Reducing Lost Circulation Problem by Using Rice Material

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ABSTRACT

Drilling fluid loss during drilling operation is undesirable, expensive and potentially hazardous problem.

Nasiriyah oil field is one of the Iraqi oil field that suffer from lost circulation problem. It is known that Dammam, um-Radoma, Tayarat, Shiranish and Hartha are the detecting layers of loss circulation problem. Different type of loss circulation materials (LCMs) ranging from granular, flakes and fibrous were used previously to treat this problem.

This study presents the application of rice as a lost circulation material that used to mitigate and stop the loss problem when partial or total losses occurred.

The experimental work included preparing drilling fluid, which is selected to be water based mud. Amount of loss for rock samples was measured where the percentage of losses of drilling mud were 46.25% and 96.96% as well as the percentage of improvement in curing of lost circulation were calculated after rice adding. Rice materials addition was done by tow stages: a) Adding 24 Ib/bbl of fine rice and 1 Ib/bbl of course rice gave improvement in curing from 30.67% to 100%. b) Adding 24 Ib/bbl of fine rice and 6 Ib/bbl of course rice gave an improvement in curing equal to 92.12%.

Keywords: lost circulation materials, drilling fluid, treatment, rice.

تقليل مشكله فقدان سائل الحفر باستخدام ماده الرز

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الخلاصة

فقدان سائل الحفر اثناء عمليه الحفر هي مشكلة كبيرة ومكلفة وخطيرة في نفس الوقت. حقل الناصرية النفطي هو أحد الحقول العراقية التي تعاني من هذه المشكلة. الدمام وام رضومه والطيارات وشيرانيش والهارثه من أكثر الطبقات التي يفقد فيها سائل الحفر في هذا الحقل. استخدمت العديد من المواد المعالجة للفقدان في حقل الناصرية سواء كانت مواد حبيبيه او ليفيه او صفائحيه.

في هذه الدراسة تم استخدام ماده الرز كماده معالجه لفقدان سوائل الحفر للتخفيف من حدة وإيقاف مشكلة الفقدان عند حدوثها بشكل جزئي أو كلي.

التجارب المختبرية شملت إعداد سائل الحفر مائي القاعدة حيث تم قياس مقدار الخسارة لنماذج صخريه تم قياس النسبة المئوية لفقدان طين الحفر فيها حيث كانت نسبه الفقدان 46.25% و96.96%. وكذلك تم حساب النسبة المئوية للتحسن في علاج حالات الفقدان بعد اضافه ماده الرز.

تم استعمال الرز على مرحلتين أ) اضافه 24باوند/برميل من الرز الناعم مع 1باوند/برميل من الرز الخشن حيث اعطى نسبه تحسن تتراوح من 30.67% الى 100%. ب) اضافه 24 باوند من الرز الناعم مع 6 باوند/ برميل من الرز الخشن والذي اعطى نسبه تحسن92.12%.

الكلمات الرئيسية: مواد معالجه الفقدان، سائل الحفر، معالجه، الرز.

1. INTRODUCTION

Routine practice to stop lost circulation is to add LCMs to the mud system to fill the fractures and vugs created while drilling. Although using these materials decreases the loss rate, the method is not consistent because materials are selected by trial and error. **, Salehi,** and **Nygaard, 2011**. Further, it is not clear to what extent loss rate can be decreased and how long LCMs are stable and effective in the loss zone.

The complexity of diagnosing lost circulation arises for several reasons, including limited knowledge of a loss mechanism when it occurs and of an appropriate strategy to mitigate it. **, Ghalambor et al., 2014**.

1.1 Causes of Lost Circulation Zones

Lost circulation is widely classified into two major categories based on the cause of the loss: **, Toreifi, et al., 2014**.

a) Natural losses occur in formations with natural permeability, usually fractures or voids.

b) Induced losses occur in an induced fracture, caused when hydraulic forces within the well bore exceed the formation strength. The frequency and severity of natural and induced losses vary around the world and are dependent on both the geology and the drilling conditions. **‹Baker Hughes INTEQ., 1999**.

