Volume 2 Number 2 (2022)
January-June 2022
Page:131-138

E-ISSN: 2745-4584
https://ejournal.insuriponorogo.ac.id
DOI: 10.37680/almikraj.v2i1.7211

AL MIKRAJ
Jurnal Studi Islam dan Humaniora

Mitigation Of Loss Circulation Problems Using Calcium Carbonate In Well 'HF-05', 'Kanaan' Field

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Submitted: Revised: 2022/05/01; Accepted: 2022/05/21; Published: 2022/06/15

Abstract

Lossicirculation isione of theiproblems thatioften occursiin theidrillingiworld where loss of circulation or loss of circulation of mud is interpreted as a loss of circulation in a small amount or all of the drilling mud when it is circulated, so that when the drilling takes place, the circulated mud enters the drilling zone. penetrated formation. The "HF-05" well in the "KANAAN" fieldiis aidevelopmentiwell thatiaimsito proveithe existenceiof oil and gas reserves in Sukra District, Indramayu Regency. The loss circulation problem that occurred in the "HF-05" well occurred at a depth of 1945 mMD, route with a total loss of 278 bbl with a mud weight of 1.19 sg. The methodology used in handling loss circulation is collecting the necessary data, calculating hydrostatic pressure (PH), calculating drilling hydraulics, and identifying the causes of loss circulation by comparing hydrostatik pressure (PH) with formation pressure. Then carry out countermeasures using loss circulation material (LCM) type Calcium Carbonat. The results of countermeasures for loss circulation using loss circulation material (LCM) type Calcium Carboante in the "HF-05" well were successful with hydrostatik pressure (PH) lower than formation pressure (PF)..

Keywords

Loss circulation; Hydrostatik Pressure; Drilling Hydrulics; Calcium Carbonate

Introduction

The activities of oil and gas drilling operations are part of the follow-up efforts to find oil and gas, with the goal of confirming whether or not there are hydrocarbons, specifically oil and gas, in the reservoir layer being drilled.[1] The aim of drilling operations is to drill, evaluate, and complete wells that will produce oil or gas and can be produced effectively and safely. Drilling fluid, or drilling mud, is one of the essential tools in oil and gas drilling operations to achieve the

[1] Muhammad Mujtaba Asad et al., "Oil and Gas Disasters and Industrial Hazards Associated with Drilling Operation: An Extensive Literature Review," in *2019 2nd International Conference on Computing, Mathematics and Engineering Technologies (ICoMET)* (IEEE, 2019), 1–6; Emmanuel I Epelle and Dimitrios I Gerogiorgis, "A Review of Technological Advances and Open Challenges for Oil and Gas Drilling Systems Engineering," *AIChE Journal* 66, no. 4 (2020): e16842.

planned objectives(Raharja,2018). Initially, people only used water to transport cuttings, but with the advancement of technology, drilling mud began to be used in drilling operations[2]). In oil and gas drilling activities, things do not always go as planned due to problems that often occur during each drilling activity. (Ir. Bayu Satiyawira, 2018). One of the common issues in drilling operations is loss circulation. Loss circulation refers to the loss of some or all of the drilling fluid that is circulated into the formation. This happens because the drilling fluid enters formations with caves, faults, or fractures, which occurs when the hydrostatic pressure exceeds the formation's fracture pressure [3]. As a result of loss circulation, drilling operations may not proceed smoothly.

In the "KANAAN" field HF well, loss circulation occurred at a depth of 1945 mMD with a total circulation loss of 278 bbl. Loss Circulation Material (LCM) is a material used to address or resolve the issue of lost circulation. By adding loss circulation material (LCM) to the drilling mud, the zones where loss circulation occurs can be sealed to prevent further loss of drilling fluid [4]. Calcium Carbonate is a white chemical substance commonly found in limestone and chalk rocks(Hastomo,2021). By using the Calcium Carbonate additive, fractures can be sealed by forming a filter cake with low permeability and optimal thickness(Huda et al., n.d.). Therefore, addressing loss circulation in drilling wells is crucial to ensure that drilling operations proceed smoothly and safely(Rabia,1985). It is also important to continuously monitor or improve the properties of the drilling fluid or the substances within it. Based on the previous background, further research is required, and this is outlined in the final project titled "Mitigating Loss Circulation Problems Using Calcium Carbonate in the "HF-05" Well, KANAAN Field.

