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RESEARCH ARTICLE

Economic Evaluation Of Water Production Management With Rpm (Relative Permability Modifier) Treatment Based On Gross Split Contract In "Re" Well In "Dn" Field

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Abstract

The "RE" well in the "DN" field is an oil well produced in June 2004 with an initial water cut value of 15% as time went on there was a fairly high increase in the water cut value reaching 97% which means that it caused increased water production. and oil production decreased from 387 BOPD to 11 BOPD.

Appropriate handling in overcoming excessive water production, one of which is by using a method that can selectively restrain water production without restraining hydrocarbon production with RPM (Relative Permeability Modifier) Treatment. RPM (Relative Permeability Modifier) is a type of polymer with a high molecular weight as the main molecule of RPM. RPM can be done without isolating the layer zone so that it can be injected bullhead into all layer zones to reduce water permeability.

This final project research has been seen from increasing the rate of oil production and decreasing the water cut. The selected well is the "RE" well in the "DN" field which has an increasing water cut value and decreased oil production. Then calculate the economy using the gross split method to calculate the feasibility level of the RPM (Relative Permeability Modifier) Treatment project.

Keywords : RPM (Relative Permeability Modifier) Treatment, Water Coning, Gross split

1. Introduction

One of the factors causing a decrease in the rate of oil production from a well is water coning. Water coning is a situation around the wellbore where the boundary of oil and water rises to form a cone reaching the lowest perforation point, which will cause water to be produced earlier so that the increase in water production becomes faster. (Ahmed, 2001).

Various applications to avoid or just to slow down the occurrence of water coning include using water production wells to maintain the speed of rising water levels and calculating the length of the perforation hose and the optimum rate of water production, then by producing aquifer water. However, all of them will still arrive at a condition where water breakthrough from the aquifer will reach the wellbore and cause water production on the surface. (Subaruto & Ariadji, 2006).

Appropriate handling in overcoming excessive water production is by using a method that can selectively restrain water production without restraining hydrocarbon production with RPM (Relative Permeability Modifier) Treatment. RPM is a kind of polymer with high molecular weight as the main molecule of RPM. RPM can be done without isolating the layer zone so that it can be injected bullhead into all layer zones to reduce water permeability.

This final project research is seen from increasing the rate of oil production and decreasing the water cut. The selected well is the "RE" well in the "DN" field which has an increasing water cut value and decreased oil production. Then calculate the economy using the grosssplit method to calculate the feasibility level of the RPM (Relative Permeability Modifier) Treatment project.

2. Literature Review

2.1 Reserve Determination

Reserves can be defined as the estimated amounts of crude oil, natural gas, gas condensate, liquid phase recovered from natural gas, and other materials (e.g. sulfur), which are considered of commercial value to be recovered from accumulation in the reservoir using existing technology at some point in the economic conditions and with government regulations in force at the same time. (Permadi, 2004).

2.2. RPM (Relative Permeability Modifier) Treatment

To overcome the problem of increasing high water production, one of the methods of water conformance is the relative permeability modifier treatment. This treatment is carried out by injecting a relative permeability modifier type chemical and several other chemicals together with water into the reservoir formation hole (Darlymple & Jaripatke, 2009).

2.3. Mechanics of RPM (Relative Permeability Modifier) Treatment

The working principle of this treatment is by injecting a chemical relative permeability modifier and several additives into the reservoir, RPM is the main polymer (single-polymer) used and functions to reduce the water flow rate over the oil flow rate, as can be seen in the figure (Darlymple & Jaripatke, 2009).

2.4. Treatment Design

The amount of treatment fluid is determined by calculating the required volume of fluid calculated from the wellbore. This radial penetration must occur at the desired treatment height. The equation for this calculation is shown below (Pietrak, Stanley, Weber, & Fontenot, 2005).

