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Performance Comparison of the Driller's Method and Wait and Weight Method for Effective Well Kick Management of Rig AAM#18 ZJ70DBS 2000 HP

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Orginal Article

Performance Comparison of the Driller's Method and Wait and Weight Method for Effective Well Kick Management of Rig AAM#18 ZJ70DBS 2000 HP

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Abstract
KW Well in the S Field is a development well in Bojonegoro, East Java, drilled with the AAM #18 ZJ70DBS 2000 HP rig. Drilling activities in the oil and gas sector frequently encounter risks, one of which is a well kick, defined as the entry of formation fluids into the wellbore that can escalate into a blowout. This research focuses on implementing the Wait and Weight method to manage a kick in KW Well, after the Driller's Method had initially been applied. The Wait and Weight technique was selected because it lowers pressure at the casing shoe, completes control with a single circulation, and works well in loss-prone formations. The analysis used field data such as casing and drill string dimensions, hole size, LOT results, depth, initial mud weight, pump rate, shut-in drill pipe and casing pressures, and pit gain. The kick occurred due to hydrostatic pressure being insufficient to balance formation pressure. Using the Wait and Weight method required 3,679.84 pump strokes and 122.66 minutes of pumping. In contrast, the Driller's Method needed 6,227.16 strokes and 3 hours 28 minutes. This comparison shows that the Wait and Weight method is more efficient in both time and pump strokes, making it a preferable option for managing kicks under similar well conditions.
Keywords: Driller's Method, Formation Pressure, Wait and Weight Method, Well Control, Well Kick

1. Introduction

The KW Well in Field S, Bojonegoro, East Java, is a development well drilled with the AMM #18 ZJ70DBS 2000 HP rig. While drilling, the well encountered a kick, meaning formation fluids entered the wellbore because the mud's hydrostatic pressure was insufficient to balance the formation pressure, creating a risk of blowout. Proper kick control is critical to avoid serious impacts such as environmental harm, major financial losses, and loss of life (Kodong et al., 2020). In earlier cases, the driller's method has been applied effectively to manage gas blowouts, yet a more efficient approach is often required to secure the well and minimize formation damage. This research examines the use of the wait and weight method and compares it with the driller's method. The wait and weight technique is considered efficient since it involves a single circulation, generates lower casing shoe pressure, and is suitable for formations prone to losses. The study aims to identify the root cause of the gas blowout in the KW Well, implement both control methods, and evaluate their performance. The findings are intended to support better decision making when choosing well control techniques for wells with comparable operating conditions.

Well control is the effort to keep drilling mud hydrostatic pressure above formation pressure, while still matching real field conditions (Ginting, 2019). Based on its functions, well control can be classified into three categories:

1. Primary Well Control
   Primary well control focuses on maintaining mud hydrostatic pressure high enough to exceed formation fluid pressure but still below the fracture pressure of the formation. If mud pressure drops below formation pressure, formation fluids can flow into the wellbore (Aberdeen Drilling School, 2002).
2. Secondary Well Control

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Secondary well control is applied when the wellbore fluid (mud) pressure fails to prevent the influx of formation fluids into the wellbore, allowing them to flow to the surface. In such cases, the flow must be shut in using equipment commonly referred to as a blowout preventer (BOP) (Aberdeen Drilling School, 2002). The BOP serves as a secondary control device in managing kicks during drilling, workover, and well service operations (Alexandri, et.al., 2002).

