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Technical and Economical Study on Increasing Oil Production in Old Wells (Traditional) by Performing Well Maintenance in the CP Field

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ABSTRACT

The CP field is an brown field with a production potential of 2,185 BOPD. However, the realization of CP Field production in the first semester was 1,931 BOPD (88.4% of the production target). From Low & Off data for the period from January to September 2020, it was found that the biggest problem contributing to LPO (Lost Production Opportunity) was caused by artificial lift wells and reduced production from old (traditional) wells.
Several solutions can be done in order to solve the problem. Among them is by carrying out well maintenance, both those experiencing a decline in production or wells that have the potential to be activated. By implementing this, it is hoped that it will be able to maintain stability and even increase oil production and distribution through the old (traditional) well. The screening of reactivation well candidates is carried out with the technical evaluation stage and the economic evaluation stage. The engineering evaluation was carried out by analyzing the history of well production and analyzing the distribution map of the wells in the CP Field. Based on this data, 2 (two) candidate wells were obtained, namely LDK-38 and LDK-108. Then proceed with carrying out technical calculations of Rig capacity, namely by calculating Lifting Loads, Rotating Loads and Circulating Loads and continuing with the preparation of reactivation programs and economic calculations.
Based on these calculations, it was found that the need for the Rig Capacity to carry out the reactivation work of the 2 (two) wells was 21 (twenty one) HP, so the Spindle Rig was chosen to do the work because the cost was more economical, which was Rp. 45,000,000, - for the work. per-well reactivation. Therefore, the total cost required for the reactivation of 2 (two) wells is Rp. 90,000,000,-. The reactivation program for the LDK-38 and LDK-108 wells resulted in additional production in the CP Field of + 21.73 BOPD or 5,932 bbl (January - September 2021). In addition, gross revenue of USD 572,000 was obtained (crude oil price of 49 USD/bbl).

Keywords: old well; reactivation; rigs; economical; revenue

I. INTRODUCTION

Since September 2017, Pertamina EP has been given the responsibility for managing the Ex-KSO GCI operating area, namely the CP Field, where there are quite complex problems including the lack of well production facilities and the declining number of production (decline). In addition, because the CP field is an old field or brown field. Pertamina EP has succeeded in restoring the field's production, but the production decline is still experienced, making it difficult to achieve the field production target in the first semester of 2020, which is YTD 2,185 BOPD. The realization figure for CP Field production in the first semester was 1,931 BOPD (88.4% of the production target). From Low & Off data for the period from January to September 2020, it was found that the biggest problem contributing to LPO (Lost Production Opportunity) was caused by artificial lift wells and reduced production from old (traditional) wells.

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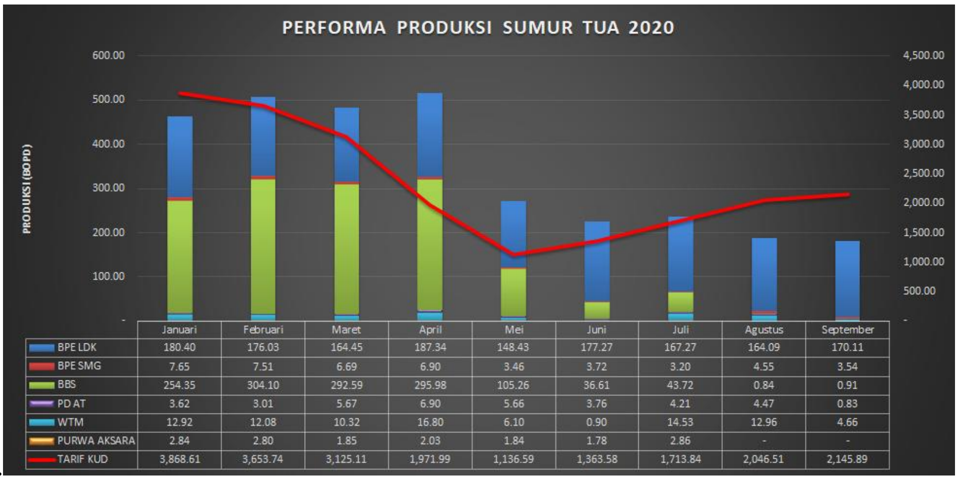