2.5. Gross Split

The existence of the Gross Split Scheme is one of the goals to eliminate the debate regarding Cost recovery. The method used is to eliminate the element of cost recovery in the pattern of sharing oil and gas profits. This is because cost recovery is often suspected of being the root of the problem, even being accused of being a means to misuse oil and gas operating funds. Others see cost recovery as a "sin". The Gross Split concept, which eliminates cost recovery, means eliminating the responsibility of the government and SKK Migas to reimburse some of the oil operating costs, which are usually borne professionally according to the cost recovery scheme. With the loss of cost recovery, SKK Migas' obligation to control and supervise cost recovery is erased.

2.6. The difference between PSC and Gross Split contracts:

Kurniawan, Temmy Surya and Jemmy Jainudin (2017) are in contrast to cost recovery PSCs, the split between the Government and contractors in the gross PSC split is determined at the outset. Direct gross revenue is split between the Government and contractors with a base split, namely 57%:43% for oil, and 52%:48% for natural gas. The split provided that the operating costs are fully the responsibility of the contractor. So, there is no more cost recovery. The split has not considered additional taxes for the Government.

2.7. Gross Split Production Sharing Contract

(Permen ESDM Number 08 of 2017), Gross Split production sharing contract is a production sharing contract in upstream oil and gas business activities based on the principle of sharing gross production without a mechanism for returning operating costs.

PSC gross split applies to new Working Areas and Working Areas whose contract period has ended but not extended. For Oil and Gas Working Areas whose contract has been extended, they can choose whether to continue using the previous contract (PSC cost recovery) or using a gross split PSC.

2.8 Economic of Migas Oil and Gas Economy

Investment is based on the profit earned. The profit indicator is needed as a parameter for decision making. To assess the economics of a project or prospect, it is necessary to look at all aspects of expenditure and income throughout the life of the project, so that the evaluation of a project will be based on income during the project cycle until the expenditure and income are the same or close to the same. (Cash Flow) to assist in making decisions to continue or reject the project. However, Cash Flow alone cannot be used as a reference, we need other parameters such as NPV and IRR as considerations for making decisions (Benny Lubiantara, 2012).

2.9 Investment

Investment is the initial financing for projects of economic value that are offered. Investment in the development of energy resources in Indonesia includes exploration costs in finding new sources of reserves and field development. Investments can be grouped into Capital Investment (Tangible Investment) and Non-Capital Investment (Intangible Investment).

2.10. Gross Revenue

Gross revenue (GR) is the result of multiplying the rate of production (bpd) by the price of oil. The rate of oil production is determined based on the predicted production profile that has previously been calculated. The price of Indonesian crude oil depends on the world crude oil market price. . The oil price used is the Indonesian Crude Price (ICP).

2.11. Escalation Factor

In calculating Net Cash Flow, it is also advisable to take into account the possibility of inflation in the future. The existence of inflation will affect the increase in investment in the form of capital and operating costs. For example, in the future the cost to build (production facilities) will be affected by rising steel prices and labor costs that will build these facilities. The amount of inflation is stated in the Escalation Rate. Donald G. Newnan (1984).

2.12. Depreciation

Depreciation is related to the cost of capital, which means a reduction in the value of capital goods as a result of damage or a decrease in use value over time. The length of time for depreciation depends on the contractual agreement, and the depreciation method used in this study is the Declining Balance method. In this case, the value of an item will decrease rapidly over time.

2.13. Non Capital Cost

Non-Capital Costs consist of costs incurred in the years of conducting field exploration and development, these costs will be recovered immediately in the first year of production without depreciating.

2.14. Operating Cost

Operating Cost is costs incurred either in connection with production operations (variable costs) or costs that are certain to be incurred by the company in the form of general administration which do not affect the size of production (fixed costs).

2.15. Recovered Cost

Recovered is cost that gained by the contractor and it is accordance with Benny Lubiantara (2012)

2.16. Unrecovered Cost

Unrecovered Cost is a cost that cannot be recovered by the contractor because the Gross Revenue is less than the total Cost Recovery. Unrecovered Cost can only be calculated in the following year after knowing the total Cost Recovery that can be obtained by the contractor.

2.17. Taxable Income

Taxable Income is taxable income.