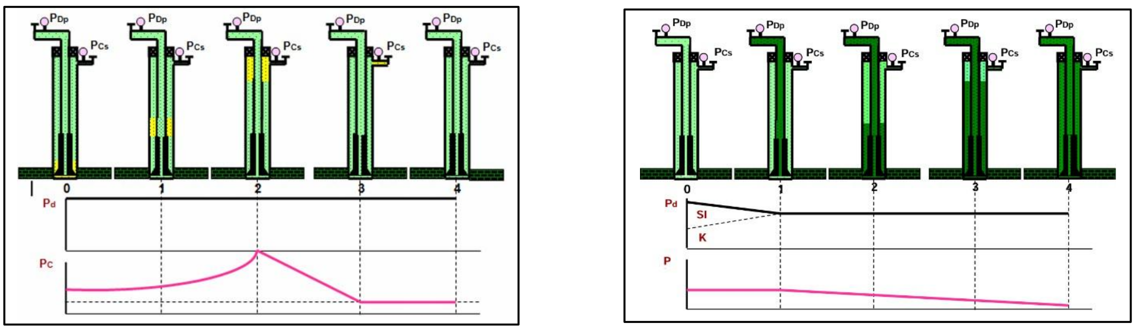
3. Tertiary Well Control

Tertiary well control includes measures used when both hydrostatic control and surface equipment cannot manage formation pressure. One example is an underground blowout. Responses at this stage may involve drilling relief wells, applying dynamic kill techniques, or using other specialized methods (Aberdeen Drilling School, 2002).

A kick occurs when formation pressure becomes greater than the hydrostatic pressure of the drilling mud, or when abnormal formation pressure develops, allowing formation fluids to enter the wellbore (Laksono, 2019). Kicks can be triggered by several conditions, such as mud density that is too low to balance formation pressure, inadequate mud volume during tripping, swabbing effects while pulling out of hole, lost circulation, gas-cut mud, and similar situations. Common warning signs of a kick include a sudden rise in rate of penetration, higher return flow, increased mud volume in surface tanks, reduced pump pressure along with higher pump speed, and visible gas bubbles in the mud, among other indicators. Various well control techniques are available to handle kicks, including the driller’s method, the wait and weight method, and the concurrent method. The driller’s method, often called the two-circulation method, removes the influx through two separate circulations before pumping kill mud (Mitchell, 1995). The time between these circulations is typically used to prepare the required kill mud (Susilo, 2019). The wait and weight method maintains constant bottom hole pressure while circulating the influx out and, at the same time, introducing heavier kill mud to replace the original mud in the well (Kumar & Sharma, 1996). Because it combines these steps, it is also known as the single-circulation method. In practice, the existing mud is circulated while newly weighted mud is pumped downhole (Sofyan et.al., 2013). The concurrent method, on the other hand, controls the well by gradually increasing mud weight while the kick is being circulated out (Elgibaly, 2019).

Figure 1

Illustration of the Driller’s Method a) First Circulation, b) Second Circulation



(a) (b)

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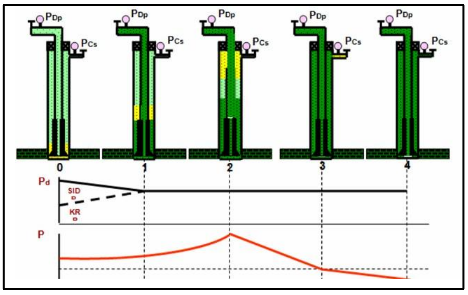
Figure 2
Illustration of the Wait and Weight Method - Second Circulation



Kick Problem
Calculating the Kill Mud Weight (KMW)

$$KMW, ppg = OMW + \left(\frac{SIDPP}{0{,}052 \times TVD}\right) \quad (1)$$

Calculating Kill Rate Pressure (KRP)

$$KRP_1, psi = (Pump\ Pressure - SIDPP \quad (2)$$

$$KRP_2, psi = KRP_1 + \left(\frac{Q2}{Q1}\right)^{1.9} \quad (3)$$

$$KRP_2, psi = KRP_1 + \left(\frac{SPM2}{SPM1}\right)^{1.9} \quad (4)$$

Calculating Initial Circulating Pressure (ICP)

$$ICP, psi = KRP + SIDPP \quad (5)$$

Calculating Final Circulating Pressure (FCP)

