. Annual construction investments are listed as follows:

Table 5. Investment estimation of the construction of oilfield K

Year	Units	2014	2015	2016	2017	2018	Total
Drilling engineering investment	10^4USD	1687	1374	1145	1941	1687	7835
Production engineering investment	10^4USD	133	108	89	179	143	655
Ground engineering investment	10^4USD	602	681	568	568	568	18527
Total	10^4USD	2423	2163	1803	2689	2399	11478

4.1.3. Cost forecast

According to the cost prediction method described hereinbefore, the changes of annual operating costs are between 45 to 275 dollars per tonne and the annual average operating costs are 128 dollars per tonne.

The situations of natural production and construction are respectively shown in Fig. 4. and Fig. 5.

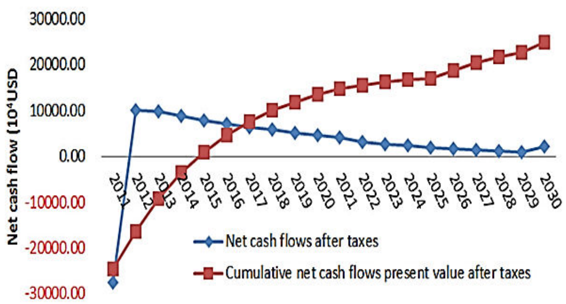

Fig.4. The cash flow diagram of natural production

The key financial indicators of oilfield K including two situations, natural production and construction, are shown in Table 6. From the comparative results of key financial indicators, we can see that the net present value and internal rate of return under construction are higher than natural production (NPV1 = 182.18 million USD, NPV2 = 249.06 million USD). Project payback period slightly extend and total investment yield changes little. Therefore, no matter considering from economic value perspective or enhanced oil recovery perspective, the construction projects of oilfield A are superior[46-48].

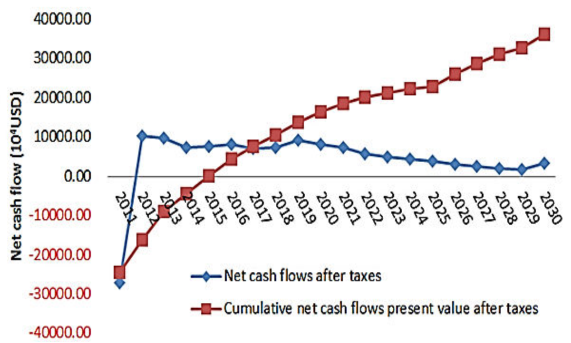

Fig.5. The cash flow diagram under construction

4.2. Investment timing selection

According to the investment timing selection method of oilfield construction mentioned before, we calculated the construction project value between 2014 and 2017 respectively. The year of maximum value of the project is the best time to reconstruct. The project value of construction between 2014 and 2017 is higher than the value of natural production. So we can just compare the value of each year and the best year to reconstruct for oilfield K is 2014.

Table 6. *The compare of key financial indicators of oilfield A*

Items	Units	Financial indicators under natural production	Financial indicators under construction	Remarks
Basic data				
Total investment	Million USD	310.14	426.18	
Construction investment	Million USD	291.1	405.89	
Liquidity	Million USD	14.55	20.29	
Sales revenue	Million USD per year	103.58	143.91	Average
Total cost	Million USD per year	42.09	56.71	Average
Depreciation	Million USD per year	29.52	26.74	
Unit oil operating costs	USD/tonne	137.9	127.4	Average
Sales taxes and surcharges	Million USD per year	9.27	12.89	Average
Total profit	Million USD per year	54.9	75.16	Average
Profit after tax	Million USD per year	41.17	56.37	Average
Evaluation indicators				
FIRR (after-tax)	%	19%	21%	
FNPV (after-tax)	Million USD	182.17	249.06	
Static investment payback	Years	4.77	4.94	
Total investment yield	%	17.95	17.88	

5. Conclusions and recommendations:

In the process of production and management, oil and gas companies inevitably face oilfield construction, which is determined by the law of the oilfield development. Objective economic evaluation before construction is the premise to ensure success. Through systematic research on economic evaluation of an oilfield construction project, the main conclusions include:

The economic evaluation of oilfield construction could use "with and without comparison" method, which calculates the oilfield value under the situations of natural production and construction. For both cases, this paper established the NPV evaluation model respectively, which fully considers the main factors that affect the value of construction. In the calculation of the parameters, we can use Arps decline curves to calculate natural decline yields. Investment should focus on well pattern infilling investment and EOR investment to overcome the disadvantages of previous estimated costs. Based on historical data, operating cost analysis can use detailed the estimation method related to cost drivers which affects the cost changes, and we can adopt the analogy method to estimate the cost if the cost data are difficult to obtain.

