

Designing an Icm program for drilling depleted zones

[Design](#)



Questions concerning the content of this paper should be directed to the individuals listed as author's of this work. Abstract Prior to the drilling of the depleted Simile sand in the Barr well, we were asked to investigate:

Prevention of whole-mud loss by fracturing of the formation; No reduction of production capacity from the formation as the result of addition of the LLC:

The use of mechanized cellulose fibers to prevent mud loss to the Simile sand; No Increase In formation damage as the result of use of the LLC: and these fibers are used as lost circulation material; Facile clean-up of the filterable and LLC in the

Simile sand if necessary. The depth of invasion of mechanized cellulose fibers used as a lost circulation material in a synthetically mud, particularly as related to the anticipated 5-inch perforations in the Simile sand; and The ability to dissolve filterable with the ponderousness's alkaline hypochlorite (33% sodium hypochlorite and 15% KOCH) in the Simile sand.

The results of our investigation suggest that: Mud loss could occur if only the fine-size LLC is used (and not the coarse or extra coarse); Production capability is not expected to be affected by the presence of the LLC; Very limited to no formation damage from the LLC is expected in the near-hellebore region, and no damage is expected past the first h inch; and Clean-up of the LLC is highly unlikely to be possible with currently available methods.

Our investigation indicates that: The fine cellulose fibers suggested by the O lessen fluid loss due to seepage into a permeable zone, but do not provide protection against mud loss in even a and coarse products would do so; The

presence of fine mechanized cellulose fibers in synthetic-based mud does not adversely affect permeability (up to 2 D); The depth of invasion of these fibers is only a few ore volumes, at most; and The hypochlorite treatment is not a viable option for clean-up of the fibers in a synthetic-based mud environment.

A 13.5 lb/gal SUB weighted up from the field value of 12.5 lb/gal with barite was obtained from the mud company; this weight is in the range expected to be used for drilling the Simile sand. We used 8 lb/bulb LLC; this means that the LLC is only 2%, on a weight basis, of the total weight of the solids (8 lb/bulb out of a total of 8 lb/bulb + 310 lb/bulb of barite, the latter number obtained from the recipe supplied by the service company). Thus, on a purely statistical basis, the probability of significant invasion by the LLC is very low.

Introduction The drilling program for the Barr project involves drilling through the partially depleted, seafaring Simile sand. The plan is to add a mechanized cellulose lost circulation material (LLC) to the synthetically drilling mud (SUB) in this zone in an effort to reduce fluid loss to the formation. The concerns for the Simile sand portion of the well are the following: Experimental Work The mechanized LLC product recommended for testing was Highland Glen Fine, which, according to measurement results provided by the manufacturer has the following particle size striation: did dad dad Highland Glen Fine 6. Microns 35 microns 126 microns Barite 1.6 microns 15 microns 50 microns 2 R. L. MCNEIL, S. C. CLINGER (I. E. , 10% of the Highland Glen Fine particles are smaller than 6.7 microns, while 10% of

the Barite particles are smaller than 1.6 microns) In contrast, the barite used by the mud company has a considerably larger fraction of fine material; thus, more barite would be expected to enter the formation than would be the LLC material.

Ceramic disks of nominal pore sizes 5 and 10 microns, obtained from the manufacturer, were used for the permeability tests. According to a representative of the distributor of the disks, the 5- and 10-micron disks could be expected to have permeability around 500 MD and 2 D, respectively; these values are in the range expected for the Simile sand. Prior to use, the disks were saturated with seawater, in accord with standard practice. Microscopic examination of the 5-micron disks showed that they were uniform in composition and color (white).

In contrast, the 10-micron disks were crystals, small black particles, and patches of yellowish color of unknown origin scattered randomly throughout the disk; in addition, these disks had the appearance of an oil impregnation that extended through about half their thickness. Felicitates were prepared using standard HTTP (high temperature, high pressure) cells, the disks, and a differential pressure of 500 SSI over 30 minutes at 1 SPOOF. Return permeability in the production direction were measured using standard procedures, with 5 SSI differential pressure.