1.1.1 Natural Losses

Natural losses can occur within three formation types:

a) Formations with conductive natural fractures or faults.

b) Losses into high matrix permeability formations (gravels and coarse sands).

c) Vugular or cavernous formations

1.1.2 Induced Losses

Induced losses result from the creation and extension of fractures by the drilling operation. Induced fractures result when the equivalent circulation density (ECD) of the drilling fluid exceeds the fracture gradient. This causes the formation to part, opening a fracture. Unlike natural losses that first occur at the bit, induced fractures occur at the weakest exposed formation. Induced fractures happen, when the ECD is increased, while weighing up, tripping, drilling too fast, or as the result of a mud ring or other situation causing a temporary pressure surge that breaks down a weak formation. The location of the fracture is often closer than the hole bottom. This attribute of induced fractures complicates the identification of the loss zone and the placement of materials designed to combat the problem. **, Baker Hughes INTEQ., 1999**.

1.2 Lost Circulation Severity

Loss circulation may be categorized based on the intensity and type of circulation loss zone. Although no generally accepted standard exists to classify the problem in terms of intensity, operators usually use the following terms to describe the severity of the fluid loss.

1.2.1 Seepage loss

Although some studies concluded that seepage loss may happen in any formation**, Messenger, 1981**. seepage loss mostly occurs in porous and permeable formations where a firm low permeability mud cake cannot be formed. Under static conditions, seepage loss rate may vary from in a range of 10 to 20 bbl/hr and under dynamic conditions, less than 10% of the fluid may be lost. **, Sweatman, et al., 1997**. Some studies have limited seepage loss to less than 10 bbl of fluid loss per hour. **, Cowan, et al., 1991**. Others have defined the upper limits of 25 bbl/hr and

10 bbl/hr for the seepage loss when drilling with WBM and OBM, respectively. **, Nasirov S., 2005**.

1.2.2 Partial loss

Partial loss of fluids happens in unconsolidated sands and loose gravels as well as zones containing one or more small natural or induced fractures. , **Baker Hughes INTEQ., 1999**. Some studies concluded that partial losses rarely occur in induced fractures. [**Robert, 2007**] The loss rate of 20 to 50 bbl/hr in static conditions and 20% to 50% of the drilling fluid in dynamic mode happens during a partial loss of fluids. In another study, ranges of 25 to 100 barrels per hour and 10 to 30 bbl/hr have been presented as the partial loss range for WBM and OBM, respectively.

, Nasirov, 2005. In another classification, all fluid losses in a rate between 10 bbl/hr and 25 bbl/hr have been categorized as partial circulation losses. **, Ivan, 2003**.

1.2.3 Severe losses

Severe lost circulations happen in long sections of unconsolidated sands and larger fractures. Fluid is lost at a rate of 50 to 150 bbl/hr and 50% to 100% in static and dynamic conditions, respectively during severe lost circulation. In some studies, severe losses have been defined as loss rates of fluid loss higher than 500 bbl/day. Severe losses have also been described as conditions in which more than 30 barrels of oil-based muds or 100 bbl of WBMs are lost per hour**, Nasirov, 2005**. and in another work **, Ivan, 2003**. all circulation losses over 25 bbl/hr have been classified as severe losses.

1.2.4 Total losses

Total fluid loss, however, occurs when all the mud flows into a formation with no return to surface. Unless the fracture is induced, losses normally cannot be stopped by pumping conventional LCM pills. The alternative reinforcing plug or cement. However, a pill of LCM often is the first choice since, if successful, it delivers a quick response and it's easy to apply. If this pill does not heal the fracture, a reinforcing plug or cement should be set across the loss zone. **, Bp Lost Circulation Manual, 1995**.