This paper proposed an investment timing selection model based on the size of NPV of construction project in each year. Generally, oilfield should reconstruct when oil production is decline to ensure maximum production. This is mainly for the following reasons: 1) Time value of money. Since time value of money, the later the resources are mined, the lower the value is which discounted to the time of the evaluation period. 2) Equipment utilization. The reduced production will inevitably lead to waste of facilities which are in accordance with the production capacity of the stable production period. 3) Contractual constraints. Generally, oil and gas contracts provide the oilfield development life which local government is entitled to recover land in the expiry date. Therefore, mining underground resources as much as possible within specified number of years is one of the goals of oil and gas companies.

This paper carry on an in-depth research on the economics of oilfield construction, which adopt two major the ways of well network encryption and polymer flooding, from the perspective of technology. With the progress of technology, some more effective and environmental construction ways (such as carbon-dioxide flooding, microbe flood, etc.) may be large-scale applied in oilfield construction. However, the new technologies that may be large scale applications are not considered in the evaluation model. In addition, non-technical factors (such as management innovation, improving the quality of staff etc.) which are not studied in this paper also have an impact on economic benefits of oilfield construction. With the progress and popularization of oilfield construction technologies in the future, the impact of the new technologies can be considered in the evaluation model built in this paper. The effect of non-technical factors on economic benefits of oilfield construction can be incorporated into the evaluation model established in this paper from the perspective of input-output analysis, or set up a separate economic evaluation method against the specific effect in the process of oilfield production. Economic analysis of oilfield construction under the influence of technical factors to reflect the projected economics of an oilfield construction project enable it to be a more comprehensive and objective analysis.

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Nomenclature:

Q_{t1} The oil production after well pattern infilling at the year "t_1"
N_{p1} The cumulative oil production after well pattern infilling at the year "t_1".
D_1 The production decline rate after well pattern infilling.
Q_1 The initial oil production after well pattern infilling.
Q_{t2} The oil production after polymer flooding at the year "t_2"
N_{p2} The cumulative oil production after polymer flooding at the year "t_2".
D_2 The production decline rate after polymer flooding.
Q_2 The initial oil production after polymer flooding.
D The decline rate of production.
I_k The investment of development wells.
I_z The investment of single injection well.
n_z The number of injection wells
I_c The investment of single production well.
n_c The number of production wells.
I_g The investment of single drywell.
n_g The number of drywells.
I_d The investment of ground construction engineering.
ε The utilization for existing ground facilities.
f The comprehensive investment index of single well.
c_F Fixed costs.
n_t The number of wells at the year "t".
c_m The material costs of single well.
m_l The well logging times at the year "t".
c_l The well logging costs of single well each time.
m_2 The operating times at the year "t".
c_s The operating costs of single well each time.
c_v The injection costs of flooding materials.
q_{bt} The injection volume at the year "t".
c_e The power costs of unit liquid production.
q_{yt} The liquid production at the year "t".
c_d The transportation costs of liquids per tonne.
c_h The light hydrocarbon recovery charges eachtonnes of oil.
r The ratio of industrial management cost.
C_t The operating costs after construction.
c_t The unit operating costs
Q_t The production at the year "t".
C_t' The annual operating costs after construction.
NPV_1 The net present value of natural production.
P The crude oil prices.
T_r The combined tax rate.
C_j The operating costs.
f_s The commodity rate of crude oil sales.
I_l The investment of liquidity.
I_c The initial investment.
i_0 The benchmark discount rate.
T The number of years between evaluation point and abandon.
NPV_2 The net present value after construction.
Q_t' The incremental oil at the year "t".
NPV_{2t} The net present value of construction project at the year "t".

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