International Journal of Application on Sciences, Technology and Engineering (IJASTE)
Volume 1, Issue 1, 2023. ISSN 2987-2499

PRACTICAL APPROACH SOLVING THE LOST CIRCULATION PROBLEM DURING DRILLING OPERATION

Rizki Akbar[1, a)] and Rini Setiati, Sri Feni Maulindani, Djunaedi Agus Wibowo[2, 3, b)]

Author Affiliations
[1,2,3,4]*Petroleum Engineering, Universitas Trisakti*
Kyai Tapa, DKI Jakarta
.

Author Emails
a) Rizki Akbar: rizkiakbar@trisakti.ac.id
[b)]rinisetiati@trisakti.ac.id, srifeni@trisakti.ac.id, djunaedi.agus@trisakti.ac.id
b)
Submitted: November-December 2022, Revised: January 2023, Accepted: February 19, 2023

Abstract. With increasing demand for oil and gas resources, oil and gas well drilling is performed challenge and harsh environment. One of the drilling campaign challenges facing the oil and gas industry now an issue of lost circulation while drilling. Great strides have been made in understanding and solving this problem. The lost circulation is the most troublesome and costly problem in drilling for oil and gas, Althoughyearly costs in materials, lost time and lost holes reach millions of dollar, no functionally new lost circulation materials or techniques have been developed in the past ten years. However, most products and measures to combat loss of circulation tend to promote specific service businesses. Although many experiment and modelling studies have been conducted over the past three decades, there are still divergent view on the underlying mechanisms of leakage and borehole reinforcement. The purpose of this study was to develop a practical method guide that is generic and not specific to service company products, but also serves as a tecnical guide for drilling crew to avoid lost circulation issues in drilling operation.

Keywords: Drilling, Problem, Lost Circulation, Solving, Operation

INTRODUCTION

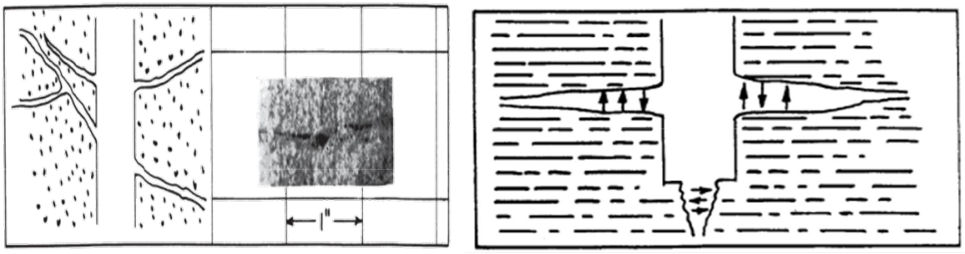
Lost circulation is one of the drilling problem occur in site, such as in high permeable formation, depleted reservoir, and fracture formation. Scope of the lost circulation problem starts at below mudline zone, unconsolidated formation and extends to consolidated formations fractured by hydrostatic uplift produced by drilling fluid (Moore, 1986). Then, this could be explained as minimized or no fluid flow up from annulus casing as the fluid is pumped into the drill string or casing. Lost circulation can also through to highly permeable formation while drilling or during trips, when pressure surge happens during to running in hole of drillstring-casing into wellbore.The oil and gas industry spend millions dollars each year dealing with lost circulation and another problems adverse effects such as lost drilling time, blocked pipelines, blowouts and, more rarely, costly well shutdown. Two factors are required for circulation when it happen in downhole: 1) pressure in wellbore must exceed the pore pressure; 2) must be a flow path the lost to occur. Circulation may be loss even if the fluid density is within the normal range; the density is less than a density of fracture formation. Stopping lost circulation before it gets out of hand is critical for safety and commercially viable operation (Abbas et al., 2004). From many previous experiences, most drilling problems have related to lost circulation, since it increases hole instability problems (Byrom, 2014). Problems associated with lost circulation include wellbore collapse (Rabia, 2002; Hassani et al.,