2. PRESENT WORK

The present work is about the use of rice as LCM to plug core samples that have large natural fractures. **Table 1** summarize the core samples specifications. Tests were performed in closed loop circulating system **Fig. 1** which was designed and built for this purpose. It has four main components: a circulating system, a mud loss collector, a pressure measurement system and a dynamic mud cell.

A detailed description of the used system showed in **Fig. 2**, which give a schematic diagram of different components.

3. METHODOLOGY OF THE EXPERIMENTS PERFORMED

The tank was used for draining the fluid. The tank was filled with 100 liters of mud. A Gear pump (flow rate =12 m^3/hr., Hp = 7.5, Pressure =110 psi) was used to circulate the mud from the mud tank at 100 psi, across the face of the core that is held in the dynamic mud loss cell. The pump rate was adjusted to maintain a flow velocity across the face of the core of 0.22 m/sec, the circulating temperature was maintained at 56°C (reservoir temperature). The volume of mud loss was collected in a cylinder to compute the cumulative volume of the mud loss with time. The pressure across the sample and the drilling mud was recorded using a pressure gauge. The dynamic mud loss cell was consisted of a core holder similar to standard Haussler core holder where the core was placed inside a rubber sleeve and the two sealed together by means of overburden pressure applied by hydraulic hand pump. A thermal jacket was used to surround the Haussler cell to provide and maintain the desired temperature.

The experiments were carried out as follows:
1- The core sample was sited in Haussler Cell and the pressure of cell (500) Psi was applied around the rubber sleeve to prevent any fluid by-pass.
3- The Haussler core holder was connected with thermal jacket to raise the temperature to reservoir formation temperature (56C°).
4- The prepared drilling mud was then circulated across the face of the core. The out flowing mud loss was collected in a fraction sampler.
5- The volume of mud loss was measured with time.
6- Repeat the tests by adding different concentrations of Rice to the drilling fluid.
7- These steps were repeated for each core sample and for each fluid type.

The composition of the mud systems that were used are presented in **Table 2** and their properties presented in **Table 3.**

4. RESULTS AND DISCUSSION

Tables 4 and **5** and **Fig. 3** to **6**, illustrate that adding of 15 lb/bbl of fine rice to the base mud gave a reduction in loss percentages from 96.96% to 80.03% and from 46.25% to 26.26%, which means an improvement in curing percentages from 17.46%–43.23%. Adding 24 Ib/bbl of fine rice and 1 Ib/bbl of coarse rice together gave a reduction in loss percentage from 96.96% to 67.22.% and from 46.25% to 0%, which means an improvement in curing equals to 30.67% to 100%. Finally, adding 24 Ib/bbl of fine rice and 6 Ib/bbl coarse rice together gave a reduction in loss percentages from 96.96% to 7.64%, which means an improvement in curing equals to 92.12 % when loss was stopped and sealing was achieved after 3.6 minutes only. **Fig. 7 and 8** illustrate the core samples (represent partial (46.25%) and complete(96.96%) losses) before and after treatment.

1. CONCLUSIONS AND RECOMMENDATIONS

1. The size of the treated material is very important, for example adding (24) Ib/bbl of fine rice with (1) Ib/bbl of coarse rice together gave an effect (30.67%), while adding (24) Ib/bbl of fine rice with adding (6) Ib/bbl of coarse rice gave 92.12% effective when the amount of the loss is 96.96%. that mean (5) Ib/bbl of coarse rice gave change in improvement from 30.67% to 92.34%. Therefore, a mixture of coarse granular (of rice) material and a fine material (of rice) can be considered as an optimum treatment to stop loss of drilling fluids.
2. To achieve the complete treatment of lost circulation, the concentration of rice is preferably in the range from about 50 percent to about 60 percent by weight of the total materials from drilling mud can be considered.
3. The results revealed a strong relationship between fluid loss and the sealing efficiency, i.e. lower fluid loss gave higher sealing efficiency. For example, 1 Ib/bbl of course rice with 24 Ib/bbl of fine rice gave an improvement in curing (30.76%) for (96.96%) losses while same quantity of same material gave treatment (100 %) for (46.25%) losses.
4. For future studies its recommended to take the size, dimensions and specific gravity of rice and PH of drilling mud which contains the treatment materials into consideration.