Figure 1. Graph of Production Performance of Old (Traditional) Wells 2020

Reduced production from the management of the Old Well (traditional), due to the difficulty of maintaining the stability of well production. Even though it is done traditionally, some wells also experience problems with production volume. The reduced volume of liquid and an increase in the percentage of water cut are the main problems in several Old Wells, resulting in a reduced volume of oil produced.

Several solutions can be done in order to solve the problem, including by carrying out well maintenance, both those experiencing a decrease in production or wells that have the potential to be activated. By implementing this, it is hoped that it will be able to maintain stability and even increase oil production and distribution through the old (traditional) well.

II. METHOD

Efforts have been made to increase production of old (traditional) wells in the CP field by reactivation of wells considering that there are many old inactive wells, namely 141 (one hundred and fourty one) wells. In addition, it is necessary to conduct technical and economic studies prior to the reactivation of the well in order to obtain optimal results. Here are the details of the method that will be carried out:

1. Collecting daily production data, well cross section and well distribution map.
   The data collected is used as a first step to conduct research.
2. Conduct well reactivation candidate selection.
   Screening is done by evaluating the production performance of each Old Well. Then from the results of the production history data, the cross section of the well and the distribution of the wells, we can predict which wells have the potential for maintenance or reactivation.
3. Implementation of reactivation of wells.
   Selected wells are reactivated according to the previously prepared program.
4. Performing the preparation of optimization programs and preparation of Rig.
   Prepare well optimization programs and determine the type of rig to be used. All equipment used needs to be prepared and the economy calculated before being used in maintenance work or reactivation of wells.
5. Evaluate program results and well production.
   After the well maintenance/reactivation work is completed, it is necessary to carry out an overall evaluation, from preparation to implementation.

III. DISCUSSION

3.1. Selection of Candidates for Well Reactivation

3.1.1. CP Field Well Production Performance Analysis

The first step we can take to select candidates for well maintenance and reactivation of wells is to analyze the production data of existing wells and production history of wells that are not producing (abandon wells). The CP field has an operational permit for 263 (Two Hundred Sixty Three) old wells with a total of 122 (One Hundred Twenty Two) active wells and 141 (One Hundred Forty One) inactive wells. The average production of the CP Field throughout 2019 was 395 (three hundred and ninety five) BOPD. The following is data on 10 wells with the highest production in the CP Field as shown **in Table III-1**.

Tabel 1. **Top 10 Production Well CP Field**

No	Well Name	Production (BOPD)
1	LDK-108	15.8
2	LDK-107	10.4
3	LDK-204	5.5
4	LDK-105	4.5
5	LDK-142	4.5
6	LDK-200	4.4
7	LDK-39	3.8
8	LDK-46	2.8
9	LDK-211	2.4
10	LDK-44	2.2

3.1.1. CP Field Well Distribution Map Analysis

The CP field is one of the old well fields that has potential in the Central Java Region as shown in **Figure 3.** below this. The well distribution map can be used to show a general description of the surface conditions of the CP Field. Then on the map we put a mark on each active well along with the amount of production. Inactive wells around active wells with high enough production can be used as initial screening to determine candidate wells that have the potential to be reactivated as shown in **Figure 2.** below this.

