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# Economic Study of Matrix Acidizing Stimulation and New Zone Behind Pipe (NZBP) At Abraw Field Using Cost Recovery Psc and Gross Split PSC Fiscal Term

SIMPOSIUM IATMI 2018
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PADANG| 1-3 OKTOBER 2018

# ECONOMIC STUDY OF MATRIX ACIDIZING STIMULATION AND NEW ZONE BEHIND PIPE (NZBP) AT ABRAW FIELD USING COST RECOVERY PSC AND GROSS SPLIT PSC FISCAL TERM

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**Abstract**

Workover is a way to increase production at ABRAW field. There are two methods that have been done, including matrix acidizing stimulation and NZBP as solution to increase production at ABRAW field. The analysis is carried out through economic study using cost recovery PSC and gross split PSC fiscal term analyze matrix acidizing stimulation and NZBP with profit indicators. There are net present value (NPV), rate of return (ROR), and pay out time (POT). Spider diagram is created to determine the sensitivity analysis of the economic, which is aimed to find out the interest results for contractor. The economic calculation after matrix acidizing stimulation jobs for cost recovery PSC earned NPV US$7,701,030. ROR is 328.3%, and POT is 0.29 years. Then, matrix acidizing stimulation jobs for gross split PSC earned NPV US$20,565,110. ROR 894.9%, and POT 0.11 years. For NZBP jobs after calculated cost recovery PSC earned NPV US$3,009,210. ROR is 77.4 %, and POT is 1.33 years. Then, NZBP jobs for gross split PSC earned NPV US$6,086,900, ROR 153.4%, and POT is 0.596 years. According to the economic calculation result, it can be conclude that matrix acidizing stimulation and NZBP with gross split PSC is giving an interest result for contractor. It is evidenced by higher value of NPV in matrix acidizing stimulation and NZBP. Also, POT for gross split PSC is better than cost recovery PSC. There are additional factor, affected two schemes fiscal term, are oil price and OPEX. These factor show that gross split PSC is giving a better profit than cost recovery PSC and also give an interest result for contractor. This proves that gross split PSC better than cost recovery PSC.
Keywords: Matrix Acidizing Stimulation, NZBP, Cost Recovery PSC, Gross Split, OPEX.

## 1. Introduction

An effort recognized as workover is done to increase production at ABRAW field. Matrix acidizing stimulation was implemented to five wells whose total production is 851.9 BOPD and costs US$123,056.62. All five wells amount to US$615,283.12 and each of it consists of material and service. Meanwhile, NZBP has three wells whose total production is 620.34 BOPD and costs US$431,133.93. All three wells amount to US$1,293,401.80 and each of it consists of rig contract, material, perforating service and camp facility. These costs are based on company. In addition, this economic study is focusing on cost recovery PSC and gross split PSC fiscal term through profit analysis. Cost recovery scheme on PSC is done after gross income reduced by operating cost. Eventually, operating cost will be returned to contractor from oil production when oil field has been produced commercially. If oil field is not commercial, operating cost could not be returned and all the risk definitely borne by contractor. Then, it is new scheme that gross split which sees the complete elimination of the cost recovery system, and removes the need for related project budget scrutiny by Indonesia's upstream oil and gas regulator SKK Migas. In gross split system, there are base split, variable split, and progressive split. As stated in regulation of the Minister of Energy and Mineral Resources number 8 of 2017 on gross split PSC that the government and PSC contractors will instead split gross production without any deduction of exploration, development and production related capital expenditure, operating costs and taxes.

In this paper, two fiscal term cost recovery PSC and gross split PSC would be calculated in economic study with matrix acidizing stimulation and NZBP jobs at ABRAW field through analysis which are Net Present Value (NPV), Rate of Return (ROR), and Pay Out Time (POT). Also, using sensitivity analysis creates spider diagram is to determine economic parameter (cummulative production, OPEX, and cost) the most influent profit indicator as well.

## 2. Basic Theory

### Matrix Acidizing Stimulation

Acidizing is carried out in ABRAW field in a depth of 1,833 m - 1,835 m, namely in the Batu Raja Formation which is considered as limestone reservoir. It is usually done to eliminate the effect of decreasing formation permeability around the wellbore (formation damage) by increasing the pores of the rock and dissolving the drilling particles that cover the pore space, so that $k_o$ is expected to increase.

There are three types of acidizing techniques, namely matrix acidizing, acid fracturing, and acid washing. The acidizing method did in this ABRAW field is matrix acidizing. In this operation the acid solution is injected with pressure under the fracture pressure of the formation. It is hoped that the acid reacts with the walls of the rock pores so that it can remove deposits of rock matrix blockers (dissolve them) which ultimately enlarge the pores and the fluid reservoir can flow more freely. The types of scale include calcium carbonate (CaCO3), calcium sulfate (CaSO4), barium sulfate (BaSO4). Formation of ABRAW Field is regarded as limestone formation, so that the type of acid used is HCl.

