International Journal of Oil, Gas and Coal Engineering
2018; 6(6): 159-163
http://www.sciencepublishinggroup.com/j/ogce
doi: 10.11648/j.ogce.20180606.15
ISSN: 2376-7669 (Print); ISSN: 2376-7677(Online)

Research & Prospect on Technical Essentials and Benefits of Input-Output of Alkali Surfactant Polymer

Zhang Qingsheng[1], Yang Haiyan[1], Zhou Xiya[3], Sun Xiaobao[2], Xiao Zuowei[1], Li Yuqi[1], Zhou Xianjun[1], Liu Qingmei[4]

[1]Department of Overall Planning, Daqing Oilfield Engineering Co., Ltd, Daqing, China

[2]Departmennt of Pipeline Research, Daqing Oilfield Engineering Co., Ltd, Daqing, China

[3]Department of Planning, Daqing Natural Gas Planning & Design Institute, Daqing, China

[4]No. 2 Department of Petroleum Recovery, Daqing Oilfield Exploitation and Development Institute, Daqing, China

Email address:
zhangqingsheng@petrochina.com.cn (Zhang Qingsheng), yanghaiyan@petrochhina.com.cn (Yang Haiyan)

To cite this article:
Zhang Qingsheng, Yang Haiyan, Zhou Xiya, Sun Xiaobao, Xiao Zuowei, Li Yuqi, Zhou Xianjun, Liu Qingmei. Research & Prospect on Technical Essentials and Benefits of Input-Output of Alkali Surfactant Polymer. *International Journal of Oil, Gas and Coal Engineering*. Vol. 6, No. 6, 2018, pp. 159-163. doi: 10.11648/j.ogce.20180606.15

Received: August 12, 2018; **Accepted**: October 8, 2018; **Published**: November 7, 2018

Abstract: In its 60 years' development, Daqing oilfield has come to the later developing phrase of high water cut after going through the primary flowing production and secondary water flooding production, and faces a quite severe quandary. As the most important tertiary oil recovery technologies to increase crude oil production, the Alkali Surfactant Polymer flooding technique is becoming increasingly developed every day, it is a necessity for enhancing the output and producing benefit of Daqing oil field to correctly understand the economic principle of Alkali Surfactant Polymer flooding and to establish a scientific economic evaluation method and a reliable parameter system. Also, to carry out the study of economic evaluating based on investment, cost and revenue data of Alkali Surfactant Polymer flooding technique project which are implemented in recent years is of great importance in the industrial application of Alkali Surfactant Polymer flooding technique. It is of great importance to explore the effective method for economic evaluation of Alkali Surfactant Polymer flooding. Based on the completed projects, this paper summarizes the economic principle of input and output of those projects, attempts to effectively evaluate the economic situation of Alkali Surfactant Polymer flooding technique, and prospects of the economic benefit of the industrial application of Alkali Surfactant Polymer flooding technique primarily.

Keywords: Alkali Surfactant Polymer Flooding, Input-Output, Industrial Application, Economical Benefits, Prospect

1. Introduction

As the most important stimulation mechanism, Alkali Surfactant Polymer flooding plays a decisive role in the late period of Daqing oil field exploitation. In addition, as one of the Alkali Surfactant Polymer technologies, Polymer flooding has been industrialized for years [6]. Although Alkali Surfactant Polymer flooding has been gradually industrialized in the past few years as mentioned while its recovery rate has been enhanced, the huge investment of Alkali Surfactant Polymer flooding can not be ignored. Thus, it is particularly important to establish a scientific economic evaluation method and a reliable parameter system for correctly understood the economic principle of Alkali Surfactant Polymer flooding. It is an inevitable requirement of the Daqing oil field to enhance the output and producing benefit of Daqing oil field [1]. In recent years, the field test of Alkali Surfactant Polymer flooding has been carried out gradually in No.1 Oil Processing Plant, No.2 Oil Processing Plant and No.6 Oil Processing Plant, and the research of related economic evaluation will be fundamentally important in the future economic evaluation work of Alkali Surfactant Polymer flooding technique industrialization according to the situation of the investment, cost and revenue of the pilot project [2]. Based on the completed projects, the writer summarizes the economic principle of input and output of those projects, attempts to effectively evaluate the economic situation of Alkali Surfactant Polymer flooding technique, and prospects of the economic benefit of the industrial application of Alkali Surfactant Polymer flooding technique primarily as follows [4].

