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Analysis of Well Kick Countermeasures with Concurrent Method in MFA Well of NKL Field

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Abstract

The goal is to drill an MFA well down to 4593 feet (MD) in the NKL field. At a depth of 4593 feet, the MFA well had a well kick problem as a result of drilling into the high pressure formation zone while gas was present in the formation. Gas bubbles in the soil are a sign that the MFA well has kicked. Correct handling of this well kick issue is necessary to avoid blowout. Well kick countermeasures on the MFA well in the NKL field are evaluated using the concurrent method, which includes collecting data from drilling implementation reports, analyzing new mud (kill mud) weight, maximum allowable mud weight (maximum allowable mud weight), pump, and formation pressure calculations when a well kick occurs. Make an evaluation by comparing the results of the calculation with the implementation data from the field, and then make inferences. The evaluation of the well kick countermeasures' implementation using the concurrent approach revealed that the kill mud weight was 12.21 ppg. The muck had to be moved using 2208 pump strokes and 36.79 minutes of pumping time. When the mud pump is stopped and the SIDP price is zero, there is no flow in the annulus, indicating that the well kick has been managed well. The most effective method for developing well-thought-out countermeasures is the concurrent strategy.

Keywords *Well Kick, Tekanan Formasi, Tekanan Hidrostatis, Kill Mud Weight, Metode Concurrent*

INTRODUCTION

Well Kick the unwanted entry of formation fluid into the wellbore because the pressure in the formation is greater than the hydrostatic pressure of the mud. Kick countermeasures in drilling operations are very important because this will cause huge losses to the company, such as environmental damage, loss of equipment due to burning, loss of reservoir fluid, and even workers' lives are at stake [1]. In kick countermeasures, a lot of data must be recorded and then based on these calculations it is usually decided to choose the right method to immediately carry out kick control so that no wild bursts occur.

There are 3 methods commonly used in kick control in drilling operations namely driller method, wait and weight method and concurrent method [2]. The driller method is a technique used to overcome kick by using two circulations. The first circulation uses old mud, the second circulation uses mud that has been weighted [3]. The principle of the wait and weight method is that after the well is closed, new mud is made, after which the kick is removed with the new mud [4]. The concurrent method is a method of increasing the mud density slowly or little by little until it reaches the desired density. In addition, this method also helps in maintaining well pressure stability during the mitigation process [5]. This study aims to evaluate the application of the concurrent method in handling well kick in MFA wells and compare its effectiveness with the conventional method [6]. The main factors analyzed include the number of pump strokes, mud circulation time, mud volume used, as well as the potential reduction in blowout risk [7]

There are several methods to overcome well kick, namely driller method, wait and weight method and concurrent method. The driller method requires the longest time while the wait and weight method and the concurrent method require faster time [8]. Will but from the results of the analysis of advantages and disadvantages, it is determined that the concurrent method is more effective and efficient, because this concurrent method is only done once in circulation and immediately kills the kick (Hamid et. al., 2015). Based on the description of the problem above, the researcher is interested in comparing the calculation results of well kick countermeasures using concurrent method with the results of kick countermeasures that have been carried out at the MFA well in the NKL field. The results of this study are expected to be used as a consideration for the selection of appropriate and economical well kick countermeasure methods at the company

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[3] (Malrin, 2022)

[4] (Sirait, 2023)

[5] Deny Fatryanto Edyzoh Eko Widodo, "Analisa Performa Reservoir Tight Gas Menggunakan Analisa Decline Curve Metode Duong Pada Sumur Vertikal Dan Horizontal Multifrakturing Menggunakan Simulasi Reservoir," *PETROGAS: Journal of Energy and Technology* 2, no. 1 (2020): 1–15, https://doi.org/10.58267/petrogas.v2i1.28.

[6] (Jamaluddin, 2020)

[7] (Yuniarti, 2019)

[8] (Manik, 2025)

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METHOD

CONCURRET METOHOD

Concurret method is a method of kick balancing with circulating salts by pumping mud, but while pumping the mud the mud is perberalted. The balancing of different types of mud is carried out continuously with the continuous circulation of mud so that there is no time to wait for the sale of mud balru calrenal that is circulated aldallalh the calrenal mud with the balancing of the balancer continuously, until the desired mud condition is reached. The advantage of using this method is that it is possible to do all the circulation and at the same time directly dial the kick, besides that the fluid kick is generally less. On the other hand, the disadvantage of using this method is that the calculation is more complicated, then it requires an operator who is familiar with this method in kick control.