### New Zone Behind Pipe (NZBP)

NZBP is an activity to open new zones in productive layers that have never been developed. This action can be carried out by opening several productive zones at the same time in an effort to increase oil recovery. NZBP did in ABRAW Field involves the moving of layer from BRF (Batu Raja Formation) at a depth of 1,833 m - 1,835 m to TAF (Talang Akar Formation) at a depth of 2,226 m - 2,229 m. It is done by reperfation in perforation holes which had previously been opened for LCT (Layer Contain Test) purpose with perforator gun bullet under overbalance perforating technique.

In the production sharing contract there are several elements used in calculating the economic indicators of a project.

### Net Present Value (NPV)

The Net Present Value (NPV) is the value of the net profit of a project measured at the present time. A project is said to be feasible if the NPV is positive or greater than the minimum NPV target that can be obtained by the company, if the NPV value of a project is negative then it can be said that the project suffered a loss. If the NPV value of a project is zero then the amount of expenditure to carry out the project is the same as the amount of revenue. The general form of the NPV equation is expressed as below :

$$NPV = \sum_{t=1}^{n} CF_o + \frac{CF_n}{(1+r)^n} \quad \text{……... (1)}$$

Where:

$CF_o$ = cash flow value at initial investment (cash in flow)

$CF_n$ = cash flow at n-year(cash out flow)

r = discount rate

n = n-year

**Rate of Return (ROR)**

Rate of Return (ROR) shows the relative value of earning power from the capital invested in the project, namely the discount rate which causes the NPV to equal zero. ROR prices must meet the following equation:

$$0 = \sum_{t=1}^{n} CF_o + \frac{CF_n}{(1+ROR)^n} \quad \text{(2)}$$

Typically, each company has a minimum limit value of the desired ROR stated in the MARR (Minimum Attractive Rate of Return). A project is considered feasible if the ROR is greater than the bank interest or greater than MARR

**PSC Cost Recovery and Gross Split Contract Model**

The Standard PSC contract model currently used in Indonesia and PSC Gross Split is a production sharing contract based on the principle of production sharing without a cost recovery mechanism so that all costs incurred for block operations are fully borne by the contractor. Then in August the Indonesian Government revised the previous law so that being a Law Number 52 of 2017 which is different is some split value or each component (Surya Temmy Kurniawan and Jaenudin Jemi, 2017). Costs incurred by the Contractor, will be replaced by the Government, through cost recovery.

## 3. Methodology

Stages of completion This study consists of collecting required data and analysis. The required data are contributions and legislation, the current PSC model and the profit sharing mechanism, total reserves, production and oil prices, operating costs, and others.

In this study, there are 4 main steps taken to get evaluation and analysis from the results of the final calculation (see figure 1).

1. Data preparation such as production history, budgeting work program, and fiscal term.
2. Calculation such as investment planning, and investment budgeting analysis.
3. Data processing, Research data with engine work contract models

4. Analysis data of Engine, This project can be used quantitatively as a guide or evaluation tool in project decisions. Net present value, Rate of return, Profitability Index, and Payback Periode. Sensitivity Analysis & Decision Making Analysis.

Analysis of comparative calculation of the type of contract model between PSC Cost Recovery and PSC Gross Split using the flow diagram of contracts for the results of Cost Recovery and Gross Split (variable factor, progressive factor and tax loss carry forward) beetween Alfa field (offshore) and Beta field (Onshore) The commercial fields has the potential for oil reserves to be managed by testing the feasibility of the results of comparisons of calculations.

## 4. Case Study

**MATRIX ACIDIZING STIMULATION**

Being started in 2007, matrix acidizing stimulation has been done at ABRAW field. In 9 years, there are five wells have been accomplished. Through production decline analysis to identify well production problems, and predict well performance and life based on real production data. The beginning of production is 170.3802 BOPD, the total wells are five and decline factor is 15%. ABRAW field has five wells whose each well production 170.3802 BOPD. The total production of five wells is 851.9 BOPD. According to the data, it does the calculations to find out the production in the first year to ninth year with exponential decline. In second year to ninth year, it experiences decreased production by 15% per year, (see Table 1).

**Cost Recovery PSC**

Matrix acidizing stimulation costs US$123,056.62. It consists of material and service for one well. The total five wells cost US$615,283.12. It is the costs incurred by the company. According to economic analysis through cost recovery PSC earned NPV US$7,701,030., ROR is 328.3%, and POT is 0.29 years for contractor. Then, it does calculation of economic sensitivity analysis to create spider diagram for each the value of NPV, ROR, and POT for contractor. Cumulative production is higher line on the graph than lifting cost and cost (see Figure 2). It indicates that cumulative production leads to a high impact in NPV for contractor. The value OPEX and cost for ROR in one line or approach the same value. In the end, The economic calculation in matrix acidizing stimulation through cost recovery PSC earned government share gross revenue 87%, contractor share gross revenue 12%, and cost recovery that given is 1%. In share production, government acquires cumulative production is higher than contractor. It means that government gets more profit than contractor through this cost recovery PSC fiscal term (Figure. 3).