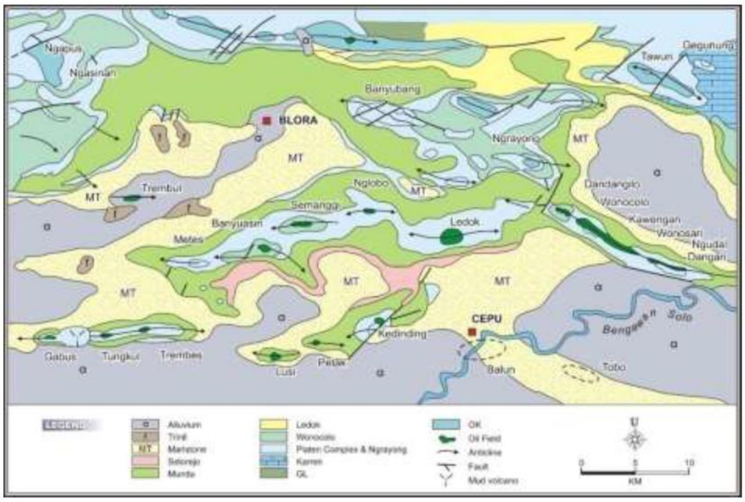

Figure 2. Map of the Potential of the Old Well in the Blora and Surrounding Areas
Source: Journal of Mineral, Energy and Mineral UPN "Veteran" Yogyakarta Vol 1, No.2, 2017

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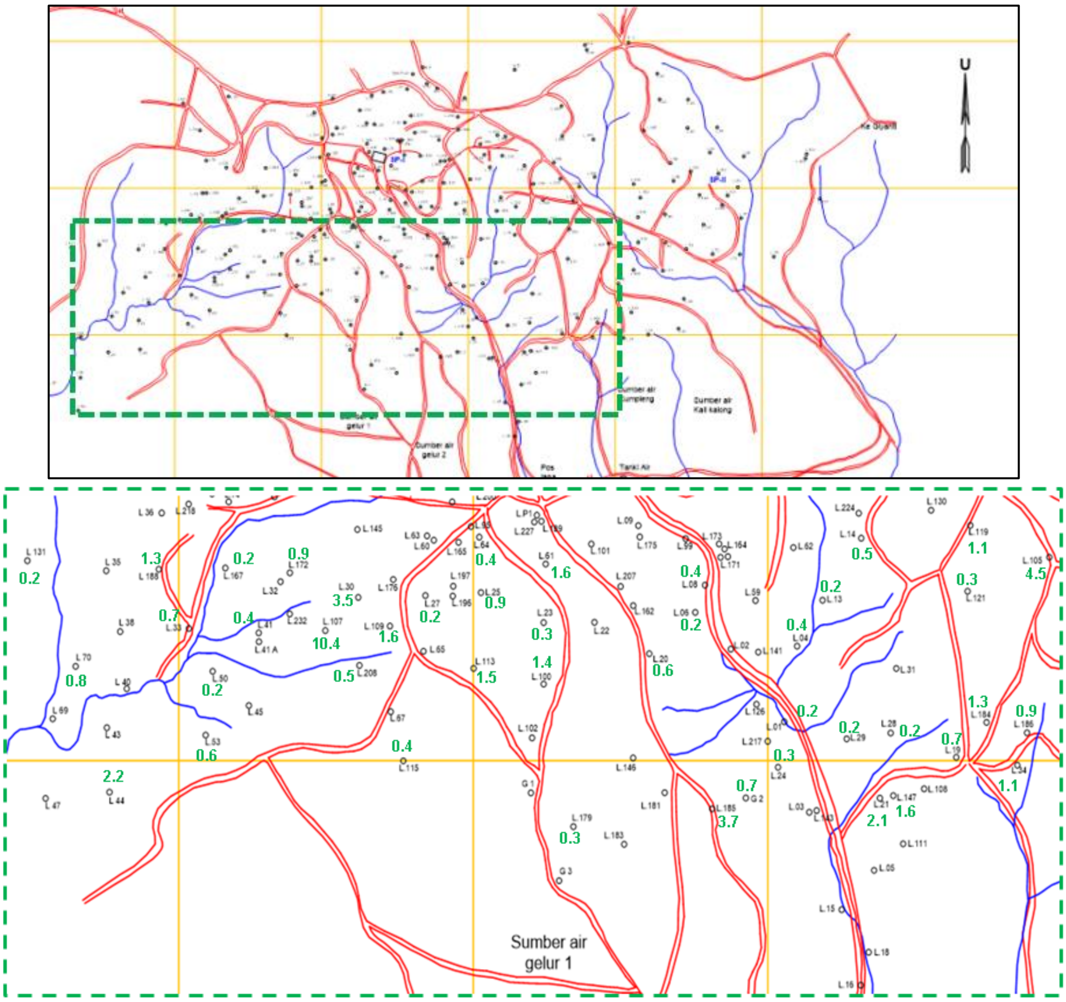