2. The Investment and Cost of Alkali Surfactant Polymer Flooding

The Alkali Surfactant Polymer flooding is mainly generated by alkali, surfactant and polymer, based on their synergistic effect [5], to boost the recovery rate which can be generally increased by more than 20%[3]. And its input characteristics are as follows:

2.1. Constructing Projects Investment

The investment of constructing projects includes the investment on developing wells, petroleum production engineering and surface constructing of Daqing oilfield. Table 1 has shown the investment of several pilot areas.

The investment of high concentration polymer flooding on single-well on oilfield surface is about 2 million yuan, far less than the investment of Alkali Surfactant Polymer flooding which has reached 2.5-2.8 millions yuan. Though analysis, the large scale of the injection system and the sewage treatment system in the ground construction is the main reason for the high investment. Accordingly, these two factors should be specially focused and controlled in managing the investment of future Alkali Surfactant Polymer flooding projects.

The tonnage oil constructing investment has been calculated in order to inspect the level of investing on Alkali Surfactant Polymer flooding, and the results are shown in Table 2.

Table 1. *The investment on pilot projects of No.1, No.2 and No.6 Oil Producing Plants.*

Projects	Number of Producers		Index of Single Well/per 10,000 Yuan	
	Oil Wells	Water wells	Underground & Surface	Surface
Project in No.1 Oil Producing Plant	63	49	396.71	251.63
Project in No.2 Oil Producing Plant	39	29	489.44	253.76
Project in No.6 Oil Producing Plant	62	44	347.04	197.96
Average			400.35	232.25
The present level of investment			400-450	250-280

Ps:*The low investment rate is caused by the utilization of existing facilities, while other facilities like disposal station are yet to be built.
**The result is calculated on the total investment of three oil producing plants and wells

Table 2. *The investment of tonnage constructing on Alkali Surfactant Polymer flooding.*

Projects	No.1 Oil Producing Plant	No.2 Oil Producing Plant	No.6 Oil Producing Plants	Average
Investments on constructing /per 10,000 Yuan	44431.5	33281.6	36786.52	
oil increment/10^4t	75.53	71.45	46.01	
tonnage constructing investment/Yuan	588.26	465.8	799.53	617.87

From table 2, we can see that the investment rate of tonnage constructing on Alkali Surfactant Polymer flooding is fairly close to-or even lower than-the investment of polymer flooding.

2.2. The Expense of Chemical Enhancers

The expense rate of Alkali Surfactant Polymer flooding chemical enhancers can effectively investigate the input level of chemical enhancers [7], and its expense rate on several pilot areas are measured in table 3.

Table 3. *The expense rate of Alkali Surfactant Polymer flooding chemical enhancers.*

Name of Projects	No.1 Oil Producing Plant	No.2 Oil Producing Plant	No.6 Oil Producing Plants	Average
The expense of chemical enhancers/per 10,000 Yuan	42616.02	34492	35777.62	
oil increment/10^4t	75.53	71.45	46.01	
tonnage expense on chemical enhancer/Yuan	564.23	482.74	777.61	608.19

At present, the cost of tonnage polymer flooding enhancers is about 250 yuan. From the measurement of several pilot blocks, the ratio of tonnage expense on Alkali Surfactant Polymer flooding enhancers to tonnage expense on polymer flooding enhancers is generally 2.5:1.

2.3. Operating Cost

According to statistics, the operating cost of crude oil produced by water driving in the old area of Daqing oilfield is 400~450 yuan per ton. After the adoption of polymer driving, the operating cost of crude oil extraction has increased, but it remains at a low level, about 500~550 yuan per ton. The operating cost of crude oil extraction used by the Alkali Surfactant Polymer flooding technology is about 650 to 850 yuan per ton.