2.18. Tax

Tax is one source of government revenue. The government takes its share of oil and gas production through a tax imposed on the contractor's income derived from the business. The tax system created by the government is intended to maximize government revenue. The current tax on contractors is 25%. This tax is imposed on Taxable Income.

2.19. Contractor Share

Contractor Share (CS) is the total income that can be received by the contractor after splitting it with a base split.

2.20. Net Cash Flow

Net Cash Flow (NCF) or is the contractor's net income or the amount of contractor's income that has been taxed.

2.21. Government Share

Government Share (GS) is the total revenue of the State (Government) after dividing by base split.

2.22. Government Take and Contractor Take

Government Take (GT) and Contractor Take (CT) are the percentage of total government and contractor revenue from project profits.

2.23. Economic Indicator

Economic Indicator is a factor to determine the advantages and disadvantages of the Contract. Economic indicators that are often used are: NPV (Net Present Value), IRR (Internal Rate of Return), and POT (Pay Out Time). NPV and IRR are always related to the time value of money (Time Value of Money), while POT is not. Time Value of Money is the time value of money which is a method for knowing the value of money or profits from a Cash Flow in the future. (Newnan Donald G, 1984).

2.24. Net Present Value (NPV)

The Net Present Value (NPV) is the difference between the money received and money spent taking into account the current Time Value of Money. NPV shows the value of net profit received from a business during the life of the business at a certain Discount Factor level. A project is said to be feasible if the NPV is positive, if the NPV value of a project is negative, it can be said that the project is experiencing a loss. The NPV value of a project is zero, so the amount of expenditure is equal to the amount of revenue (Newnan Donald G, 1984).

2.25. Internal Rate of Return (IRR)

The Internal Rate of Return (IRR) is an indicator value that is identical to how much interest the investment can provide compared to the prevailing bank interest rate or the Minimum Attractive Rate of Return (MARR). At the IRR interest rate, NPV = 0 will be obtained, in other words, the IRR implies an interest rate that can be given by investment, which will give an NPV value = 0 (Newnan Donald G, 1984).

2.26. PayOutTime (POT)

Pay Out Time (POT) or Pay Back Period is a period needed to be able to recoup investment expenses. POT can be known from the accumulated Net Cash Flow (Cummulated Net Cash Flow), the POT mechanism can be found by using the interpolation equation.

Some of the weaknesses of POT are that it ignores the time value of money (Time Value of Money) and cannot show the amount of profit to be obtained or in other words POT is not a measuring tool for "profitability" but only a measuring tool for the speed of return of funds. A project is said to be feasible if the POT is small compared to the age of the project or smaller than the minimum target time the company can return its capital or investment.

3. Research Method

This final project research was conducted at PT. Pertamina Asset I Field Jambi by collecting data related to RPM Treatment related to well production data, well completion data, and reservoir data. The research method used is field research or this research uses data from oil fields. The data used are secondary data provided by field supervisors, previous research, journals, papers, expert opinions, principles and theories from guaranteed literature, petroleum engineering textbooks, relevant journals and discussions with supervisors which lead to conclusions which are purpose of research.