**Gross Split PSC**

Gross split calculations complete elimination of the cost recovery system and remove the need for related project budget scrutiny. In gross split system, there are base split, variable split, and progressive split. It is appropriate in regulation of the Minister of Energy and Mineral Resources number 8 of 2017 on gross split PSC, (see component of variable split and progressive, Table 2). The value base split in gross split is 43% for contractor and 57% for government. Then, variable split consists of 10 components. In this matrix acidizing stimulation, there are two components influenced field status and component level within the country. Field status is condition overview level for ABRAW field and the status is POD I whose percentage 5%. Component level within the country the percentage is 3%. The last gross split system is progressive split. Progressive split consists of two components. There are total cumulative oil and gas production and oil/gas prices. The most influence is oil price around 6.5-7.5%. Matrix acidizing stimulation costs US$123,056.62., and the total cost for five wells are US$615,283,12. It is the cost incurred by the company. According to economic analysis through gross split PSC earned NPV US$20,565,110. ROR is 894.9%, and POT is 0.11 years for contractor. Then, it does calculation of economic sensitivity analysis to create spider diagram for each value of NPV, ROR, and POT for contractor. There are three components influence them such as cumulative production, OPEX and cost. Each component is giving impact. Cumulative production line on the graph is higher than the other components and giving significant impact to NPV for contractor. OPEX and cost for ROR tend to have different value (see Figure 4). In the end, the economic calculation in matrix acidizing stimulation through gross split PSC earned government takes 67% and contractor takes 33%. In share production, contractor acquires cumulative production is higher than government. It means that contractor gets more profit than government through this Cost Recovery PSC fiscal term. It's appropriate with all risk their take, (see Figure 5).

**New Zone Behind Pipe (NZBP)**

NZBP is the activity to open new zone in productive formation that is never developed before in one well. This activity possibly opens few productive formations at the same time. Since in 2001, NZBP has been done at ABRAW field. In 7 years, there are three wells have been opened. It is the same as matrix acidizing stimulation calculation through production decline analysis to identify well production problems, and predict well performance and life based on real production data. The beginning of production is 206.78 BOPD, the total wells are three and decline factor is 15%. The total production in three wells is 620.34 BOPD. According to the data, it does the calculations to find out the production in the first year to seventh years with exponential decline. In second years till seventh years, it experiences decreased production by 15% per year, (see Table 3).

### Cost Recovery PSC

NZBP's cost is US$431,133.93. It consists of rig contract, material, perforating service and camp facility for one well. The total cost for three wells are US$1,293,401.80. It is the costs incurred by the company. According to economic analysis through cost recovery PSC earned NPV US$3,009,210. ROR is 77.4%, and POT is 1.33 years for contractor. Then, it does calculation of economic sensitivity analysis to create spider diagram for each the value of NPV and ROR for contractor. Cumulative production is higher line on the graph than OPEX and cost. Similar to matrix acidizing stimulation. It indicates that cumulative production gives a high impact in NPV for contractor. Differed in matrix acidizing stimulation. The value of OPEX and cost for ROR significantly increased occurs, (see Figure 6). In the end, The economic calculation in NZBP through cost recovery PSC earned government share gross revenue 64%, contractor share gross revenue 7%, and cost recovery that given is 29% (see Figure 8) same as matrix acidizing stimulation. In share production, government acquires cumulative production is higher than contractor, (see Figure 7).

### Gross Split PSC

As same as in matrix acidizing stimulation's calculate. Gross split system in NZBP. There are base split, variable split, and progressive split. All the split components have same value in previous data (see Table 2). NZBP's cost is US$431,133.93. It consists of rig contract, material, perforating service and camp facility for one well. The total cost for three wells are US$1,293,401.80. According to economic analysis through gross split PSC earned NPV US$6,086,900. ROR is 153.4%, and POT is 0.596 years for contractor. Then, it does calculation of economic sensitivity analysis to create spider diagram for each the value of NPV and ROR for contractor. There are three components influenced them such as cumulative production, lifting cost and cost. Each component is giving impact. Cumulative production's line on the graph is higher than the other components and giving significant impact to NPV for contractor. OPEX and cost for ROR and POT tend to have different value (see Figure 8). In the end, the economic calculation in matrix acidizing stimulation through gross split PSC earned government takes 67% and contractor takes 33%. In share production, contractor acquires cumulative production is higher than government. (see Figure 9).

## 5. Result and Discussion

Economic study of matrix acidizing stimulation and NZBP at ABRAW field using two fiscal term. There are cost recovery PSC and gross split PSC. Each workover is matrix acidizing stimulation and NZBP have analyzed through cost recovery PSC and gross split PSC. The economic variabel parameter used is NPV, ROR and POT. The main purpose in analyzing this workover is to know the comparison between cost recovery PSC and gross split PSC and which one contributes an interest result for contractor and also giving overview about gross split PSC fiscal term that applied Indonesia.