The high Alkali Surfactant Polymer flooding operating cost attribute to the heavy workload of maintenance and repairing and the high difficulty produced water treatment, for example the serious scaling problems due to lift on mechanical extraction wells and stuck pump frequently, screw pump wells break frequently, causing great influence to extraction. The problem of prolong pump inspection cycle and thoroughly solve scale formation has been bothering Daqing oil field for many years.

In order to meet the requirements of reinjection development, the treatment of Alkali Surfactant Polymer flooding produced fluid need to add a lot of chemicals, polymer driving and Alkali Surfactant Polymer flooding produced water treatment chemicals used in the reference price and dosing concentration are shown in table 4.

Table 4. *The price and dosage of chemical agents used in ternary and polymer driving.*

Item	De-emulsifier	Floating agent	Anti-scale	Detergent	Germicide
The price per ton/ten thousand	1.5	1	1.2	0.5	1.5
The dosage of chemical agents with Alkali Surfactant Polymer flooding/mg.L^{-1}	50	200	50	50	50
The dosage of chemical agents with polymer driving/mg.L^{-1}	50		10		50

Table 4. *Continued.*

Item	Flocculants	Regulator	Sludge-thickening	Effluent oil treatment
The price per ton/ten thousand	0.4	0.3	1.5	1.5
The dosage of chemical agents with Alkali Surfactant Polymer flooding/mg.L^{-1}	200	700	2	2
The dosage of chemical agents with polymer driving/mg.L^{-1}	50			

Compared to polymer driving, the cost of chemical agents treated with the oil recovery solution has been increased in several test blocks. The result is shown in table 5.

Table 5. *Increasing cost in chemical reagent for tons of oil production fluids in each test area.*

Project	A Project of Factory One	A Project of Factory Two	A Project of Factory Six	The Average
Oil increment/×10^{4}t	75.53	71.45	46.01	
The additional cost of ton oil recovery solution for the treatment of chemical agents /yuan	68.76	52.86	78.27	66.63

Compared to polymer driving, it can be seen that produced fluid treatment chemicals costs is creasing, in addition, operating costs of per ton on Alkali Surfactant Polymer flooding maintenance, repairing and other costs increase at the rate of about 100 ~ 250 yuan.

3. Economic Evaluation of Alkali Surfactant Polymer Flooding

The characteristics of ternary composite driving are high input and output. It determine that its economic evaluation cannot completely copy the evaluation methods of water driving and polymer driving [8], especially in the cost prediction of in-depth and meticulous research to improve the reliability of economic evaluation results.

The operational cost estimation of oil and gas development projects usually adopts the relevant factor method, which is to estimate the operating cost based on the factors driving the changes in operating costs and the corresponding cost quota. The cost drivers include the number of extraction wells, liquid extraction, oil extraction, and water injection. The cost parameter based on the actual financial data of the previous year's cost of in each oil extraction plant. Since the Alkali Surfactant Polymer flooding has been entered the industrialization promotion stage in Daqing oilfield, it is necessary to study the characteristics of the cost on the ternary composite driving project [10].

The cost parameter is determined by the cost data of the completed Alkali Surfactant Polymer flooding test project. The basic method is to calculate the total cost and cost drivers (extraction wells, liquid extraction, oil extraction, water injection, etc.) of each cost item during the calculation period. For the total calculation, taking the Alkali Surfactant Polymer flooding test project of the Sixth Factory as an example, and the calculation results are shown in Table 6.

Table 6. *Determination of cost parameters on Alkali Surfactant Polymer flooding test projectin six factories.*

Cost parameter	Alkali Surfactant Polymer flooding Test project cost calculation results a	All block cost parameters for factory six b	Deviation rate (a-b)/b×100
Cost of materials per well /ten thousand	4.32	2.08	107.92
The cost of fuel for ton oil /yuan	7.51	6.09	23.26
The power cost of ton liquid /yuan	15.84	5.99	164.47
Annual salary for a single person /ten thousand		4.50	
The cost of ton oil of water displacement /yuan	0.94	3.59	-73.73
Single well down hole operating expenses /ten thousand	25.02	8.43	196.82
Single well logging test fee /ten thousand	2.58	1.07	141.51
Oil and gas treatment cost of ton oil /	1.23	1.36	-9.22
Transportation costs for ton oil /yuan	2.28	4.99	-54.27
The other direct costs of ton oil /yuan	10.98	25.94	-57.65
Annual management fee for a single person /ten thousand		1.00	
Annual other management fee for a single person /ten thousand		2.80	
The operating cost of ton oil /yuan	1203.15	573.02	109.97