Solubility of the mechanized cellulose in HCl was stated by the manufacturer as 35%. We weighed 0.5 g of Highland Glen Fine in 10 ml of acid. Our tests were carried out by heating the LLC/acid at OFF for eh hours in a 5-gallon oil bath and leaving the samples to LOL off in the bath overnight. The samples

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were vacuum filtered through a Whitman 42 filter. Results and Discussion Fracture Sealing. Highland Glen Fine and Highland Glen Coarse were added individually to synthetic-based mud at about 40 lb/bulb and placed above a 3' 8-in. Hick steel disk into which had been cut a slit 0.02 in. wide and about 2 in. long. The sample containing the fine LLC did not plug the "fracture" at all, while the sample containing the coarse LLC plugged the "fracture" within about 30 seconds and did not allow more than a few tenths of a c of additional fluid loss over the remainder of the 30-minute test. We infer from these results that the SUB with DADE 2001 only Highland Glen Fine will not seal even a 0.02-in. wide fracture and so will allow the loss of whole mud if such a fracture occurs.

In contrast, we infer that the use of the Highland Glen Coarse material will substantially prevent whole-mud loss. Best Practices on LLC by service companies recommend the use of an equal blend of fine, medium, and coarse materials, since the addition of too many fine particles may affect the drilling fluid rheology. Addition, larger particles may be more effective at sealing larger fractures or formation openings. Permeability Changes. Measured values of the production permeability, relative to the initial values, were 105% for the 5-micron disk after cake deposition and 77% for the 10-micron disk. Equivalence of the initial and final values for the 5-micron disk indicates that the cake simply lifted off the disk and suggests that there was no formation damage. The slightly reduced production permeability of the 10-micron disk after deposition of the cake indicates that the cake did not entirely lift off and suggests the possibility of some formation damage; the

source of any damage could not be identified with certainty from this experiment. Invasion.

The following approaches were used to establish whether any of the cellulose passed through the disk and whether any lodged in the disk: The presence of particulate matter in the effluent from the HTTP test would indicate that either barite or cellulose had passed through the disk and, therefore, that we might anticipate invasion of at least h in. In the Simile sand. To test whether any particulate matter was in the effluent, we made use of the Tyndale effect, in which a very bright light is placed at right angles to the angle of observation; floating particulate matter would be detectable as bright spots in the liquid.

No bright spots were observed in the effluent from either disk. We have attempted to capture this with a photograph; unfortunately, since placing the bright light normal to the observation angle yielded a very bright spot in the middle of the picture, we chose to illuminate the fluids from four different angles. Figure 1 shows the result. DESIGNING AN LLC PROGRAM FOR DRILLING DEPLETED ZONES A direct test of the invasion of the cellulose into the disks (into the formation) involved breaking the disks, adding a few drops of concentrated sulfuric acid to the broken surfaces, and observing the result through a microscope.

Concentrated acid is known to dehydrate sugars, leaving residual carbon. The effect on solid sugars is similar to the action of the "snakes" used to celebrate July 4 .) A control test involved adding sulfuric acid to a sample of cellulose; the fluid immediately turned dark brown, and the residual solid

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turned black. Figure 2 shows the acid-treated cellulose. Figures 3 and 4 show a blank 10-micron disk (Figure 3) and a 10-micron disk on which a cake had been deposited (no invasion at all, as evidenced by the absence of any dark color except at the surface, Figure 4).

Figures 5 and 6 show a detailed view of the two disks. No difference is observed between the two 10-micron disks. Thin sections of the two 10-micron disks were analyzed microscopically, with a sample of Highland Glen Fine for comparison. No difference was detected between the two disks, and no LLC was detected in the disks. We conclude from these experiments that no significant invasion of either the 5-micron or the 10-micron disk took place. The above interpretation is in accord with expectations based on the sizes of the LLC particles.