### Matrix Acidizing Stimulation

The economic calculation after matrix acidizing stimulation jobs for cost recovery PSC earned NPV US$7,701,030. ROR is 328.3%, and POT is 0.29 years. Then, matrix acidizing stimulation jobs for gross split PSC earned NPV US$20,565,110. ROR 894.9%, and POT 0.11 years. According to the value of NPV and ROR for matrix acidizing stimulation shows that gross split fiscal term is giving an interest result for contractor because it is giving a high profit for this fiscal term. (see Table 4).

### New Zone Behind Pipe (NZBP)

The economic calculation NZBP jobs for cost recovery PSC earned NPV US$3,009,210. ROR is 77.4 %, and POT is 1.33 years. Then, NZBP jobs for gross split PSC earned NPV US$6,086,900, ROR 153.4%, and POT is 0.596 years. According to the value of NPV and ROR for matrix acidizing stimulation shows that gross split fiscal term is giving an interest result for contractor because it contributes a high profit for this fiscal term. (see Table 5).

There are additional factor affected two schemes fiscal term oil price and OPEX. In schemes cost recovery PSC or gross split PSC have own influenced their trend in those factors. First factor is oil price. When oil price is from US$20 to US$110 occurs a significant difference between cost recovery PSC and gross split PSC. Especially oil price trend in gross split PSC is enough higher than cost recovery PSC. Then, second factor is OPEX. You can see in when the value US$5/bbl till US$25/bbl occurs quite different it makes OPEX trend in gross split PSC is better than cost recovery PSC (see Table 6 and Figure 10). In the end, all the economic calculation and two factors affected cost recovery PSC or gross split PSC fiscal term is gross split PSC. It is giving a better profit than cost recovery PSC and also give an interest result for contractor.

## 6. Conclusion

Based on the research and discussion that has been done, the conclusions obtained from this study are as follows:

1. Gross split PSC is a fiscal term which can provide a sense of security to the amount of investment issued by the contractor until the project is feasible.
2. In gross split system, there are base split, variable split, and progressive split. The value base split in gross split is 43% for contractor and 57% for government. Then, variable split consist of 10 components. In this workover, there are two components influenced field status and component level within the country Field status is condition overview level for ABRAW field the status is POD I whose percentage 5%. Component level within the country the percentage is 3%. The last gross split system is progressive split. Progressive split consists of two components. There are total cumulative oil and gas production and oil/gas prices. The most influence is oil price around 6.5-7.5%.
3. Gross split PSC is contract schemes designed to attract contractors to invest. Because if the project does not reach a certain economic level the government through the Minister of Energy and Mineral Resources may provide an additional incentive of 5% split to the contractor as set out in the Minister of Energy and Mineral Resources number 8 of 2017 in article seventh, first paragraph.
4. According to the economic calculation result that the amount value of NPV for matrix acidizing stimulation and NZBP with cost recovery PSC scheme are US$7,701,030and US$3,009,210. Then, gross split PSC scheme is US$20,565,110 and US$6,086,900. Also, POT for gross split PSC is better than cost recovery PSC.
5. There are additional factor affected two schemes fiscal term oil price and OPEX. These factor show that gross split PSC is giving a better profit than cost recovery PSC and also give an interest result for contractor. This proves that gross split PSC is better than cost recovery PSC.

## 7. Recommendation

There are several things that are suggested for further research are Reviewing the economy for the gas field or marginal field and comparing the gross split of Indonesia with the concession contract adopted by the United States that follows the royalty system.

## 8. Acknowledgement

The author would like to thank Mr. Muhammad Ariyon, ST., MT, Mr. Andy Arfah and Mr. Tomi Setiawan for providing guidance and advice so that the authors can complete this research.

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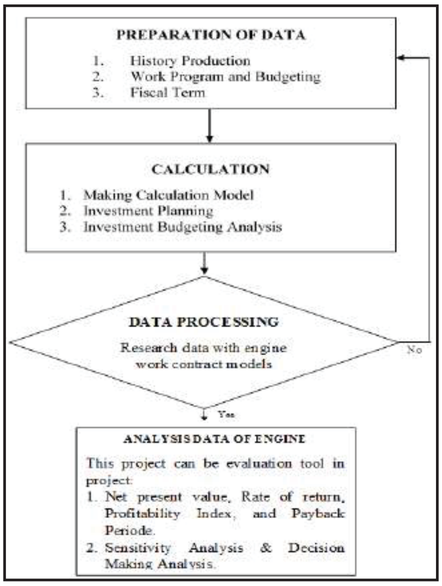