It can be seen that the calculation results in Table 6 are very different from the current cost parameters. One important reason is that although the cost parameters for economic evaluation are calculated by financial data, the caliber of the cost items is not consistent. The former is basically a mixture of element subjects and operation items, and the latter is divided according to element subjects. Therefore, in the process of converting financial data into cost parameters for economic evaluation, there must be decomposition and consolidation of cost items, which results in a comparison of the results. Regardless of the above reasons, only in terms of the calculation results, the expenditure level of the Alkali Surfactant Polymer flooding on the material fee and the power fee is relatively higher than that of the water driving or the polymer driving, and the expenditure level on the fuel fee and other direct costs. However, the increase is limited or even decreased. The main reason is that the driving factor of the two is the oil extraction, while the Alkali Surfactant Polymer flooding is about one times higher than the polymer driving.

In order to verify the reliability of the above cost parameters, two sets of models were established, as shown in Table 7.

Table 7. *Cost parameter verification model.*

Model	Construction investment	The cost of chemical	The cost of operations	crude oil price
A	Actual investment	Actual cost	Prediction by measured parameters	$ 70/bbl
B	Actual investment	Actual cost	Actual cost	$ 70/bbl

The economic evaluation (model A) based on the cost parameters measured by the cost data of several test areas is close to the actual situation (model B), indicating that the similar blocks of each oil extraction plant are used in the economic evaluation of the pre-ternary compound driving research. This set of parameters is suitable.

However, based on the measurement results of the cost parameters of the test project, the limitations of the cost prediction are obvious. It requires that the proposed project is basically close to the test project. However, the number of test projects is limited, and the measured cost parameters cannot meet the requirements for large-scale industrialization to promote economic evaluation of large-scale composite driving. Therefore, based on the existing plant-level cost parameter system, according to the characteristics of the Alkali Surfactant Polymer flooding, it is necessary to adjust some cost parameters to predict the economic evaluation cost of the ternary composite driving project. The research work on the cost change law of the composite driving is further strengthened.

4. Alkali Surfactant Polymer Flooding Economic Benefits Prospects

The problem of polymer driving and Alkali Surfactant Polymer flooding has always been concerned by all parties [9]. The analysis shows that choosing the development method, which is undoubtedly one-sided from the one of the oil increase, and the economic benefits are at all times. It is the core interest pursued by enterprises. In this process, economic evaluation will play a vital role.

The three most important factors determining the economic benefits on ternary e driving are inputs (including investment, cost), oil increase, and crude oil prices. Investment and cost can be gradually reduced and controlled through effective management of the enterprise and technological progress.

Based on the existing research results, a rough estimate of the ton oil input of the ternary composite driving and polymer driving is given. The results are shown in Table 8.

Table 8. *Comparison of ton oil input of ternary composite driving and polymer driving.*

Project	polymer driving	ternary composite driving
Construction investment of ton oil /yuan	600.00	600.00
chemical auxiliaries for ton oil /yuan	250.00	625.00
The operating cost of ton oil /yuan	525.00	750.00
Total	1375.00	1975.00

The ton oil input index of the ternary composite driving is about 1.44 times that of the polymer driving oil input index. At present, the ternary composite oil displacement technology can ensure that the ratio of the oil increase of the two is 1.5 to 2 times, so From the perspective of input, the input levels of the two types of oil displacement methods are comparable.

After comparing the alternatives of polymer driving, the following conclusions can be drawn: the critical crude oil price of a ternary compound driving project in a plant is $35.61 / bbl, and the critical crude oil price of a ternary compound driving project in the sixth plant is $71.64 / bbl. When the price is higher than this price, the use of ternary composite driving is economically more advantageous, and vice versa. Polymer driving should be used. It can be seen that the prospect of industrialization of ternary composite driving is good in the case of an upward trend in oil prices.