The research location at the "HF-05" well in the "KANAAN" field is situated within the North West Java Basin. The North West Java Basin is a forearc basin located in the northwestern part of Java Island. The North West Java Basin is a back-arc basin system located between the Sunda microplate and the tertiary thrust of the Indo-Australian plate. The North West Java Basin consists of fourteen sub-basins, some of which have proven hydrocarbon reserves that are still active, while the rest are believed to contain oil and gas pockets [5]. The North West Java Basin has 7 (seven) tectonic events in Southeast Asia that significantly influence the structural and

[2] Ikhwannur Adha, "RESERVOIR DI LAPANGAN CIPLUK KENDAL" 3, no. September (2021): 39–50.
[3] (Tinggi & Migas, 2021)
[4] Firdaus Firdaus and Rohima Sera Afifah, "Analisa Injeksi Surfaktan+KCL Untuk Meningkatkan Perolehan Produksi Minyak Pada Formasi AB-2b Di Formasi Air Benakat," *PETROGAS: Journal of Energy and Technology* 4, no. 2 (2022): 27–41, https://doi.org/10.58267/petrogas.v4i2.126.
[5] (Sima, 2022)

stratigraphic development in the North West Java Basin (Daly et al, 1987). The research location at the "HF-05" well in the "KANAAN" field is situated within the North West Java Basin. The North West Java Basin is a forearc basin located in the northwestern part of Java Island.

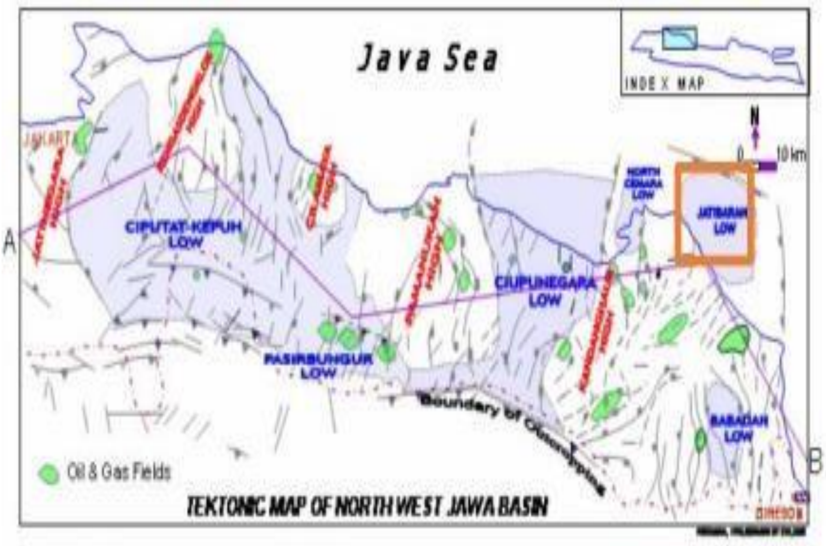

Figure 1 Research Location in the North West Java Basin

Source: M. Rio Aulia et al., 2020

Based on the North West Java Basin, it is part of the back-arc basin system in the western part of Indonesia. The North West Java Basin is formed by the subduction zone system between the Sunda microplate and the Australian plate. This basin is controlled by a normal fault system oriented in a north-south direction. As a result of the normal faulting, high areas called horsts are formed, low areas called grabens, and the division of the basin into sub-basins. Currently, the North West Java Basin is divided into three sub-basins: the Ciputat sub-basin (from west to east), the Pasir Putih sub-basin, and the Jatibarang sub-basin. The following is the regional stratigraphic division of the North West Java Basin:

Method

This study utilized a quantitative and analytical method to identify the causes of loss circulation and determine effective mitigation strategies in the "HF-05" well, located in the KANAAN field, North West Java. The research began with the collection of detailed field data, including well depth, casing and tubing specifications, and the properties of the drilling mud used at the time of the incident. Key parameters such as mud weight, viscosity, gel strength, filtration rate, pH, and ion concentrations were gathered to evaluate the mud's performance. Subsequently, hydrostatic pressure (PH) at a depth of 1945 mMD was calculated using mud density and well depth to assess whether the pressure exceeded the formation's pore and fracture pressures. Further analysis involved calculating the Equivalent Circulating Density (ECD) and Bottom Hole Circulating Pressure (BHCP) to simulate the actual pressure exerted during active mud circulation. These results were then compared with formation pressure and fracture pressure data at corresponding depths to determine if overpressure was the primary cause of mud loss. The data revealed that both hydrostatic and circulating pressures were higher than the formation pressure, confirming that the mud invaded the formation, causing loss circulation. To mitigate this, a new mud formulation was designed using Calcium Carbonate as a Loss Circulation Material (LCM), with the aim of lowering hydrostatic pressure to a value below the fracture gradient. This revised formulation was calculated using data such as the number of LCM sacks, water volume, and respective densities. The effectiveness of this solution was evaluated by ensuring the new hydrostatic pressure would no longer exceed formation pressure, thereby reducing the risk of further losses and stabilizing the drilling operation.