**Figure 1** – Workflow

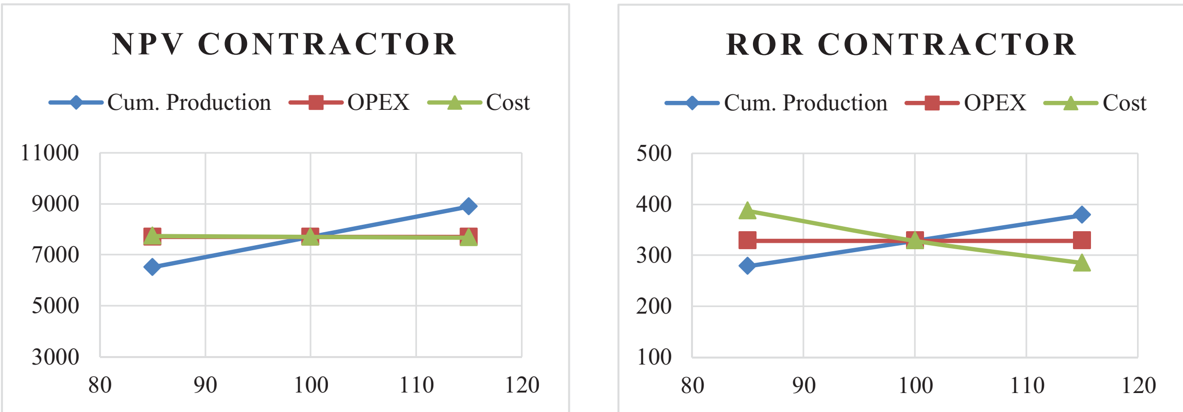


**Figure 2** – Sensitivity Analysis NPV and ROR Contractor for Matrix Acidizing Stimulation Using Cost Recovery PSC

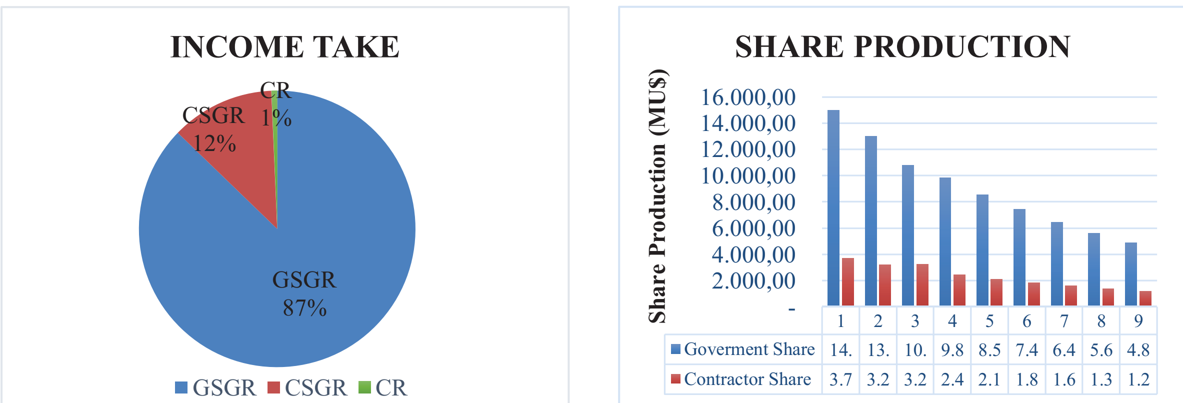


**Figure 3** – Diagram and Graph Production Share for Matrix Acidizing Stimulation Using Cost Recovery PSC

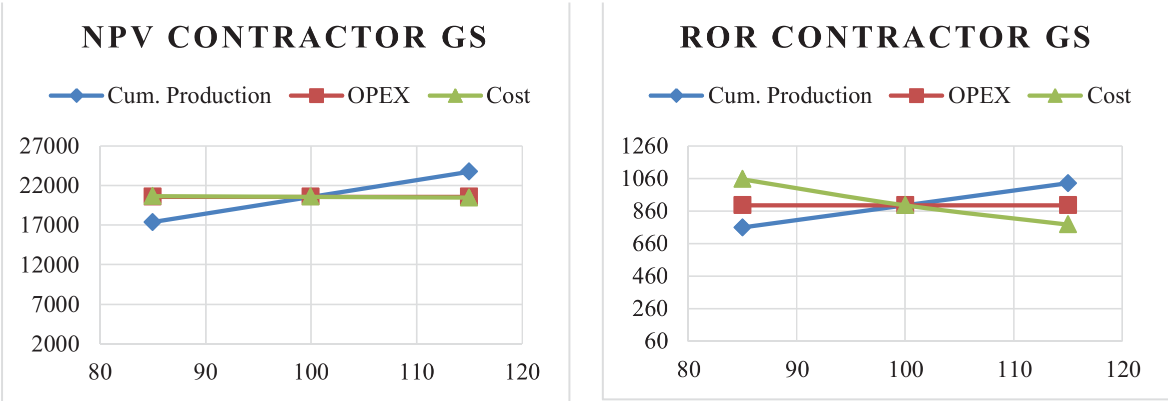


**Figure 4 -** Sensitivity Analysis NPV and ROR Contractor for Matrix Acidizing Stimulation Using Gross Split PSC

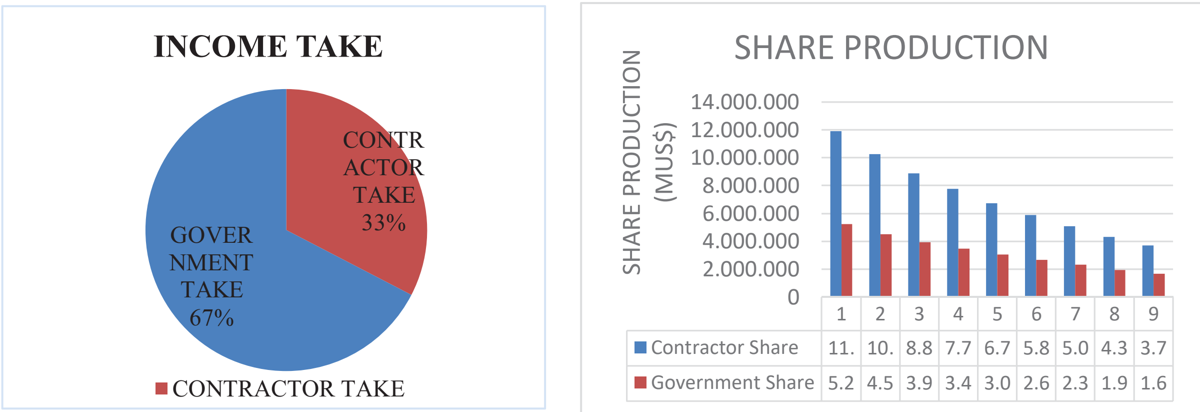