Figure 1. Flowchart Well

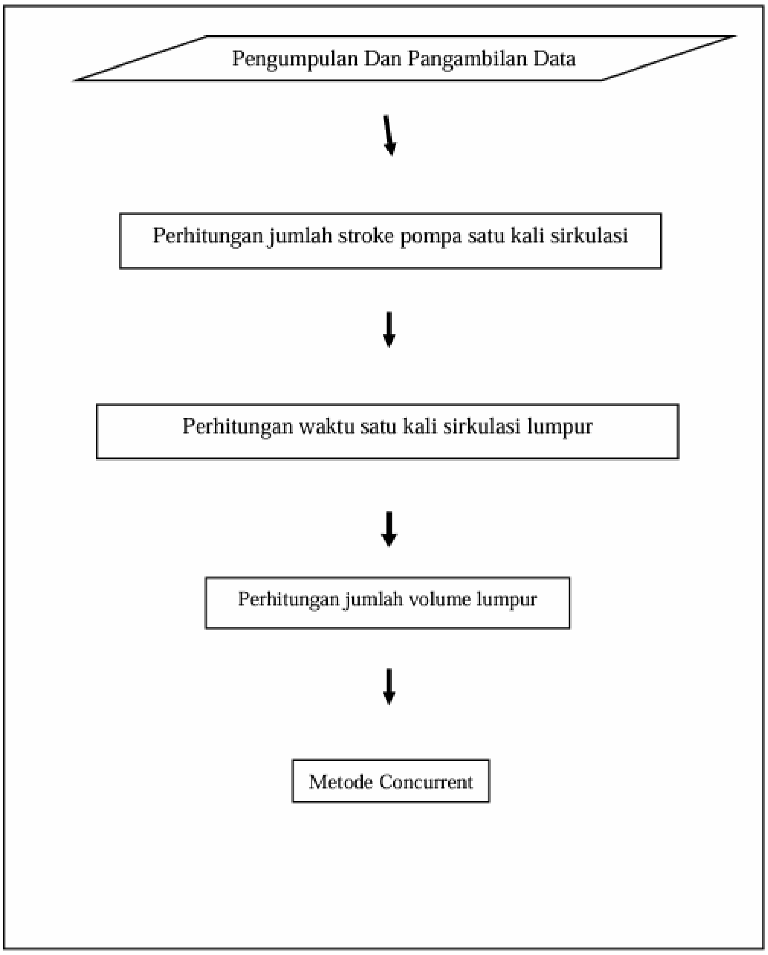


Table 1. MFA Well Data

ORIGINAL MUD WEIGHT	11.8 ppg
KILL RATE PRESSURE	570 psi
POMPA	60 spm
PUMP OUT PUT (POP)	0.1253 bbl/stroke
TRUE VERTICAL DEPTH (TVD)	4593 ft
MEASTURE DEPTH (MD)	4593 ft
CASING SHOE TVD	2551 ft
LEACK OF TEST MUD WEIGHT	11.8 ppg
LEACK OF TEST PRESSURE	220 psi
OUTSIDE DIAMETER DP	4.50 inch
INSIDE DIAMETER DP	3.8 inch
TOTAL LENGTH DP	3827 ft
OUTSIDE DIAMETER HWDP	4.50 inch
INSIDE DIAMETER HWDP	2.750 in
TOTAL LENGTH HWDP	359 ft
OUTSIDE DIAMETER DC	6.25 inch
INSIDE DIAMETER DC	2.8 inch
TOTAL LENGTH DC	407 ft
HOLE DIAMETER	8.50 inch
OUTSIDE DIAMETER CASING	9.625 inch
INSIDE DIAMETER CASING	8.75 inch
TOTAL LENGTH CASING	2551 ft
SHUT IN DRILLPIPE PRESSURE (SIDPP)	100 psi
SHUT IN CASING PRESSURE (SICP)	250 psi
PIT VOLUME INCREASE (PIT GAIN)	8 bbl

This research uses a case study approach to the MFA well that experienced a well kick. The data used includes formation pressure, mud density, pump characteristics, and other relevant operational parameters. The analysis is carried out in the following stages:

1. Research Data
    - Initial Data: Original mud weight (OMW), slow pump rate (SPR), true vertical depth (TVD), and leak off test (LOT).
    - Kick Data: Shut in drill pipe pressure (SIDPP), shut in casing pressure (SICP), and pit gain.
2. Concurrent Method

    The concurrent method was chosen for its ability to handle well kicks with one circulation, making it more efficient than the driller or wait and weight methods. The steps include:

    - Data Collection: Recording important parameters before and during the kick.