5. Conclusion

After years of continuous exploration and practice, the ternary composite driving technology of Daqing oilfield has become increasingly mature, and economic benefits have become the key to the large-scale industrialization of this technology. The research shows that the first two factors (including investment, cost) and the rate of oil increasing determine the economic benefits of Alkali Surfactant Polymer flooding are gradually developing in a good direction as the controllable factors of the enterprise, while the objective reality of the fluctuation of crude oil price is unpredictable. Enterprises should be required to seize opportunities and challenges in a timely manner, and gradually carry out the work of industrialization and promotion of ternary compound driving in accordance with the strategy of prioritizing and prioritizing benefits.

In the process of industrialization and promotion of Alkali Surfactant Polymer flooding, the role of economic evaluation in the preliminary research on Alkali Surfactant Polymer flooding project should be brought into full play, and the economic benefit comparison analysis of various oil displacement methods should be carried out around different oil displacement technical routes. Taking into account the different characteristics of ternary and polymer driving input and output, for the project suitable for ternary and polymer driving, comprehensive analysis of the economic benefits of the two oil displacement methods, from crude oil price, oil increasing range, etc. In terms of comprehensive consideration, conduct corresponding economic evaluations, select the most economically optimal oil displacement method, and reduce the risk of blind investment.

References

[1] Xu Jing. Discussion on the economic condition of field Alkali Surfactant Polymer flooding usage Daqing oilfield [J]. Ground Engineering, 2014, 33 (10):98-99.

[2] Sun Chunfen, Zhao Lanshui, Jin Guifen, etc. Analysis on the economical benefit of polymer and Alkali Surfactant Polymer flooding [J]. Petroleum Planning and Design, 2006, 17 (1):23-26.

[3] Li Xuejun. Research on the technical process of Alkali Surfactant Polymer flooding in ground engineering [J]. Petroleum Geology & Oilfield Development in Daqing, 2001 (4):35.

[4] Wang Fenglan, Wu Xiaolin, Chen Guangyu, Li Hongfu, Zhang Guoyin. Technical progress of Alkali Surfactant Polymer flooding (ASP) in Daqing oilfield [J].Petroleum Geology & Oilfield Development in Daqing, 2009, 28 (5):154-162.

[5] Li Jie, Yao Shichun, Yu Xiaodan, Chen Qing. The influencing factors of Alkali Surfactant Polymer flooding effect in Daqing oilfield [J].Petroleum Geology & Oilfield Development in Daqing, 2011, 30 (6):138-142.

[6] Niu Jingang. Practices and understanding of polymer flooding enhanced recovery technique In Daqing oilfield [J].Petroleum Geology & Oilfield Development in Daqing, 2004, 5, 91-93.

[7] Cheng Jiecheng, Wu Junzheng, Hu Junqing. The important theory and technology of raising oil recovery by three way combination drive. Acta Petrolei Sinica, 2014, 35 (2):310-318.

[8] Jing Keyao, Pei Jianwu, Liu Hongbo, Zhang Yuxu. Economic evaluation method and parameter study of polymer flooding tertiary oil recovery project. Petrochemical technology and economy, 2000, 4:22-25.

[9] Hu Ke. Application of Project Comparison Method in Technical and Economic Evaluation of EOR in Oilfield. Industry and Resorces, 2010, 12 (s1):34-37.

[10] Li Huahua, Duan Wenbiao, Lei Xinhui, Zhou Jin. Study and application of economic evaluation method for investment project of tertiary oil recovery. Low Permeability Oilfield Study, 2016, 2:154-156.

Biography

Zhang Qingsheng: Senior Engineer, graduated from Jilin University in 1993 with a master degree of Applied Mathematics, and engaged in technical economy and engineering management now. He has published several papers on engineering investment & economic evaluation, and has helped organise or actively participated in several major projects both inside and outside Daqing oilfield. He has profound theoretical basis and rich practical experience in field project management and economic evaluation.