**Figure 5 -** Diagram and Graph Production Share for Matrix Acidizing Stimulation Using Gross Split PSC

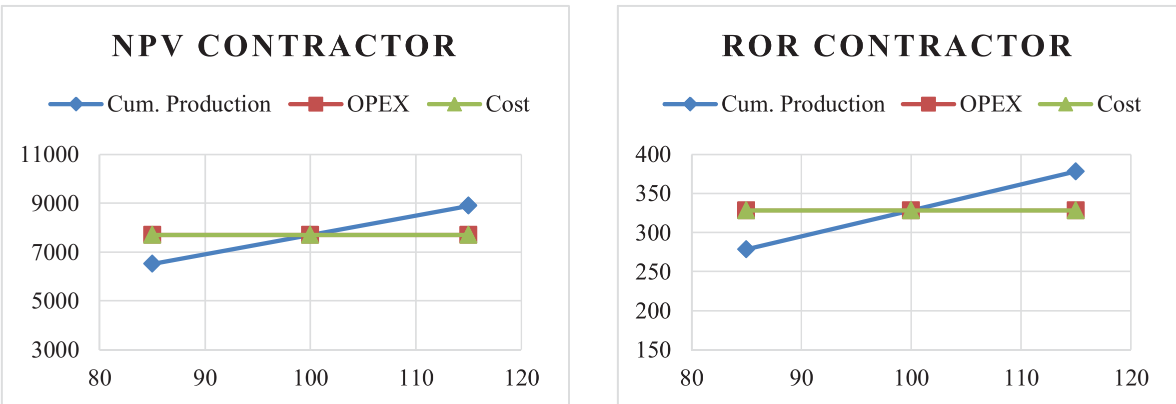


**Figure 6 -** Sensitivity Analysis NPV and ROR Contractor for NZBP Using Cost Recovery

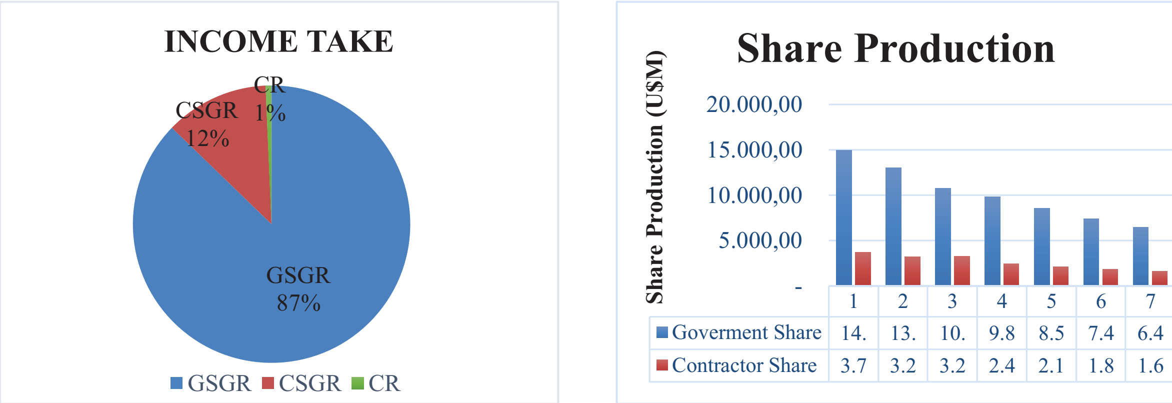


**Figure 7 -** Diagram and Graph Production Share for NZBP Using Cost Recovery PSC

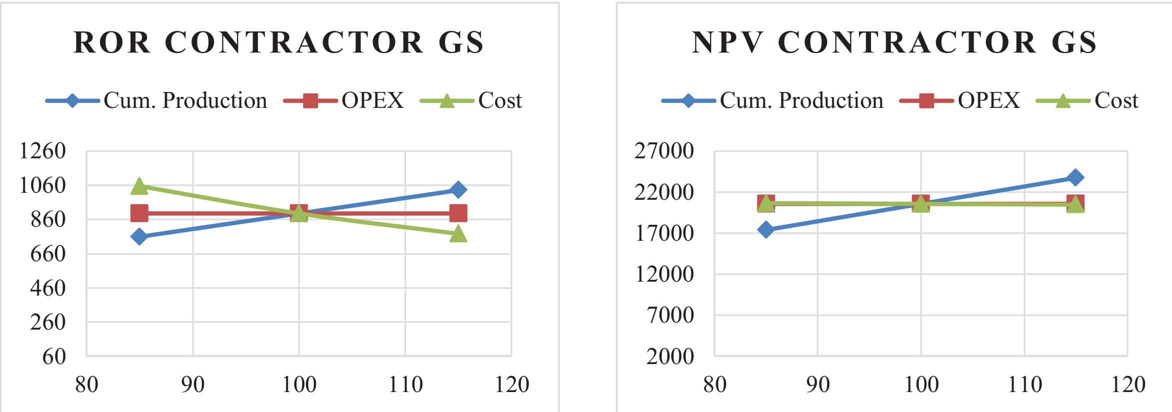