Figure 3. Well Distribution of CP Field
Source: PT Pertamina EP Cepu, 2021

3.2. Well Reactivation

Based on the description of point 3.1.1. and 3.1.2. above, the author chose candidate 2 (wells) in the CP Field to be reactivated because it has a fairly good production history in 2018 and around the well there are many active wells which indicate that the well cluster in the area is included in the productive category. The wells are LDK-38 and LDK-108 as shown in **Figure 4.** below this.

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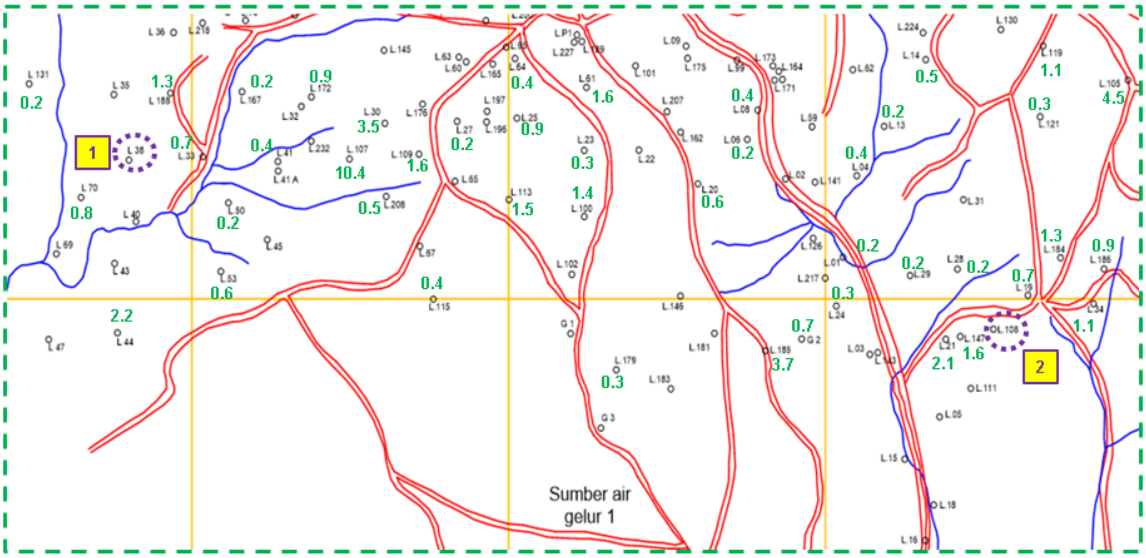

Figure 4. Reactivation Well Candidate Position
Source: Author, 2021

The following is detailed data for 2 (two) wells that will be reactivated as shown in Table V-4 below.

Table 2. LDK-38 and LDK-108 Well Production Data

Well LDK-38
Coordinate
X : 561.803,53
Y : 9.218.503,73

No	Month	Production (BOPD)
1	Jan-18	11,8
2	Feb-18	13,5
3	Mar-18	11,8
4	Apr-18	14,6
5	May-18	13,1
6	Jun-18	13,0
7	Jul-18	13,6
8	Aug-18	11,0
9	Sep-18	10,5
10	Oct-18	11,5
11	Nov-18	10,4
12	Dec-18	12,4

Well LDK-108
Coordinate
X : 563.175,67
Y : 9.218.252,23

No	Month	Production (BOPD)
1	Jan-18	23,1
2	Feb-18	24,9
3	Mar-18	23,6
4	Apr-18	21,3
5	May-18	19,6
6	Jun-18	20,0
7	Jul-18	18,3
8	Aug-18	18,7
9	Sep-18	19,0
10	Oct-18	19,4
11	Nov-18	20,7
12	Dec-18	21,1