5. The factors of the mixing and mixture waiting time before treatment should be take an interest for any similar study since the time factor have an important effect on changing the mixture properties

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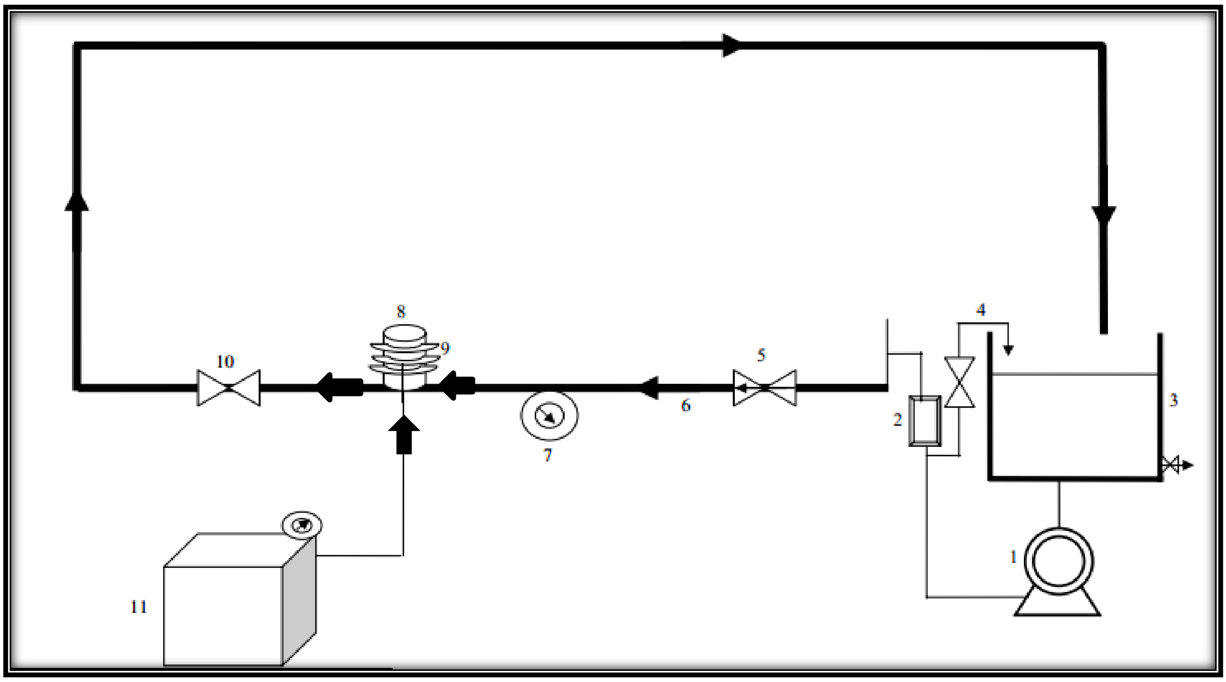
Nomenclatures

bbl/hr= barrel per hour
ECD= equivalent circulation density
FV=funnel viscosity
Ib/bbl= pound per barrel
LCMs= lost circulation materials

OBM= oil based mud
PV=plastic viscosity
WBM= water based mud
YP= yield point

Figure 1. Closed loop circulating system.



1. Gear pump, 2. Flow meter, 3. Tank, 4.By pass line, 5. One-way valve, 6. Entrance length, 7.gauge pressure, 8.Core holder, 9. Thermal jacket, 10. Valve, 11. Hydraulic hand pump

Figure 2. Schematic diagram of flow system.