**Figure 8 -** Sensitivity Analysis NPV and ROR Contractor for NZBP Using Gross Split PSC

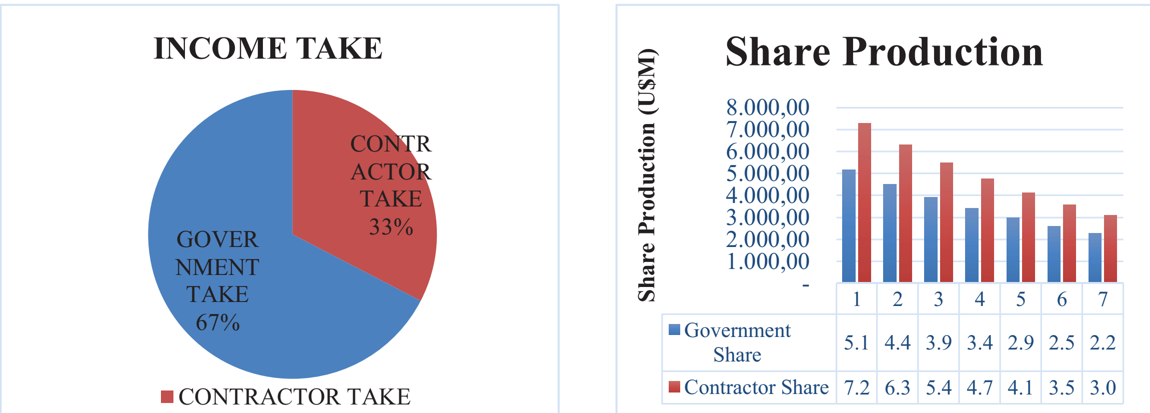


**Figure 9 -** Diagram and Graph Production Share for NZBP Using Gross Split PSC

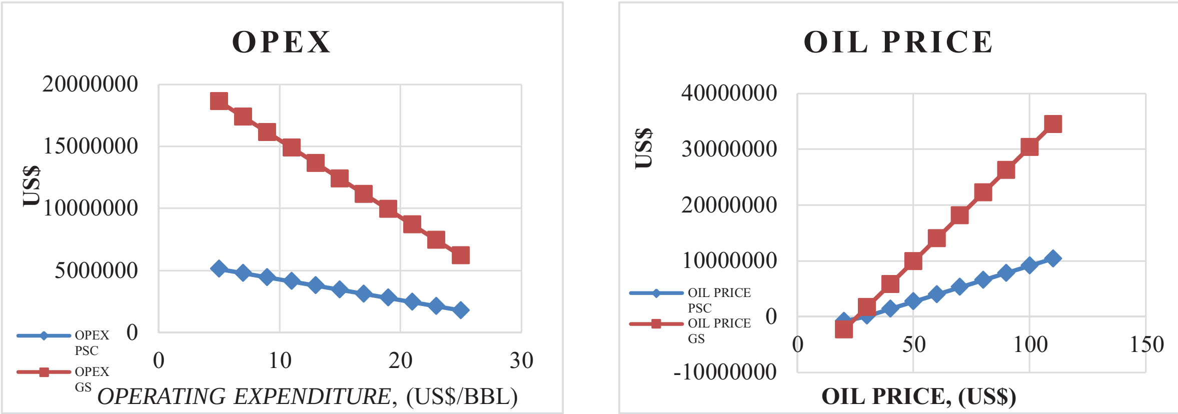


**Figure 10 –** The Impact of OPEX and Oil Price toward Cost Recovery and Gross Split PSC

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**Table 1 –** Profile Of Cummulative Production In Matrix Acidizing Stimulation At Abraw Field