$$FCP, psi = (KRP \times KMW) : OMW \quad (6)$$

Calculating Surface to Bit Strokes (STB)

$$STB = (Cap_{dp} \times MD) : PO\ pompa \quad (7)$$

Calculating Bit to Surface Strokes (BTS)

$$BTS = (Cap_{dp} \times MD) : PO\ pompa \quad (8)$$

Drilled Method Calculation
Calculating total Strokes

$$Total\ Stroke = SBTS + (SSTB + SBTS) \quad (9)$$

Calculating Total Time

$$Total\ Time = TBTS + (TSTB + TBTS) \quad (10)$$

Wait and Weight Method Calculation
Calculating total Strokes

$$Total\ Stroke = STB + BTS \quad (11)$$

Calculating Surface to Bit Time

$$Surface\ to\ Bit\ Time, minute = STB : SPM \quad (12)$$

Calculating Bit to Surface Time

$$Bit\ to\ Surface\ Time, minute = BTS : SPM \quad (13)$$

Calculating Total Time

$$Total\ Time = STB\ Time + BTS\ Time \quad (14)$$

2. Methods

This study was conducted as part of the completion of a final assignment, in which the author examined a real case involving a kick incident in the KW Well, Field S. The methodology employed included literature review, data collection, and data processing. The literature review involved reviewing relevant references to strengthen the theoretical

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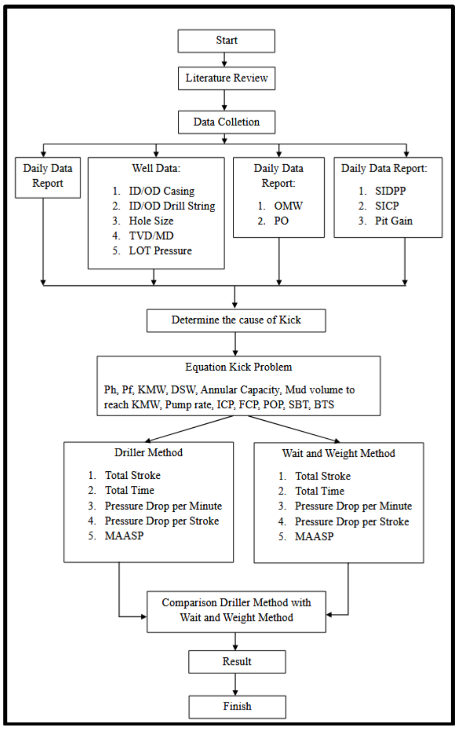
foundation. The collected data comprised the daily drilling report (DDR), well data (total depth, casing and drill string ID/OD, hole size, TVD/MD, formation pressure, and LOT), mud data (original mud weight, pump output, hydrostatic pressure), as well as shut-in pressure data (SICP, SIDPP) and pit gain. Once the data were obtained, calculations were carried out using the wait and weight method to determine kick control parameters, including hydrostatic and formation pressures, kill mud weight, drill string and annulus volumes, initial circulating pressure (ICP) and final circulating pressure (FCP), pump output, total circulation strokes, and the maximum allowable pressure. The results of these calculations were then used to circulate mud into the wellbore to control the kick in the KW Well, Field S.

Figure 3.
Research Flowchart



Characteristic data

In this case, the required information was collected by reviewing sources such as academic papers, journals, and previous studies. The data presented here are secondary in nature. (Table 1-5).

Table 1
Field Data KW Well S Field.