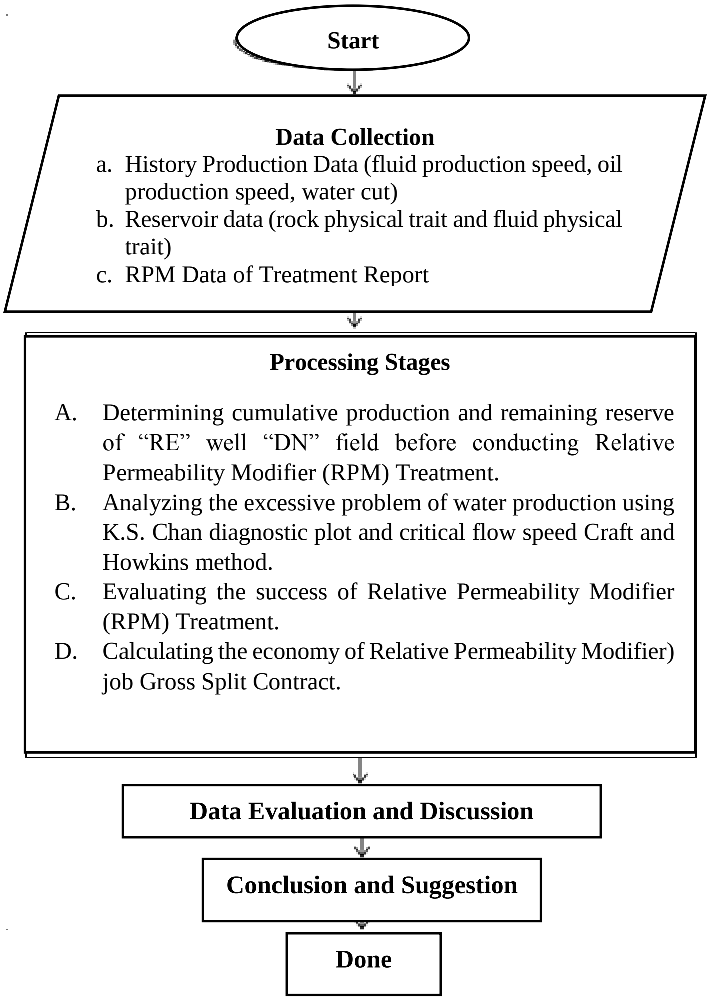

Fig 1. Research Diagram

4. Finding and Discussion

4.1. Determination of the Amount of Reserves and Remaining Reserves of the "RE" Well

Calculation of total reserves (OOIP) is a stage considered important considering how many reserves and potential remain in the "RE" well, so that it will determine the success of fluid production. The following is the "RE" well data, among others:

Area Reservoir	= 40 Acre
Net Pay	= 50,2 ft
Porosity	= 17 %
Saturation Water	= 20 %
Formation Volume Factor	= 1,24 bbl/STB

$$OOIP = \frac{7758 \times A \times h \times \emptyset \times (1 - Sw_i)}{Bo_i}$$

$$= \frac{7758 \times 40\ Acre \times 50{,}2\ ft \times 0{,}17 \times (1 - 0{,}2)}{1{,}24\ ^{bbl}/_{STB}}$$

$$= 1.708.561\ STB$$

In calculating the number of remaining reserves, looking at the cumulative production of the reservoir, the cumulative production (Np) for the reservoir well "RE" is 133,862 bbl. So that the Remaining reserve can be calculated as follows:

$$Remaining\ Reserve\ (RR) = OOIP - Np$$

$$= 1.708.561\ STB - 133.862\ bbl$$

$$= 1.574.699\ STB$$

Dealing with the calculation above, it can be seen that the remaining reserves of the "RE" well are still very large.

4.2. Identification of Water Coning

Identification of water coning is by looking at whether the "RE" well is proven to have water coning or not, namely by the K.S. Chan and then analyzed the coning free flow rate (critical flow rate) with the Craft & Hawkins method. Before carrying out a water coning analysis, first evaluate the water cut performance in the "RE" well (figure 2).