3.3. Rig Selection

The rig chosen to carry out the reactivation work is the Spindle Rig which is commonly used in groundwater wells, because these rigs have low rental costs and can be used in old wells whose depth is relatively shallow (+ 300 m). In

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addition, it is not possible to use the Own Rig owned by PT Pertamina EP Cepu (Rig 250 HP) because the Rig is intended for other well service work that is still productive and is managed directly by PT Pertamina EP Cepu, especially in the CP Field. The following is the shape of the Rig Spindle that will be used to carry out the reactivation work of the old well in the CP Field as shown in **Figure 3.4.** with the following specifications for the KOKEN CR-2B Spindle Rig.

Figure 5. Spindle Rig
Source: Author, 2021

- Spindle Rig Specification Data :
  - *Rig*
    - *Brand* : Koken
    - *Model* : CR-2B

- *MFG No.* : D03 CR 043
- *Weight* : 4900 kg
- *MFG. Year* : 2003
- *Drilling Depth* : 1800 - 2200 m
- *Inside Diameter* : 106 mm

Table 3. Rig Specification

Rotation		Low	2nd	3rd
High	rpm	125	220	360
Low		28	50	80

- *Torque (Max)* : 8 kN-m
- *Thrust* : *Push-down* 145 kN-m; Push-up 240 kN-m
- *Stroke* : 600 mm
- *Hoisting capacity* : 71 kN
- *Slide stroke* : 600 mm
- *Dimensions (LxWxH)* : 3.375 x 1.540 x 2.595
- *Power Unit* : 40 – 50 PS

* Pump
  - *Brand* : Tone
  - *Model* : NP-1000
  - *MFG No.* : POONP 113
  - *Weight* : 2100 kg
  - *MFG. Year* : 2000
  - *Bore* : 65 mm
  - *Stroke* : 50 mm

Table 4. Pump Specification

Speed Reduction	Top	4th	3rd	2nd	Low
Capacity (L/min)	1050	710	470	275	175
Max. Pressure (kg/cm2)	24	29	29	29	29
No. Stroke (mm)	65	57	31	22	15

- *Set Pressure Pin Size*

Table 5. Rig Specification

PRESS, kg/cm2 (PSI)	PIN DIA, mm
72 (1020)	5.5
59 (840)	5
48 (680)	4.5

38 (540)	4
29 (410)	3.5
21 (300)	3

- Rig Tower
  - *Bottom dimensions* : 3 m x 4 m
  - *Upper dimensions* : 1,1 m x 1,1 m
  - *Standing height* : 14 m
  - *Material* : *Tubing pipe* 89 mm & H-beam 200 mm

3.3.1. Technical Calculation of Rig Capacity

The technical calculation of the Rig load is needed to find out the minimum Horse Power (HP) needed to carry out the reactivation work of the LDK-38 and LDK-108 Wells. In general, to calculate the capacity of the rig we need to calculate the lifting load, rotating load and circulation load with the following details :

3.3.1.1. Lifting Load

The formula needed to calculate the lifting load is as follows:

$$\textit{Lifting Load} = Wm \times Vt/33{,}000 \qquad (1)$$

where,

Wm = weight of drill pipe series in mud (lb)

Vt = traveling block lifting speed (ft/m)

Is known :

- Well Data = 202 m or 662.76 ft
- Length DP = 487.07 ft, MW DP = 5 lb/ft
- DC length = 165.69 ft, MW DP = 7 lb/ft

Lifting load calculation:

$$\textit{Weight of the circuit in air } (Wu) = (LDP \times WDP) + (LDC \times WDC) \qquad (2)$$

where,

LDP = Length of DP (ft)

WDP = DP nominal weight (lb/ft)

LDC = DC Length (ft)

WDC = DC nominal weight (lb/ft)