2016; Al Awad, 2020), a severe formation damage, differential/mechanical sticking (Growcock et al., 2009; Magzoub et al., 2020a), also by kick that uncontrolled (Cook et al., 2011). As a statement of Ivan and Bruton (2003), "Deepwater drilling pushes loss control to a more critical level as it involves narrowing pore pressure/fracture gradient windows, low temperature drilling fluid temperatures, high equivalent circulating density and great permeability. Non-productive time (NPT) Synthetic fluid in barrels (SBM) cost..
During drilling, circulation is often lost in several zones, requiring the drilling to be terminated and remedial action taken. In some cases, remediation guidelines often involve placing conventional cement compositions in areas where thief zone is permitted.

LITERATURE REVIEW

Much effort has gone into understanding the mechanisms by which cycles run out of control. Lost circuit guided while well construction is not just about choosing the suitable lost circulation material, it require a complete engineering approach (Whitfill, 2008). Some methods include analysis of wellbore stability, equivalent circulating density (ECD) modeling, leakage flow path geometry considerations, selection of drilling fluids and lost circulation material to minimize ECD effects, and field observing use annulus pressure while drilling (APWD). Techniques for monitoring flow connection and precision application of lost circulation material. In most drilling operations, the lost circulation material must prevent fluid loss to advance drilling. The lost circulation material should respond, stop cracks, bridging to provide sealing. Sealing could be temporarily or even permanently. Permanent seals are used to seal off thieves' areas, non-production layers, during temporarily seals are used to block lost zone in layer of payzone (Fidan et al. 2004). Previously, research has shown which some products are more efficient in addition to lost recycled material (Sanders et al., 2010). Lost circulation material is divided into basic grouped along their physical and chemical properties.

When the problem occur in fracture formation is one of the major drilling problem. Loss of mud into the formation can occur through fracture created by the drilling operation or through pre-existing natural fractures. If the fracture already exists, fracture might be permanent open, in which case the loss of the formation might happen in drilling fluid pressures that only exceed the formation pressure. Induced fractures occur when the drilling fluid weight required to control the wellbore also maintaining stability exceed the formation fracture resistance pressure (Majidi et al., 2011). Determining type of damage that caused by lost is an important sequence in addressing lost returns. Figures a and b are examples of natural and induced fracture.



a b

FIGURE 1. (a) Natural or Intrinsic Fractures and (b) Induced Fractures (Howard and Scott, 1951)

TABLE 1. Identifying of Fractures

Natural Fracture	Induced Fracture
May occurs for type of the formation.	Can happen at any rock type, but is expected to occur in formations
The gradual sinking of the mud in the pit attests to the loss. If drilling continues and more fractures were exposed, it could be a total lost.	- Lost is mostly sudden and accompanied by total lost with no return. Conditions are favorable to induced fracture when drilling fluid weight exceeds 11 ppg. -Lost might following any suddenly surge pressure. - Induced fractures should be suspected if circulation loss occurs and adjacent wells do not suffer from lost circulation.

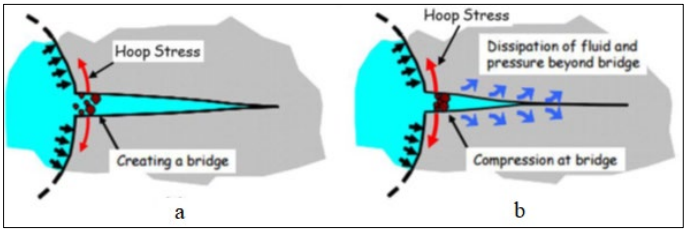


Figure 2. Schematic of Stream Caging (Alberty and Mc Lean, 2004)

As explained before, deviating from literal meaning, drilling reinforcement do not increasing the strength of the surrounding drilling rock. It is a engineered that changes the pressure distribution in the environment boreholes and fractures and/or internal fluid pressure distribution Fracturing to increase the fracturing pressure of the well, i.e. Maximum sustained pressure for a well without significant fluid loss. Encouraged by field applications and laboratory tests showing that fracture pressure can be significantly increased by well reinforcement companies, engineers and researchers have tried Develop an explanatory model of drilling physics strengthen. Drilling reinforcement significantly increases fracture pressure companies, engineers and researchers have tried developed an explanatory model of drilling physics strengthen.