PARAMETERS	UNIT	
Original Mud Weight (OMW)	9,9	ppg
Pump	30	spm
Kill Rate Pressure (KRP)	338	psi
Pump Output (PO)	0,123	bbl/*stroke*
Measure Depth (MD)	7231	ft
True Vertical Depth (TVD)	5610	ft
Casing Shoe	5350	ftTVD
Leak off Test Mud Weight	13,1	ppg

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Leak off Test Pressure	3654	psi
Outside Diameter dc	6 1/2	inchi
Outside Diameter dp	5 1/2	inchi
Outside Diameter hwdp	5 1/2	inchi
Inside Diameter dc	2,8125	inchi
Inside Diameter dp	4,67	inchi
Inside Diameter hwdp	3 1/4	inchi
Total Length dc	186	ft
Total Length dp	6022	ft
Total Length hwdp	1023	ft
Hole Diameter	8 1/2	inchi
Outside Diameter Casing	9 5/8	inchi
Inside Diameter Casing	8,681	inchi
Total Length Casing	6896	ftMD
Shut in Drill Pipe Pressure (SIDPP)	217	psi
Shut in Casing Pressure (SICP)	236	psi
Pit Volume Increase (Pit Gain)	2	bbl

3. Results and Discussion

This study applies the wait and weight method to manage a kick in the KW Well, Field S, where the driller’s method had been used earlier. The main goal is to evaluate and compare how efficient each method is. After completing the wait and weight calculations, the outcomes are assessed against the results from the driller’s method. Figure 6 shows the well profile for the KW Well in Field S.

Determining the cause of the Kick

The kick in the KW Well, Field S, occurred on 27 September 2024 during the run in hole (RIH) operation to re-enter with an 8 ½” TCB bit from a depth of 4,100 ftMD to 7,231 ftMD. At approximately 04:00 local time, while checking the flow at the flowline at a depth of 7,100 ftMD, an increase in flow rate was observed. At this stage, no mud density adjustment had been made. The RIH operation with the 8 ½” bit continued from 7,100 ftMD to 7,231 ftMD. At 11:00 local time, upon reaching 7,231 ftMD, another flow check was conducted at the flowline, revealing a greater increase in flow rate compared to the earlier observation. Consequently, drilling operations were halted by stopping the top drive, shutting down the mud pumps, and checking the flow at the flowline. The drill string was pulled up until the tool joint sat above the rotary table, then the hydraulic choke remote was opened and the blowout preventer, including both annular and ram preventers, was shut. Shut-in drill pipe pressure, shut-in casing pressure, and pit gain were documented during the shut-in. While running in hole with an 8½-inch bit, 9.9 ppg mud was in use, but this density did not provide enough hydrostatic pressure to counter the formation pressure at that depth. This indicates that the kick occurred because mud hydrostatic pressure was lower than formation pressure due to insufficient mud weight. Afterward, from 12:30 to 14:30 local time, the mud density was gradually increased to condition the system until the hydrostatic pressure matched the formation pressure, confirmed when no additional pit gain or flowline rate increase was observed.

When a kick has clearly occurred, shown by signs like a sudden drilling break on the rate of penetration indicator and related warnings, the well should be shut in right away

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following standard procedures to avoid escalation. At that point, shut-in casing pressure, shut-in drill pipe pressure, and pit gain need to be measured and logged. Once all kick data are collected, calculations for well control can begin. A key factor in mud design for blowout prevention is hydrostatic pressure. The mud must exert enough pressure to balance the formation, and as the well goes deeper, the hydrostatic pressure required also increases.

Table 2 shows the results of the wait and weight calculations used to handle the kick in Well KW, Field S. The values are used as guidance for circulating the drilling fluid, including fluid volume, pump pressure and rate, Initial Circulating Pressure, Final Circulating Pressure, and total pumping time for fluid travel from surface to bit and back to surface. These numbers function as initial references for the operation. After reaching the planned FCP and total pump strokes, the success of the kick control is checked by comparing mud weight at the inlet and outlet. If the two are the same, it confirms that the heavier mud has fully displaced the kick fluid along the wellbore, meaning the well has been successfully killed.

Table 2
Results of Wait and Weight Method Calculations.