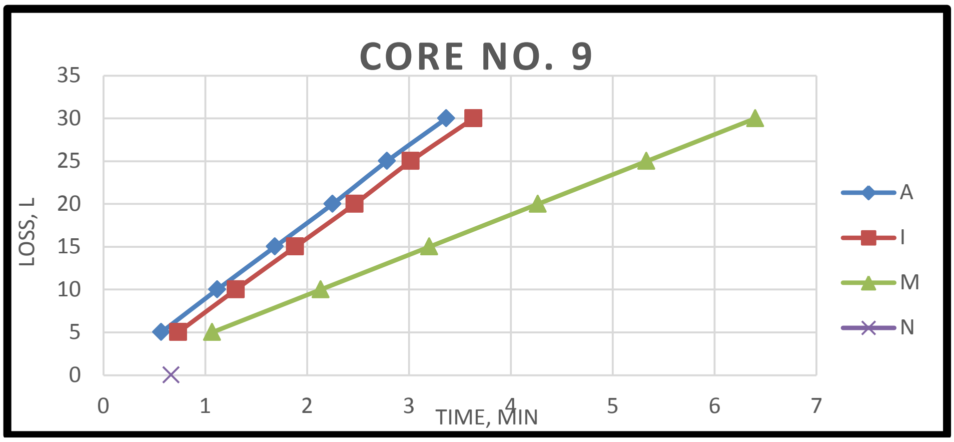


Figure 3. Relationship between muds loss and rice additions as a function of time for partial loss (46.25%).

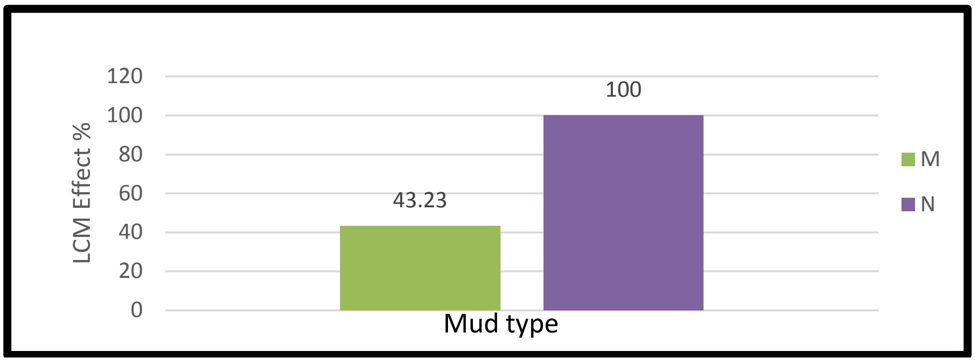


Figure 4. Effect of rice additions on improvement percentage for partial loss (46.25%).