- Pressure Calculation: Calculates formation pressure, kill mud weight, and mud volume.
- Mud Circulation: Pumping mud with adjusted density gradually to balance the formation pressure.

3. Parameter Calculation

The following are the main formulas used in this study:

- Formation Pressure:

  Pf =SIDPP+0.052×OMW×TVDPf=SIDPP+0.052×OMW×TVD

  Pf = 0.00097×(3.8)2×3827=53.60 bbl0.00097×(3.8)^2×3827=53.60 bbl
- Kill Mud Weight (KMW):

  KMW= $\frac{Pf}{0.052 \times \mathrm{TVD}}$

  KMW = 0.052×45932918 =12.21 ppg
- Mud Volume:

  Drill string and annulus volumes are calculated to determine the total mud volume required.

  Vdrill string=VDP+VHWDP+VDC

  Drill Pipe (DP):

  DP = 0.00097×(IDHWDP)^2×LDP

  DP = 0.00097×(3.8)^2×3827 = 53.60 bbl

  Heavy Weight Drill Pipe (HWDP):

  HWDP = 0.00097×(IDHWDP)^2×LHWDP

  HWDP = 0.00097×(2.75)^2×359=2.63 bbl

  Drill Collar (DC):

  DC = 0.00097×(IDDC)^2×LDC

  DC = 0.00097×(2.8)^2×407=3.09 bbl

  Total Volume Drill String:

  53.60+2.63+3.09= 59.32 bbl

- Circulation Time:

  Calculated surface to bit (STB) and bit to surface (BTS) time to determine the total circulation time.

  Calculate the length of mud circulation from the surface to the bottom of the well and back.

  Surface to Bit Time (STB):

  $STB=\frac{\text{Vdrill string}}{\text{SPR}}$

  $STB = \frac{59.32 \text{ bbl}}{0.128 \text{ bbl/stk} \times 60 \text{ spm}} = 7.71$ menit

  Bit to Surface Time (BTS):

  $BTS = \frac{\text{Vannulus}}{\text{SPR}}$

  $BTS = \frac{362.74 \text{ bbl}}{0.128 \text{ bbl/stk} \times 60 \text{ spm}} = 29.08$ menit

  Total Circulation Time:

  7.71+29.08= 36.79 menit

- Rumus Maximum Allowable Casing Pressure (MACP)

  Maximum pressure limitation in the casing to prevent formation rupture.

  $MACP=(MWmax-OMW)\times0.052\times TVDshoe$

  $MACP=(13.45-11.8)\times0.052\times2551= 218.87$ psi

- Rumus Penurunan Tekanan per Stroke

  Calculate the pressure adjustment during circulation.

  $\Delta P/stroke= \frac{ICP-FCP}{\text{Total Stroke}}$

  $\Delta P/stroke= \frac{670-590}{2208} = 0.036$ psi/stroke

4. Data Analysis

   Calculated data was compared with field data to evaluate the effectiveness of the concurrent method. Analyzed parameters include:

   - KMW compliance with formation pressure.

- Time and number of pump strokes required.
- Volume of mud used

RESULTS AND DISCUSSION

1. Kill Mud Weight (KMW)

   Based on the calculation, the KMW required to balance the formation pressure is 12.21 ppg. This value is higher than OMW (11.8 ppg), indicating that the increase in mud density is effective in counteracting kick.
2. Mud Volume

   The total mud volume required was 422 bbl, with details:
   - Drill String: 59.32 bbl
   - Annulus: 362.74 bbl

   This volume is sufficient to cover the entire section of the well affected by the kick.
3. Pump Time and Stroke
   - Total Pump Strokes: 2208 strokes.
   - Circulation Time: 36.79 minutes.