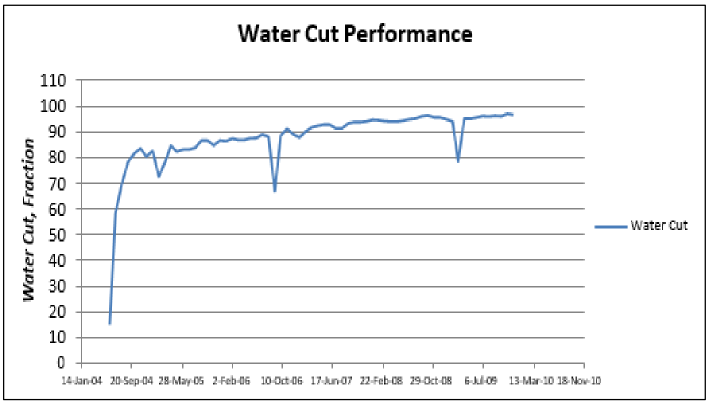

Fig 2. Water cut performance "RE" well

Dealing with the evaluation of the water cut performance of the "RE" well, at the start of production the water cut value was only 15%, but over time oil production has decreased and the water cut value has increased, and since the end of 2009 the "RE" well has been producing with a water cut value which reached a high of 97%, as seen from the stable water cut trendline in these conditions. From the results of this water cut evaluation it was concluded that the main problem in the "RE" well was water production, then with the K.S. Chan identified whether water coning was the cause of the high water production in the "RE" well. Identification of water coning with the K.S. diagnostic plot method. Chan is a plot between WOR and WOR derivative (WOR') vs time.

4.2.1. Chan Plot

Water coning was identified using the K.S. Chan on the well "RE". Plot between WOR and WOR' vs time and compared with the results of analysis from K.S Chan. Plot of WOR and WOR' results from cumulative production on the first to last day of production. Can be seen in Figure 3.

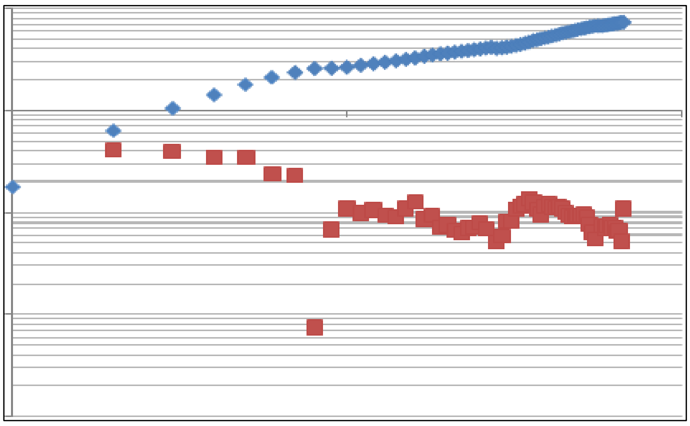

Fig 3. WOR Plot and WOR' (derivative) for "RE" well and Comparison with K.S. Chan curve.

4.2.2. Determination of Critical Flow Rate

Determination of the critical flow rate uses the Craft and Hawkins method to determine whether the oil flow rate in production wells has exceeded the maximum flow rate. The following is the "RE" well data, among others:

Oil zone thickness (h) = 50.2 f
Effective permeability of oil = 60 md
Well dewatering radius (re) = 250 ft
Well radius (rw) = 0.29 ft
Oil formation volume factor (Bo) = 1.24 bbl/scf
Oil viscosity (μo) = 2.64 cp
Static pressure (Ps) = 1525 psi
Well bottom flow pressure (Pwf) = 933.98 psi
Penetration fraction (f) = 0.196
The calculation of the critical flow rate of the "RE" well is as follows:

- Calculating Ratio Productivity

$$PR = f\left[1 + 7\sqrt{\frac{r_w}{2 f h}}\, x \cos\left(f \; x \, 90^0\right)\right]$$

$$PR = 0.196\left[1 + 7\sqrt{\frac{0.29}{2 \times 0.196 \times 50.2}}\, x \cos\left(0.196 \; x \, 90^0\right)\right] = 0.35$$

- Calculating Critical Flow Speed

$$q_{o,} = \frac{0{,}00708 \; x \; k_o \; x \; h \; x \; (Ps - Pwf)}{\mu_o \; x B_o \; x \ln\left(\frac{r_e}{r_w}\right)} \, xPR$$

$$q_{o,} = \frac{0{,}00708 \; x \; 60x \; 50.2 \; x\left(1525 - 933.98\right)}{2.64 \; x 1.24 \; x \ln\left(\frac{250}{0.29}\right)} \, x0.35 = 196.82 \; bopd$$

4.3. Evaluation of the success of the RPMs Treatment

Evaluation of the success of the RPMs Treatment can be seen from the production tests and production rates achieved. The parameters used in assessing the success of the RPM Treatment are by looking at the production rate of the well after the test and the reduction in the water cut contained in the oil.