Induced fractures usually happen in the weakest pore of the formation. The requirements of fracture formation are pressure and a surface on that the pressure can act so as to generate a force large enough to be applied to the fractured formation (Howard and Scott, 1951). Depending on the depth, the resulting cracks are straight or deviated. When the depth is about 2,800 feet or less, horizontal displacement fract typically develop because of the vertical stress (overload) is less than the horizontal stress. Vertical fract occur at depths greater than 3,500 feet because the overburden is above the deviated stress (Ramirez et al., 2005). Figure 3 shows a typical stress distribution in a wellbore.

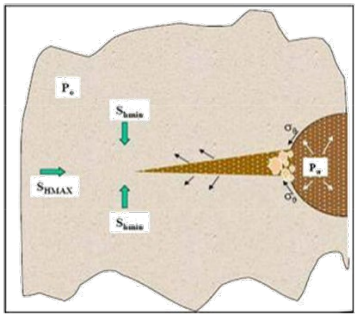


Figure 3. Stress Distribution in a Wellbore (Kumar, 2011)

Drilling procedure is designed to maintain downhole pressure to minimize high ECD that leading to induce fracture. Maintaning can be determined by drilling fluid properties consist of density, viscosity and fluid loss. ECD is a measurement combined effect of the downhole hydrostatic pressure plus frictional pressure created when the fluid irculates.

$$\text{ECD} = \frac{PTotal}{(0.052\ x\ xTVD)} \quad (1)$$

As the nearest of the fracture gradient is sufficient know in a true casing shoe, simply formation integrity test was performed instead. Formation integrity test was applied by a pressurize the formation to determined pressure without fracturing the formation; is used to testing cement integrity. Combination of leak off test and formation integrity test were used to generate certain depth trends that used to prediction of fracture gradient for another well.

LOST CIRCULATION METHODS

Lost circulation methods are also used before or when the prevalence of the matter. The answer is so classified within preventive and remedial respective. These methods showed a number of the lost circulation management methods that utilized in the oil and gas.

1. Usage of lost circulation materials A vary of bridging or plugging materials is out there for reducing lost or restoring circulation whereas drilling or well cementing. Selection of the lowest common multiple to use during a given case depends on value and accessibility in a given drilling space. Lost circulation material is designed to accomplish more than one purpose (Jiao and Sharma, 1996).
2. Wellbore Strengthening. The lost circulation solution corresponding to wellbore strengthening has to evolved. Method of bridging fractures with lost circulation material evoked within the formation is observed as wellbore strengthen. All impact of wellbore strengthening is to extend the fracture gradient of the formation. It could provides a chance to use higher mud weight windows for drilling operation, especially, for weak and depleted reservoirs.
3. Drilling Methods;
    - Aerated Drill. Aerated fluid is describe as a fluid (in the shape of mists and foams) consist of liquid (usually water), air. Aerated muds are tenuity fluids which will be to maintain a minimize overbalance whereas drilling probable loss zones corresponding to depleted formation that are competent and low pressured.
    - Blind Drill. When lost zones are vary and troublesome to be crammed and sealed by lost circulation materials, the suggested narrow is to blind drill through the formations are counter-back, once that casing is about (Redden et al. 2011).
4. Advanced Technology of Drilling. Casing while drilling uses surface and downhole components to allow regularly oilfield casing to be used as component of the drillstring, allowing the well to be drilled and cased at the same time (Tessari et al. 1999). A top drive rotates the casing from the surface. Drilling fluid is circulated up the annulus between the casing and the wellbore and down the casing internal diameter (ID). The purpose of this method is to minimize non productive time (NPT) and running casing periods in situations where partial and complete fluid losses make traditional difficulty of drilling and costly (Gallardo et al. 2010).