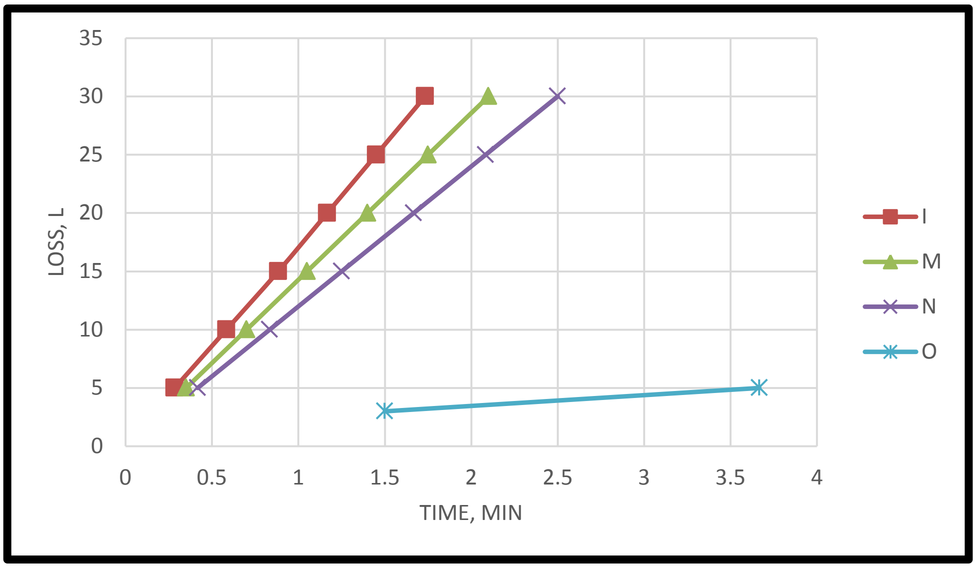


Figure 5. Relationship between muds loss and Rice additions as a function of time for complete loss (96.96%).

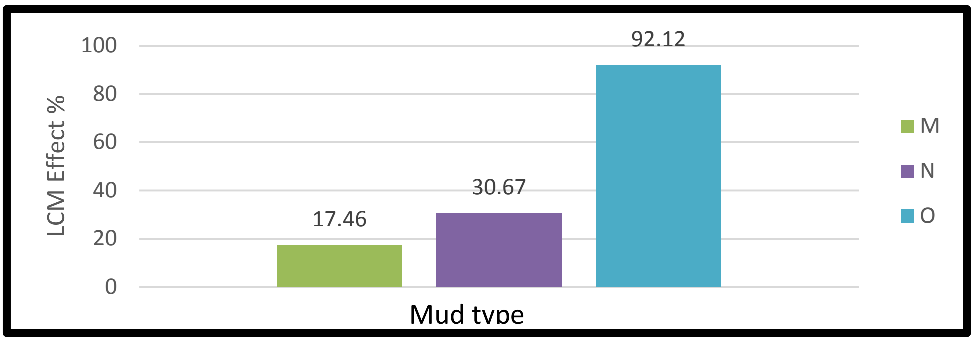


Figure 6. Effect of rice additions on improvement percentage for complete loss (96.96%).

Fig.7. core sample with partial losses (46.25%).

Fig.8. core sample with complete losses (96.96%).

Table 1. Summarized specifications of cores

Core No	Formation	Depth m	Lithology	Diameter in	Length cm	Permeability md	Losses rate%	Losses type
1	Dammam	625	Limestone Dolomite, bf-light grey at the top, bf, beige porous vuggy.	1	2.5	413.4715	46.25	partial
2		506				1104.85	96.96	complete

Table 2. Composition of the used drilling muds with rice material in ppb of water

Fluid No.	Bentonite	Barite	Soda Ash	Caustic soda	Rice (F)	Rice (C)
I	25	25	0.75	0.5		
M	25	25	0.75	0.5	15	
N	25	25	0.75	0.5	24	1
O	25	25	0.75	0.5	24	6

Table 3. Physical Properties of Drilling muds.

Fluid No.	Density (lb/gal)	$Ø_{600}$	$Ø_{300}$	Pv (cp)	Yb (lb/100ft^2)	FV (sec)
I	9.16	36	24	12	12	44
M	9.19	46	35	11	24	57
N	9.26	52	36	16	20	69
O	9.40	95	75	20	55	88

Table 4. The test results of muds loss for partial loss (46.25%).

1				
Mud type	**Mud Loss %**	**Loss type**	**Reduction in loss %**	**Improvement percentage%**
I	46.25	Partial	0	0
M	26.26		19.99	43.23
N	0		46.25	100

Table 5. The test results of muds loss for complete loss (96.96%).

2				
Mud type	**Mud Loss %**	**Loss type**	**Reduction in loss %**	**Improvement percentage%**
I	96.96	Complete	0	0
M	80.03		16.93	17.46
N	67.22		29.73	30.67
O	7.64		89.32	92.12