4.3.1. Production Evaluation

The following results of the production of the "RE" well before and after the RPM treatment can be shown in Table 4.1 as follows:

Tabel 1. Results of the production of the "RE" well before and after the RPM treatment

Date	*Gross* BFPD	*Nett* BOPD	*Water* BWPD	WC
1-Jan-09	402	20	382	95
1-Feb-09	389	18	371	94
1-March-09	531	15	516	78
1-Apr-09	541	26	516	95
1-May-09	521	25	496	95
1-Jun-09	520	23	497	96
1-Jul-09	506	19	487	96
1-Aug-09	478	19	459	96
1-Sept-09	476	18	459	96
1-Oct-09	448	17	431	96
1-Nov-09	416	12	403	97
1-Dec-09	339	11	328	97
RPM *Treatment*				
1-Jan-10	379	88	291	77
1-Feb-10	390	84	306	78
1-Marc-10	380	81	299	79
1-Apr-10	379	77	302	80
1-May-10	376	74	302	80

Based on table 4.1, before the RPM treatment, the water production was 328 BWPD. Therefore, the RPM injection treatment was carried out. After the RPM treatment at the end of December 2009, oil production has increased where previously it was 11 BOPD became 88 BOPD, and this shows the success of the RPM treatment due to an increase in oil production.

Data on the results of the "RE" well production test before and after the RPM Treatment can be seen in Figure 4.

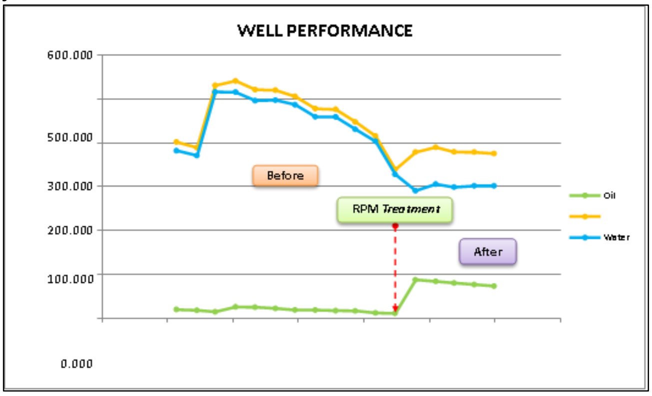

Fig 4. Production Result Before and After Treatment

4.3.2. Water Cut Evaluation

After conducting a production evaluation, an evaluation of the water cut performance is then carried out to see the changes in the water cut that occur before and after the RPM treatment. The water cut performance of the "RE" well can be seen in Figure 4.5 below:

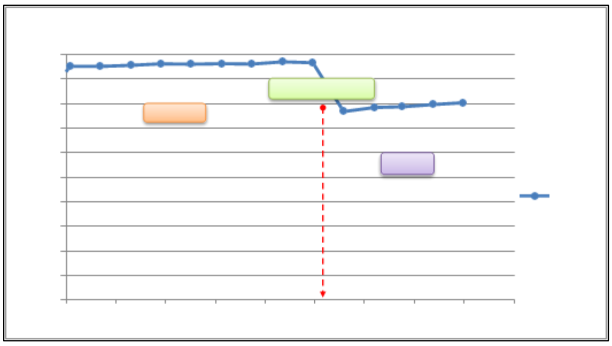

Fig 5. Water cut performance before and after RPM Treatment

4.4. Economic Evaluation

An economic evaluation of the RPM treatment is carried out to find out whether the commerciality of the work is profitable or not. The economic study was carried out based on the VI generation production sharing contract, as shown in the PSC generation VI flow chart in Figure 2.6. The RPM treatment work aims to increase the productivity of the wells, so as to make a profit. The economic parameters needed in this calculation include: NPV (Net Present Value), ROR (Rate of Return), POT (Pay Out Time) and Cash flow.

4.5. GS Method Economic Calculations

An economic evaluation of the RPM treatment is carried out to find out whether the commerciality of the work is profitable or not. The economic study is carried out based on the gross split contract.