GUIDELINES TO SOLVE LOST CIRCULATION

Extra plans (extra casing joints, adequate water source for operation) for knowing problem, such as those connected to infill drilling, and unexpected cases, those experienced in exploration drilling, must be included in the drilling program. Before make a dcision to case loss zone, sidetrack the loss interval, or even terminate the project, a fast economic estimate of much investment will through into resolving problem of the loss returns should be made.

This critical to keep human mistake to a bare minimum as a contributing component in lost circulation. Drilling activities that have been found as contributing to lost circulation include: Excessive ECDs are produced as a result of high rate of cisrculation (Preventive technique, use the minimum rate circulation will be clean the wellbore adequately). When tripping, fail to break circulation on a regular basis is a mistake (Preventive technique: Break circulation for several times on the running in hole and rotating the drillstring; when at the bottomhole, slow break circulation, and raising the drillstring as usual). High-velocity string running (Preventive technique: Running string gently, and do not reaming down quickly with the pumps on.). By optimizing mud weight and drilling procedures, you can ensure the equivalent circulating density and equivalent static density are always within the safest drilling fluid weight window during drilling, connection, and tripping. When drilling formations that are prone to losses, it is recommended to add correctly size lost circulation material in the drilling fluid (depleted formations). This approach can aid in the prevention of seepage losses and can also be beneficial to the environment. When tripping, failure to interrupt circulation on an everyday basis could be a massive mistakes (Preventive techniques: Break circulation many times on the manner to opening and rotating drillstring; when at the bottomhole, break circulation slowly, and pull the string). High-speed string running (Preventive technique: Running string gently, and do not reaming as fast as with the mud pumps on.) By optimizing mud weight and drilling procedures, you will make exactly that the equivalent circulating density and equivalent static density are perpetually among the safe mud weight window throughout operationg, make-up and break-out, and tripping. Once drilling formation that are susceptible to losses, it is suggested to feature properly sized least common multiple within the drilling fluid (depleted formations). This approach can aid in the bar of flowing losses and may even be helpful to the environment.