| Production Profile | | |
|---|---|---|
| **Years** | **Cummulative Production** | |
| | **(BOPD)** | **(BOPY)** |
| 1 | 851,9008 | 310943,8 |
| 2 | 733,2378 | 267631,8 |
| 3 | 631,1037 | 230352,8 |
| 4 | 543,1959 | 198266,5 |
| 5 | 467,5331 | 170649,6 |
| 6 | 402,4095 | 146879,5 |
| 7 | 346,357 | 126420,3 |
| 8 | 298,1123 | 108811 |
| 9 | 256,5876 | 93654,47 |

**Table 2 –** Improvement Split PSC Gross Split

| Component | Parameter | PSC Gross Split |
|---|---|---|
| Variable Split | | Koreksi Split |
| Field State | POD | 5% |
| Field Location | *Onshore* | 0% |
| Depth Reservoir | <2500m | 0% |
| Availability Supporting Infrastructure | Well Development | 0% |
| Reservoir | Conventional | 0% |
| $CO_2$ Content (%) | - | 0% |
| $H_2S$ Content (ppm) | - | 0% |
| Oil Gravity | >25 | 0% |
| Component Level Within The Country | 50-70 | 3% |
| Production Level | Primary | 0% |
| Progressive Split | | |
| Harga Minyak | 65 | 7,68% |
| Total Cummulative Production Oil and Gas (mmboe) | <30 | 0% |
| Contractor Split | Base split+Variable+progressive | 58.68% |

**Table 3** – Profile Of Cummulative Production In NZBP At Abraw Field

| Production Profile | | |
|---|---|---|
| **Years** | **Well Production** | |
| | **(BOPD)** | **(BOPY)** |
| 2001 | 620,34 | 226424,1 |
| 2002 | 533,9316 | 194885 |
| 2003 | 459,5592 | 167739,1 |
| 2004 | 395,5462 | 144374,4 |
| 2005 | 340,4498 | 124264,2 |
| 2006 | 293,0279 | 106955,2 |
| 2007 | 252,2114 | 92057,17 |

**Table 4** – The Economic Calculation Of Matrix Acidizing Stimulation At Abraw Field

| **Variabel** | **Fiscal Term** | |
|---|---|---|
| | **Cost Recovery PSC** | **Gross Split PSC** |
| **Contractor NPV (US$)** | 7,701,030 | 20,565,110 |
| **ROR (%)** | 328.3 | 894.9 |
| **POT (Years)** | 0.29 | 0.11 |
| **Contractor Share (%)** | 12 | 33 |
| **Government Share (%)** | 87 | 67 |
| **Cost Recovery (%)** | 1 | - |

**Table 5 –** The Economic Calculation Of Nzbp At Abraw Field

| Variabel | Value | |
|---|---|---|
| | Cost Recovery PSC | Gross Split PSC |
| **Contractor NPV (US$)** | 3,009,210 | 6,086,900 |
| **ROR (%)** | 77.4 | 153.4 |
| **POT (Years)** | 1.33 | 0.596 |
| **Contractor Share (%)** | 12 | 33 |
| **Government Share (%)** | 87 | 67 |
| **Cost Recovery (%)** | 1 | - |

**Table 6 –** The Impact Of Opex And Oil Price Toward Cost Recovery And Gross Split

| ***Cummulative Cash Flow*** **(US$)** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| **OPEX (US$)** | 5 | 7 | 9 | 11 | 13 | 15 | 17 | 19 | 21 | 23 |
| **Cost Recovery** | 5111.1 | 4778.7 | 4445.9 | 4113.9 | 3780.2 | 3447.4 | 3114.6 | 2781.8 | 2449.3 | 2116.2 |
| **Gross Split** | 18607.6 | 17365.3 | 16123.7 | 14880.7 | 13638.4 | 12396.1 | 11153.8 | 9911.5 | 8669.2 | 7426.9 |

| ***Cummulative Cash Flow*** **(US$)** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Oil Price (US$)** | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 |
| **Cost Recovery** | -8575.0 | 7467.3 | 13627.3 | 26507.9 | 39388.4 | 52269.0 | 65149.6 | 78032.2 | 90910.8 |
| **Gross Split** | -24204.0 | 16747.4 | 57698.8 | 98650.2 | 13960.1 | 18055.3 | 22150.4 | 26245.5 | 30340.7 |