4.5.1. Economic Analysis of RPM Treatment GS Method

Tabel 2. Economic Well "RE"

Economy Parameter	"RE" Well	
Recoverable Reserve	73.674,95	STB
Gross Revenue	4.361.459,75	US$
Project AGe	8	Tahun
Investment	26.688	US$
Operating Cost	2.145,34	US$
Net Contractor Take	1.179.739,76	US$
NPV Contractor	923.999,39	US$
ROR Contractor	1956,5	%
POT Contractor	0,049	Tahun
DPIR Contractor	34,62	

Table 3. Contractor Cash Flow After RPM Treatment

Year	NCF $(000)	Discount Rate 0%	5%	10%	15%	20%	25%	30%
0	(26,688)	(26,688)	(26,688)	(26,688)	(26,688)	(26,688)	(26,688)	(26,688)
1	540,254	540,254	514,527	491,140	469,786	450,211	432,203	415,580
2	168,924	168,924	153,219	139,607	127,731	117,309	108,112	99,955
3	155,567	155,567	134,385	116,880	102,288	90,027	79,650	70,809
4	127,483	127,483	104,881	87,073	72,889	61,479	52,217	44,635
5	43,003	43,003	33,694	26,701	21,380	17,282	14,091	11,582
6	65,632	65,632	48,975	37,047	28,374	21,980	17,205	13,597
7	64,148	64,148	45,589	32,918	24,116	17,903	13,453	10,223
8	41,417	41,417	28,032	19,321	13,539	9,632	6,949	5,077
NPV		1,179,739.76	1,036,614.77	923,999.39	833,415.05	759,135.05	697,191.62	644,770.91

It can be seen in table 4.2 the results of the economic analysis seen in the economic parameters of the "RE" well indicate that the RPM treatment work that has been carried out is profitable because the economic indicator NPV value obtained is positive, ROR > MARR of 15%, POT (return on investment spending) 0.049 years , while the economic indicators of cash flow can be seen in Table 4.3.

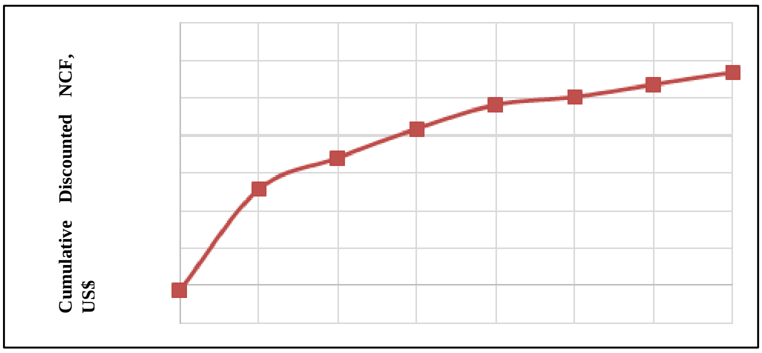

Fig 6. Graph of pay out time

5. Conclusion

Dealing with the calculations and discussion of the evaluation of the water coning problem and its handling in the "RE" well, it can be concluded as follows:

1. The "RE" well has a cumulative production of 133,669 bbl with a remaining reserve of 1,574,892 bbl.
2. The results of the K.S. diagnostic plot analysis. Chan on the "RE" well, the graph shows the slope between the WOR and WOR derivative and it can be seen from the slope of the WOR derivative that the slope is negative (below) which is a characteristic that indicates an indication of water coning then by determining the critical flow rate Craft & Hawkins the actual flow rate of oil (Qo = 387 BOPD) is greater than the critical flow rate (Qoc = 196.8 BOPD) indicating the main problem of the "RE" well is water production.
3. Evaluation of the success of handling water coning with RPM Treatment on the "RE" well, where the acquisition of oil production increased from 11 BOPD to 88 BOPD, and the water cut decreased from 97% to 77%.
4. In accordance with the economic calculations, the "RE" well obtained revenue of US$ 4,361,459 with an NPV of US$ 923,999, ROR of 1956.5%, POT for 0.049 years and DPIR of 34.62.

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