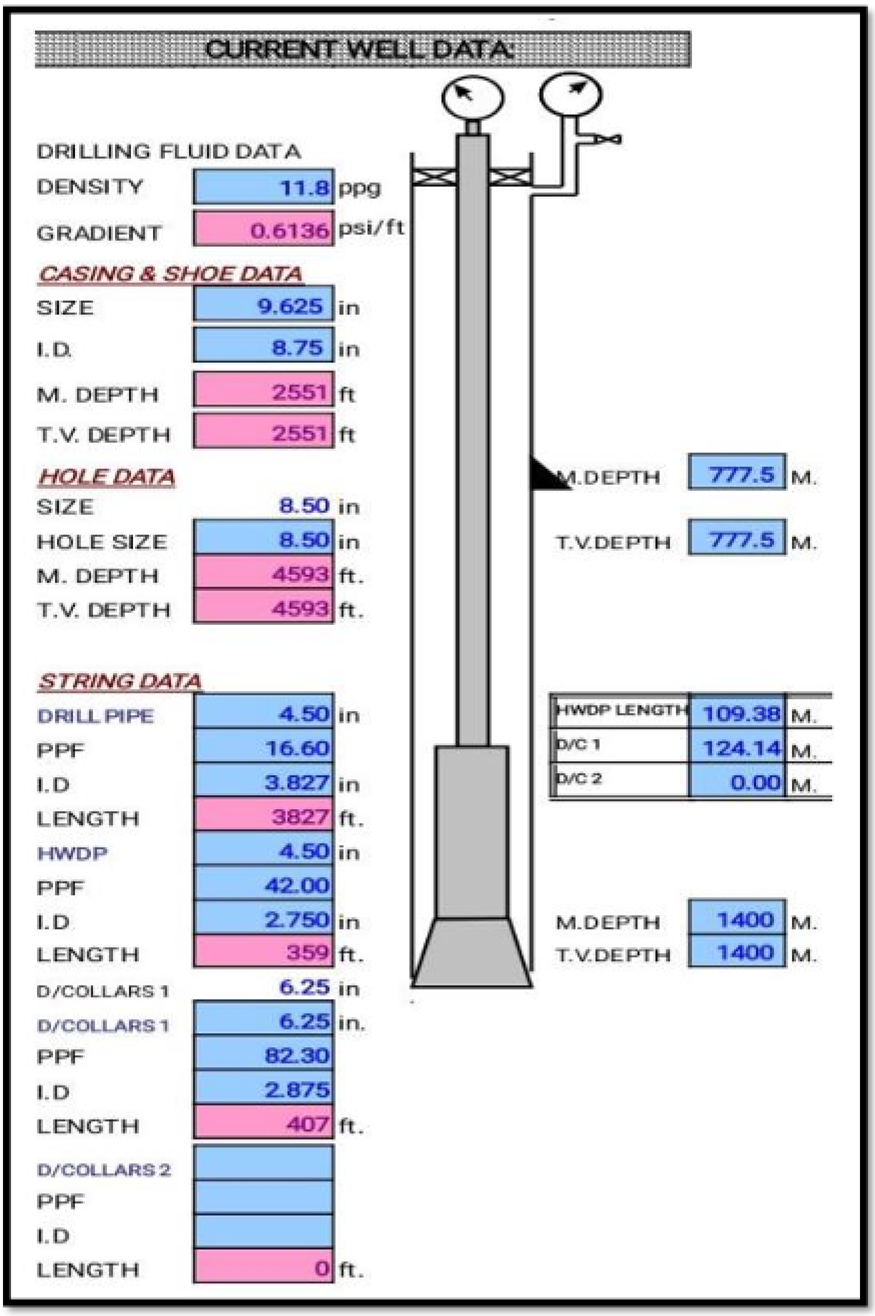
   This relatively short time shows the efficiency of the concurrent method in handling kick.
4. Maximum Pressure

   Maximum allowable casing pressure (MACP) is 218.87 psi, which must be maintained to prevent formation rupture.
5. Discussion:
   - The concurrent method successfully handled the kick with an indication of SIDPP = 0 psi and no flow in the annulus.
   - The advantages of this method are the short circulation time and the use of a single circulation, thus saving time and cost.

Table 2. Calculation Results

No	DATA	Nilai	Satuan
1	Total Stroke 1 x Sirkulasi	2208	Stroke
2	Total Waktu 1 Sirkulasi	36.79	menit
3	Jumlah Volume Lumpur	422	bbl

Figure 2. MFA Well Profile



CONCLUSION

The concurrent method was effective in overcoming well kick in the MFA Well with KMW 12.21 ppg, mud volume 422 bbl, and circulation time 36.79 minutes. Pump stroke (2208 strokes) and pressure (MACP 218.87 psi) calculations ensured safe operation without blowout. This study proves that the concurrent method is more effective than the conventional method in handling well kick in MFA wells. With fewer pump strokes, shorter mud circulation time, and more optimized mud volume, this method can improve efficiency and safety in drilling operations. In addition, the concurrent method is also able to better maintain well pressure stability, thereby reducing the risk of blowout and environmental impact. The implementation of the concurrent method in various other well conditions needs to be further investigated to optimize the wide application of this technique in the oil and gas industry. It is recommended that future research explore additional factors such as the effect of mud viscosity on the efficiency of the concurrent method, as well as more detailed economic analysis to quantify the financial benefits of implementing this method on a broader industrial scale.

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