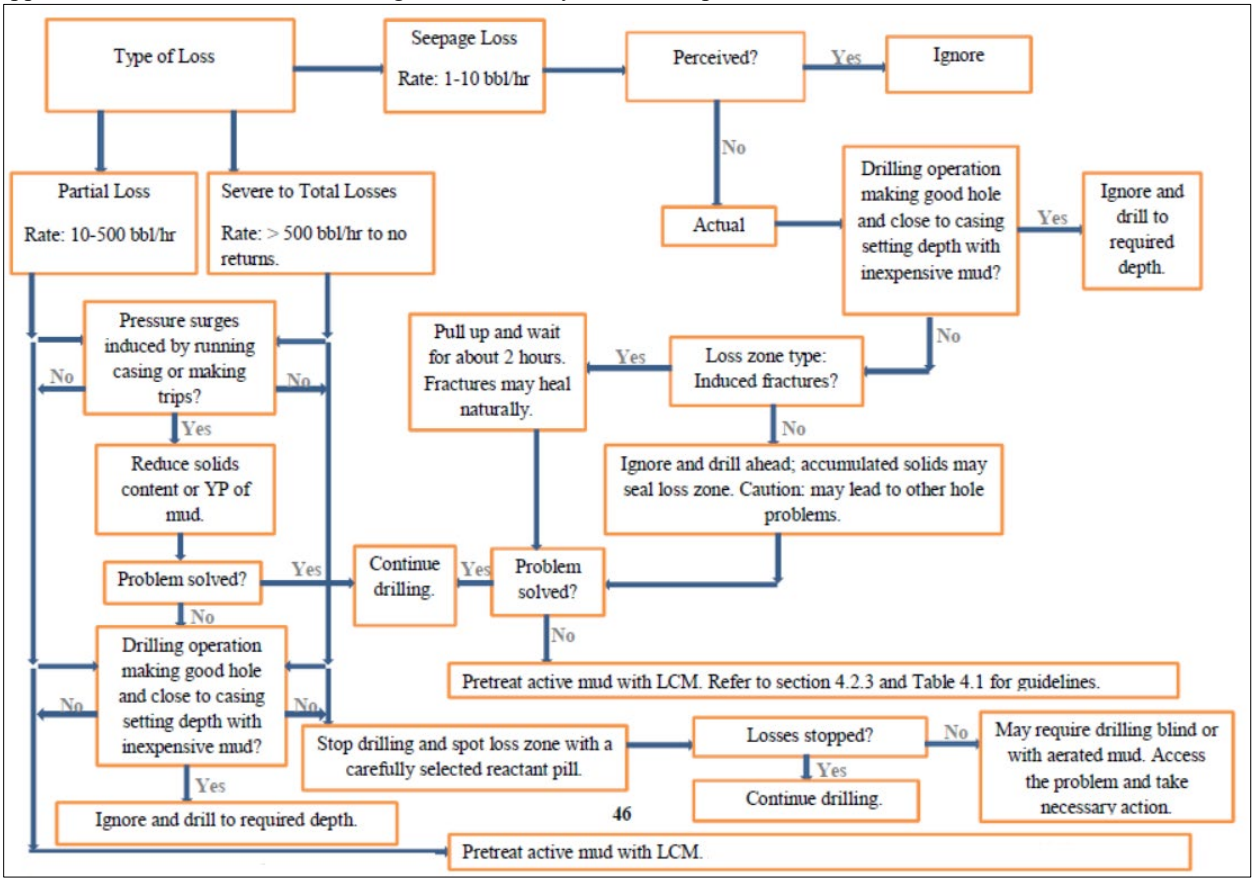


Figure 4. Lost Circulation Flow Chart Guideline

Avoid the usage of coarse lost circulation material which require by-passing the solids manipulate device this can bring about fines bridging up within side the dust and viscosity, ECD which can also additionally result in greater losses. Lost circulation material are available many one of a kind forms; every possesses a selected gain consisting of drilling cost, available and impact loss of it on drilling mud properties. However, the overall performance of a lost circulation material is primarily based totally on its concentration, particle size distribution (PSD), and shape. Size lost circulation material to regulations in bottom hole assembly; seek advice from the

producer or directional drilling services company if needed. When the enclosure is running or intermittently losing circulation due to pressure fluctuations as the downhole pressure exceeds the downhole pressure, the cycle is interrupted after one stroke, as is the case it is recommend to lower the solids content or lower the yield point (YP) value of the pores, drilling fluid instead usage of LCM. Overall properly economics can have an impact on whether or not to pre-deal with the machine with lost circulation material or cope with the trouble while/if the trouble occurs. Get prepared for properly manipulate conditions while managing losses.

CONCLUSIONS

Related on this experience, are made successfully management or bridging of lost circulation depending in many aspects consist of pressure, temperature of wellbore, depth, and fracture zones size. There is no guarantee way to completely solve the loop problem, but there are many methods can be used to prevent it from happening, especially those by inducing fractures when drilling a damaged formation. Technically guide are develope it when used with related to flowchart can be functionally a fast guideline for minimize and reduce the matter of lost circulation during drilling.

ACKNOWLEDGMENTS

Wish to acknowledge Universitas Trisakti of Petroleum Engineering for giving a permission to publish this work.