Result and Discussion

Basement Rock

Based on the lithology of the basement rocks in the North West Java Basin, it consists of igneous rocks from the middle to late Cretaceous period and metamorphic rocks from the Tertiary period. The presence of low-grade sedimentary metamorphic rocks (such as phyllite and schist) is a product of subduction associated with the active Meratus arc during the Cretaceous period.

Drilling Mud

Drilling mud is a fluid composed of a mixture of various materials used in drilling operations. Drilling mud is a crucial factor in drilling operations, as the drilling speed, efficiency, and safety heavily depend on the mud used. Therefore, the properties of the mud must be monitored, analyzed, and adjusted to field conditions to create the most suitable properties for drilling according to its requirements.

When the right drilling mud is used, drilling is expected to proceed smoothly. This can be achieved by continuously monitoring and maintaining the mud properties at each stage of drilling. Density, rheology, sand content, solids, control, fluid loss, and pH of the mud used are important characteristics of drilling mud. The drilling mud currently used initially originated from the use of water to lift drill cuttings.

Properties of Drilling Mud

Properties and composition of drilling mud play a crucial role in the drilling world. The properties and composition of drilling mud must always be monitored and controlled to maintain the integrity of specific drilling equipment during the drilling process. Casing design, drilling rate, and completion are influenced by the mud used at that time. For instance, when encountering soft rock zones, controlling the properties of the mud is essential, whereas for hard rock zones, these properties are not as critical, and sometimes water can be used. Therefore, the geological properties of an area determine the type of mud that should be used (Rudi Rubiandini, 2009). This research, for the final project, was conducted on the "HF-05" well in the "KANAAN" field, which is a development well located in Sukra subdistrict, Indramayu regency, North West Java. The drilling target in the "HF-05" well was the Talang Akar formation. One of the issues that occurred during drilling in the "HF-05" well was loss circulation. Loss circulation is a common problem in drilling, which leads to various issues and losses, such as pipe sticking, loss of mud, formation damage, and even the risk of a blowout in the formation (Rudi Rubiandini, 2009). Loss circulation occurred at a depth of 1945 mMD with a total loss of 278 bbl, and the mud used during the loss circulation was KCL polymer.

The author then conducted a series of calculations to determine the cause of the loss circulation in the "HF-05" well. From the results of the hydrostatic pressure calculations, it was found that the hydrostatic pressure (PH) at the time of the loss circulation was 3289 psi. Next, the author performed calculations for the drilling mud's hydraulics, such as the mud density during circulation (Equivalent Circulation Density or ECD) and the circulation pressure during circulation (Bottom Hole Circulation Pressure or BHCP), in order to determine the loss of circulation or mud loss caused by the hydrostatic pressure (PH). From the calculations, the Equivalent Circulation Density (ECD) was found to be 10.45 ppg, and the Bottom Hole Circulation Pressure (BHCP) was 3468 psi. From these results, the cause of the loss circulation in the "HF-05" well can be identified. Table 1 presents the drilling fluid properties and key well data from the "HF" well. These parameters serve as the basis for analyzing the causes of loss circulation encountered during drilling operations. The data includes mud weight, viscosity, gel strength, filtration characteristics, and other relevant properties that influence mud performance and wellbore stability.