Less than 2% of the LLC has particle size less than 1/3 the pore diameter in the 5-micron disk; for the 10-micron disk, the value is 5%. Clean-up of Mechanized Cellulose Fibers. By the manufacturer's statement that some of the fibers were oil-wet and some were water-wet. In order for decomposition to take place, the (water-soluble) agent causing the decomposition had to get to the surface of the fibers. This might or might not be straightforward for the water-wetted portion, but would be extremely difficult for the oil-wetted portion. The manufacturer of the fibers indicated a maximum solubility in HCl of only 35%.

Our results show a somewhat higher solubility: Wet% Acid Wet% Solubility of Highland Glen Fine 5 47 10 20 57 Filtration of the cellulose in De-ionized water took much longer (4 hours), while the acid-treated samples filtered in <https://assignbuster.com/designing-an-lcm-program-for-drilling-depleted-zones/>

about 15 minutes. It is likely that the cellulose in water gels and passes through the filter during the extended filtration. The residual felicitates after the filtration show coarsely textured fibers on the filter paper for the citrated sample, while the particles on the untreated cake appear finer. Apparently the acid has dissolved the smaller fraction of the LLC.

In a filterable made from a synthetic-based mud, the expectation would be that more than a small fraction of the fiber would be oil-wetted, making it inaccessible to acid. In any case, acid will have no effect whatsoever on the barite present as the major solid component of the filter cake. In work on other projects, we have found that felicitates made from laboratory synthetic-based mud can be broken most readily by mixtures of mutual solvents (solvents which dissolve in both hydrocarbons and water), very specific surfactants, and concentrated acid (to remove the acid-soluble weighting agent).

There is no chemical reason for the mud containing the LLC to behave any differently from the mud without the since its solubility is around 35%. As part of another project, we have conducted tests of a variety of nonionic and ionic surfactants in eater for breakup of felicitates. None of the tests has so far been unequivocally successful. The manufacturer suggested use of a cocktail of 33% NAACP (sodium hypochlorite) and 15% KOCH, which had been shown in lab tests of only the Highland Glen Fine in water to solubility up to 97% of the cellulose fiber material.

This approach, too, was rejected. Olefins are well known to be susceptible to oxidation, far more so than are polysaccharides. Thus, the chance of a

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runaway reaction was too great to allow even a laboratory test of this approach. In the field, the well would have to be cleaned thoroughly of ANY opposites of whole mud before a reaction such as this was even attempted. Our conclusion is that neither acid solubility nor treatment with hypochlorite is a viable method for removal of the LLC in a filterable made from a synthetic-based mud.

Further, such a cake has been found to be very stable under treatment with surfactants in water, the standard procedure for cleaning a hole prior to cementing. In our experience, cake breakup can be accomplished only under the action of a swiftly moving fluid consisting of an expensive mutual solvent, preferably containing a surfactant specific to the particular synthetic-based mud, and acid. As noted above, even if the majority of the LLC were made water- 4 wet, the probability is that at most only 35% of it would dissolve.

Size Changes Upon Exposure to water. We investigated the behavior of this material in water, the concern being that the LLC might expand over time and so block the formation. The experiment involved placing slide, adding a few drops of water, and observing particles in both the water-covered and the dry zones for a couple of hours. We also allowed the LLC to sit in water for a month; the results were the same as for the 2-hour test. In Figure 7, the very bright area on the top eight is the dry zone of the slide, and the brown area is the water-covered zone.

Three points are particularly important. The LLC is made up of some fibrous material but also contains a substantial amount of solid, non-bulbous

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material. 2. The fibers in the water-covered zone are actually about the same size and are present in about the same concentration as those in the dry zone. Unfortunately, the photograph does not show this very well (nor was this shown well in any of the other eleven photographs we took of this slide). We did notice that the fibers did not appear to grow or lose shape over the course of the experiment.

Compare the lengths and widths of the few fibers visible in the water-covered zone with those in the dry zone. 3. The solid, non-bulbous particles did not lose their shape during the two hours (or a month) of exposure to water; instead, they remained well defined. In addition, they appear to be about the same size as those in the dry zone. Thus, we do not believe that these particles expanded as the result of their exposure to water.