PARAMETERS	UNIT	
Pressure Hydrostatic	2884,428	psi
Formation Pressure	3101,428	psi
Kill Mud Weight (KMW)	10,63	ppg
Drill String Volume Total	139,3	bbl
Capacity Annuus Total	313,22	bbl
Volume Kill Mud Weight	452,52	bbl
Slow Pump Rate (SPR)	30	spm
Kill Rate Pressure (KRP)	338	psi
Initial Circulating Pressure (ICP)	555	psi
Final Circulating Pressure (FCP)	362,92	psi
Pump Output	0,123	bbl/stroke
Surface to Bit Stroke (STB)	1132,52	stroke
Bit to Surface Stroke (BTS)	2547,32	stroke
Stroke Total of One Circulation	3679,84	stroke
Surface to Bit Stroke Time (STB)	37,75	minute
Bit to Surface Stroke Time (BTS)	84,91	minute
Time Total 1 Cycle	122,66	minute
Pressure Drop Per Minute	1,57	psi/minute
Pressure Drop Per Stroke	0,0522	psi/stroke
MAFD	26,23	ppg
MAASP	4529,622	psi

Comparison Between the Driller's Method and the Wait and Weight Method

Table 3 provides a comparison of the Driller's Method and the Wait and Weight Method as implemented in Well KW, Field S.

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Table 3.
Comparison between the Driller's Method and the Wait and Weight Method

METHODS	TIME TOTAL (minutes)	STROKE TOTAL (strokes)
Driller	207,57	6227,16
Wait and Weight	122,66	3679,84

Discussion

After applying the Wait and Weight method in Well KW, Field S, and comparing it with the Driller's Method, the results show that the Wait and Weight approach performs better in terms of total duration and number of pump strokes. The Wait and Weight operation took 122.66 minutes, about 2 hours and 3 minutes, and required 3,679.84 strokes. Meanwhile, the Driller's Method took 207.57 minutes, roughly 3 hours and 28 minutes, with 6,227.16 strokes. From a theoretical standpoint, this means the Wait and Weight method saves about 1 hour and 25 minutes in controlling the kick. In real field situations, however, method selection also depends on operational factors. Insights from a senior company representative indicate that the Driller's Method is often preferred because it is straightforward and does not require a waiting period. Once a kick occurs, circulation can begin right away using the mud already in the hole. On the other hand, input from a rig superintendent suggests that the Wait and Weight method can be more efficient overall. Even though it may create higher initial pressures at the start of circulation, casing shoe pressure tends to decline as the influx nears the surface. With the Driller's Method, casing shoe pressure typically continues to rise. The findings of this study show that the Wait and Weight method outperforms the Driller's Method in pump strokes and pumping time. Still, the analysis did not include the time needed to prepare and condition the heavier kill mud for the Wait and Weight operation. Because of that, the conclusions here should be viewed as a comparison limited to pump strokes and circulation time up to the point where the kick is fully killed.

4. Conclusion

From the result of this study, several conclusions can be drawn:

1. The kick in Well KW, Field S occurred because the drilling mud's hydrostatic pressure was lower than the formation pressure, as the mud weight used was not high enough to balance the formation. In sequence, while running back in hole with the 8½-inch TCB bit from 4,100 ftMD to 7,231 ftMD, a sudden abnormal flow was detected at the flowline. At that moment, the mud weight was 9.9 ppg. This shows that 9.9 ppg did not provide adequate hydrostatic support against the formation pressure, making it necessary to raise the mud density.
2. Using the Wait and Weight method with a single circulation in Well KW, Field S was effective in killing the kick, requiring 3,679.84 pump strokes and a total circulation time of 122.66 minutes, or about 2 hours and 3 minutes.
3. A comparison between the Driller's Method previously used in Well KW and the Wait and Weight method indicates that the Wait and Weight approach performed better in both operational time and number of pump strokes needed to control the kick. The Wait and Weight operation was completed in about 2 hours and 3 minutes, while the Driller's Method took around 3 hours and 28 minutes. Likewise, the Wait and Weight method required 3,679.84 strokes, significantly fewer than the 6,227.16 strokes recorded for the Driller's Method.

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