To calculate the weight of the circuit in the mud, the following equation can be used:

Weight of circuit in mud (Wm) = Wu x BF

BF is the bouyancy factor which can be calculated by the following equation:

$$BF = \frac{(65{,}5-\eta m)}{(65{,}5)} \qquad (3)$$

Where:

BF = bouyancy factor

m = mud density (ppg)

To calculate the weight of the circuit in air can be calculated using the following equation :

Wu = (LDP x WDP) + (LDC x WDC)
Wu = (497,07 x 5) + (165,69 x 7)

Wu = (2.485,35) + (3.429,50)

Wu = 5.964,05 lb

To calculate the Bouyancy Factor can be calculated using the following equation :

BF = $\frac{(65{,}5-\eta m)}{(65{,}5)}$

BF = $\frac{(65{,}5-8{,}33)}{(65{,}5)}$

BF = 0,873

The weight of the circuit in the mud can be calculated using the following equation :

Wm = Wu x BF

Wm = 5.964,05 x 0,873

Wm = 5.207,32 lb

The lifting speed on the traveling block is 20 ft/m so that the amount of lifting load used can be calculated by the following equation:

Lifting Load = Wm x Vt / 33,000

Lifting Load = 520.732 x 20 / 33,000

Lifting Load = **3.1 HP**

3.3.1.2. Rotary Load

An empirical equation has been developed to prepare the required magnitude of HP, namely:

HP = F x N *(4)*

Where,

F = Torque factor value as follows

- 1.5 = < 10,000 ft with light drillstring
- 1.75 = 10,000 – 15,000 ft well with medium condition
- 2.0 = for holes with heavy drillstring

The hole size is 5 inches, the torque used is 1.5, if the largest RPM is 20 RPM then the HP drawwork can be calculated using the equation:

HP = F x N

HP = 1.5 x 20

HP = 30 HP

The power used is 50% because this well does not make new holes and playback is only done if there is a blockage or avalanche in the wellbore, then the Rotary Load used is **15 HP**.

3.3.1.3. Circulating Load

Circulating load is the load given by the slurry by the pump which drains the fluid from the surface. The pump load which is calculated as the circulating HP pump load can be calculated using the following equation.

$$HP = \frac{P \times Q}{1714} \qquad (5)$$

Where :

P = pump pressure (psi)

Q = pump flow rate (gpm)

Is known:

Pressure loss on string = 30 psi

Pressure loss in bit and annulus = 70 psi

Total pressure loss = 100 psi

The circulating pump load on the circulation system can be calculated as follows:

Circulating Load = $\frac{P \times Q}{1714}$

Circulating Load = $\frac{100 \times 50}{1714}$

Circulating Load = **2,9 HP**

So that the required capacity of the Rig to carry out pitting (reactivation) work is as follows:

HP Rig = HP Lift Load + HP Rotate Load + HP Circulation Load

HP Rig = 3.1 HP + 15 HP + 2.9 HP

HP Rig = **21 HP**.

3.4. Preparation of the Well Reactivation Program

In general, the summary of the well work to be carried out on the LDK-38 and LDK-108 wells is as follows:

1. Insert the thrombos into the wellbore to clean the materials in the well until they meet the liquid in the well.
2. Do a deepening of the liquid column about + 10 – 20 meters.
3. Adjust the depth of the bucket in the middle of the liquid column that has been set in the previous point.
4. Perform production on the well to produce liquid.

3.5. Economical Evaluation

In addition to technical screening, an economic analysis is calculated before the well reactivation work is carried out. In this calculation, the application of profitability index analysis is carried out as a reference to the suitability of the reactivation program to be carried out.