REFERENCES

1. A. Kumar, S. Savari, D. Whitfill, D. Jamison, Application of Fiber Laden Pill for Controlling Lost Circulation in Natural Fractures. AADE national technical conference and exhibition, Houston, Texas, USA,(2011) pp. 12–14.
2. A.H. Hassani, A.M. Al-Ajmi, H. Heydari, A novel model for wellbore stability analysis during reservoir depletion. J. Nat. Gas Sci. Eng. 35 (2016), 935–943.
3. B. Guo, and J.M. Rajtar, Volume Requirements for Aerated Mud Drilling, paper SPE 26956 presented at the SPE Latin America/Caribbean Petroleum Engineering Conference held in Buenos Aires, (27-29 April 1994).
4. C. Ivan, J. Bruton, B. Bloys, How Can We Best Manage Lost Circulation? American Association of Drilling Engineeers (AADE) National Technology Conference, Houston, TX, (2003), pp. 1–3.
5. D. Jiao and M.M. Sharma, Mud-Induced Formation Damage in Fractured Reservoirs, paper SPE 30107 presented at the European Formation Damage Control Conference held in The Hague, The Netherlands, (15-16 May 1995).
6. E. Fidan, T. Babadagli, and E. Kuru, Use of Cement As Lost circulation material – Field Case Studies, paper IADC/SPE 88005 presented at the IADC/SPE Asia Pacific Drilling Technology Conference and Exhibition held in Kuala Lumpur, Malaysia (13-15 September 2004).
7. F. Growcock, N. Kaageson-Loe, J. Friedheim, M. Sanders, J. Bruton, Wellbore stability, stabilization and strengthening. In: Offshore Mediterranean Conference and Exhibition. Offshore Mediterranean Conference (2009).
8. G.C. Howard and P.P. Scott, AN ANALYSIS AND THE CONTROL OF LOST CIRCULATION, paper SPE 951171 presented at the Annual Meeting of the AIME held in St. Louis, Mo. (19-21 February 1951).
9. H. Gallardo, J.P. Cassanelli, S. Barret, P. Romero, and A. Mufarech, Casing-Drilling Technology (CwD) Mitigates Fluid Losses in Peruvian Jungle, paper SPE 139065 presented at the SPE Latin American & Caribbean Petroleum Engineering Conference held in Lima, Peru (1-3 December 2010).
10. J. Cook, F. Growcock, Q. Guo, M. Hodder, E.Van Oort, Stabilizing the wellbore to prevent lost circulation. Oilfield (2011) Rev. 2012, 4.
11. J. Redden, B. Carpenter, S. Polnaszek, B.. Bloys, and J. Headley, Lost Circulation Manual. MI-SWACO (2011).
12. M. Ramirez, A. Diaz, E. Luna, Y. Figueroa, T. Per-Bjarte, Successful Application of Synthetic Graphite to Overcome Severe Lost Circulation Problem in the Troublesome Foothills of Colombia, paper AADE-05-

NTCE-30 presented at the AADE National Technical Conference and Exhibition held at the Wyndam Greenspoint in Houston, Texas, (5-7 April 2005).
13. M.I. Magzoub, S. Salehi, I.A. Hussein, M.S. Nasser, A comprehensive rheological study for a flowing polymer-based drilling fluid used for wellbore strengthening. In: SPE International Conference and Exhibition on Formation Damage Control. OnePetro (2020a).
14. M.N. Al Awad, A New Approach for Understanding the Mechanism of Wellbore Strengthening Theory. Journal of King Saud University-Engineering Sciences (2020)
15. M.W. Alberty and M.R. Mclean, A physical model for stress cages. In: SPE Annual Technical Conference and Exhibition. Society of Petroleum Engineers, (2004)..
16. M.W. Sanders, J.T. Scorsone, and J.E. Friedheim, J.E., High-Fluid-Loss, High-Strength Lost Circulation Treatments, paper SPE 135472 presented at the SPE Deepwater and Completions Conference held in Galveston, Texas, USA, (5-6 October 2010)
17. R. Abbas, H. Jarouj, S. Dole, Effendhly, H. Junaidi, H. El-Hassan, L. Francis, L. Hornsby, S. McCaith, N. Shuttleworth, K. van der Plas, E. Messier, T. Munk, N. Nadland, R.K. Svendsen, E. Therond, and S. Taoutaou, *A Safety Net for Controlling Lost Circulation*. Oilfield Review (winter, 2003/2004).
18. S. Osisanya, *Course Notes on Drilling and Production Laboratory*. Mewbourne School of Petroleum and Geological Engineering, University of Oklahoma, Oklahoma (Spring 2002).
19. T.G. Byrom, Casing and Liners for Drilling and Completion: Design and Application. Elsevier (2014).