Data	Nilai	Satuan
Depth	1945	m
Mud Weight	1,19	SG
Funnel Viscosity	68	sc/qt
Plastic Viscosity	23	cps
Yield Point	39	lbs/100ft2
Gel Strenght 10 sec	12	lbs/100ft2
Gel Strenght 10 min	16	lbs/100ft2
Filtrate API	4,8	-
Mud Cake	0,5	-
Ph	9	-
sand	0,05	%
Solid	5,52	%
K+	32.000	mg/lf
Q	844	GPM
ID casing	12,25	inch
OD	5	Inch

Based on the data in Table 1, the drilling mud used had a density of 1.19 SG and a funnel viscosity of 68 sec/qt. The gel strength and yield point values indicate sufficient carrying capacity and borehole cleaning ability. The high potassium ion content shows that a KCL-Polymer mud system was used to stabilize reactive formations. This data is essential for calculating hydrostatic pressure and identifying the potential for loss circulation. Table 2 provides the required data for calculating the new mud weight using Calcium Carbonate as a Loss Circulation Material (LCM). These values are critical for adjusting the mud formulation to reduce hydrostatic pressure and mitigate further los.

Tabel 2 Data for Determining New Mud Weight

Data	Nilai	Satuan
Volume Air	55	bbl
Berat Jenis Air	8,33	Ppg
Berat jenis *Calcium Carbonate*	22,491	Ppg
Gradien Volume *Calcium Carbonate*	10	lb/bbl

Jumlah *Calcium Carbonate*	10	Sack

Table 2 outlines the composition of the new mud system, which involves mixing 10 sacks of Calcium Carbonate into 55 barrels of water. The base density of water is 8.33 ppg, while Calcium Carbonate has a density of 22.491 ppg. The goal of this modification is to reduce the hydrostatic pressure to a level below the formation fracture pressure. This step is necessary to successfully seal the loss zones and stabilize mud circulation. Table 3 presents the formation pore pressure and fracture pressure data at various depths in the "HF-05" well. This information is used to analyze the pressure environment of the formation and determine whether the mud pressure exceeded the fracture limit.

Tabel 3 Data Formation Pressure Data from"HF-05" Well

IPCURVE	IPCRUVES_ DEFINITION	Frac Press	Pore Pressure
1925	1924.92	5,044,479	2,943,202
1950	1,949,919	5,125,575	3,008,325
1975	1,974,917	5,158,798	2,887,463
2000	1,999,915	5255.71	3,012,237
2025	2,024,913	5,323,117	3,021,463

The formation pressure and fracture pressure data in Table 3 indicate that at approximately 1945 mMD, the formation pressure was lower than both the hydrostatic and circulation pressures. This confirms that the drilling mud exceeded the fracture pressure and entered the formation, causing loss circulation. By comparing these values with calculated ECD and BHCP, it can be concluded that overpressure during drilling was the primary cause of the loss. The RJ well at the CP field is a directional drilling well. This well has a 26" open hole and 20" casing up to a depth of 741 ft, followed by a 17 ½" open hole and 13 3/8" casing to a depth of 4405 ft. The well then continues with a 12 ¼" open hole and 9 5/8" casing to a depth of 8060 ft, followed by an 8 ½" open hole to a depth of 8113 ft. The well is then completed with an 8 ½" open hole down to a depth of 9617 ft. The RJ well profile is shown in the figure. The Productivity Index (PI) for liquid and oil was determined as 1.03 bfpd/psia and 0.1299 bopd/psia, respectively.

CONCLUSIONS

Based on the results of the research conducted by the author, the following conclusions can be drawn: In the "HF" well, loss circulation occurred at a depth of 1945 mMD, with the mud density used at the time of loss being 1.19 sg. From the hydrostatic pressure calculations performed, the hydrostatic pressure (PH) at the time of the loss circulation was found to be 3289 psi. From the drilling mud hydraulic calculations, the Equivalent Circulation Density (ECD) was found to be 10.45 ppg, and the Bottom Hole Circulation Pressure (BHCP) was found to be 3468 psi. The loss circulation or the loss of drilling fluid in the "HF" well was caused by the hydrostatic pressure (PH) exceeding the formation pressure (PF), causing the mud to enter the formation. In this final project, the mitigation of loss circulation or the loss of mud in the "HF" well was achieved by lowering the hydrostatic pressure (PH) using Loss Circulation Material (LCM), which was calcium carbonate. From the mud weight calculations using calcium carbonate, the mud weight was found to be 8.36 ppg, and the hydrostatic pressure with the new mud was 2773 psi. The mitigation of loss circulation in the "HF" well was successfully carried out using Loss Circulation Material (LCM), specifically calcium carbonate, where the hydrostatic pressure (PH) became lower than the formation pressure (PF).

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