3.5.1. Net Revenue Calculation

In this economic calculation, the cash inflows and cash outflows that may occur from each well are calculated. In this way, the profit and loss margins that will arise if the well is reactivated can be determined. The following data is needed in the economic calculation:

Table 6. Expenditure Details Capital Cost

Information	Price	Detail	Total
Rig Fee	Rp.2.000.000,-	5 day	Rp.10.000.000,-
Additional Equipment Fee	Rp.10.000.000,-	1 unit	Rp.10.000.000,-
Purchase and installation of bucket pumps	Rp. 25.000.000,-	1 unit	Rp.25.000.000,-
Total Cost of each well			**Rp.45.000.000,-**

- Rig Spindle rental fee IDR/day = 2,000,000 (USD 138)
- Additional equipment cost IDR/day = 10,000,000 (USD 690)
- Pump installation cost = 25,000,000 (USD 1,785)
- Cepu crude price USD/bbls = 49
- Average duration of well off, days = 3

- Exchange Rate USD, Rupiah/USD = 14,000

The steps for calculating net revenue are as follows: (for example, using data for the LDK-38 well).

3.5.2. Net Revenue for reactivation of wells

After analyzing several parameters, two candidate wells were selected, namely LDK-38 and LDK-108 wells. For more details on the potential production and income from the production of the two wells, see the following table.

Table 7. Production and Revenue Estimation Data

Well	Production Estimation	Gross Revenue Estimation	Full Year
LDK -108	20 bbl	USD 980	USD 357.700
LDK - 038	12 bbl	USD 588	USD 314.620

1. Calculating Annual Gross Revenue.

   GR 2021 = Total Production x Oil Price
   = 32 x 49 x 365
   = 572,320 USD

2. Calculate the Rig cost based on the frequency of well maintenance.

   Rig Cost = Rig rental fee x Rig job duration
   = USD 138 x 5
   = USD 690

3. Net Income = (49-15) x 32 x 365
   = USD 397120

4. Capital Cost = Total Capital Cost x Number of Wells
   = USD 3,200 x 2
   = USD 6,400

5. Operating Cost = Total Daily Production x Operating Cost x Number of Days a Year
   = 32 x 15 x 365
   = USD 175,000

6. Net Revenue = Gross Revenue – (Opex + Capex)
   = USD 572,320 – (USD 175,000 + USD 6,400)
   = **USD 390.920**

IV. CONCLUSION

Based on the results of the reactivation of the old wells LDK-108 and LDK-38, it can be concluded that:

1. Based on the selection of candidates for reactivation of old wells, the results obtained are 2 (two) wells that have the potential for reactivation, namely the LDK-108 and LDK-38 wells with production estimates of 20 BOPD and 12 BOPD, respectively.
2. The capacity of the Rig Spindle of 50 Horse Power (HP) is sufficient for use in reactivation operations of the LDK-108 and LDK-38 Wells which require only a capacity of 21 Horse Power (HP) with details of the Rotary System of 15 Horse Power (HP) ; Lift System at 3.1 HP; and a Circulation System of 2.9 Horse Power (HP).
3. The reactivation program for the LDK-108 and LDK-38 wells using the Rig Spindle is made up of 4 (four) stages, including the following:

   a. Insert the thrombos into the wellbore to clean the materials in the well until they meet the liquid in the well.
   b. Then do the deepening of the liquid column about + 10 – 20 meters.
   c. Do the setting at the depth of the bucket in the middle of the liquid column that has been set in the previous point.
   d. Perform a production test on the well to produce liquid.
4. Based on the results of the economic evaluation, the following results were obtained:
   a. The investment cost (capital expenditure) for the LDK-108 and LDK-38 wells is USD 6,200 or Rp 90,000,000 with details of the Rig rental fee of Rp. 20,000,000; additional equipment rental fee of Rp. 20,000,000; and the cost of purchasing and installing the pump is Rp. 50,000,000.
   b. Operational costs (opex) with an estimated cost per barrel of 15 USD and a total estimated production of 32 BOPD for two wells.
   c. The gross revenue generated was USD 572,000 with a crude oil price of 49 USD/bbl.
5. After reactivation at the LDK-108 and LDK-38 wells, an increase in crude oil production in the CP Field was obtained with a total of + 21.73 BOPD or 5,932 bbl.

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