Journal of Petroleum Science and Engineering 165 (2018) 962–969

Contents lists available at ScienceDirect

Journal of Petroleum Science and Engineering

journal homepage: www.elsevier.com/locate/petrol

# Performance of polyethylene and polypropylene beads towards drill cuttings transportation in horizontal wellbore

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ARTICLE INFO

*Keywords:*
Drilled cuttings
Drilling mud
Water-based mud
Polymer beads
Polyethylene beads
Polypropylene beads

ABSTRACT

Drilled cuttings removal is critical in drilling operations, especially in horizontal wells. These cuttings are postulated to be among the possible causes of many costly complications, such as mechanical pipe sticking, bore hole instability, drag and torque. This study proposes a new approach that uses polymer beads as a mud additive to improve cutting transportation. In this study, the effect of the concentration of polyethylene (PE) and polypropylene (PP) polymer beads on cuttings transport efficiency (CTE) in water-based mud in a horizontal wellbore was investigated. Experiments were conducted in a lab-scale flow loop equipped with a 13-ft (3.96 m) test section consisting of a concentric annulus acrylic outer casing (2 in. ID) and a static inner PVC drill string (0.79 in. OD). A total of 150 tests were conducted using 10 ppg water based mud (WBM) with 1%–5% by vol. Concentrations of polymer beads (PE and PP) were added at a range of 8–9.5 cp. Six different sizes of drilled cuttings ranging from 0.5 to 4.0 mm were used as samples to determine the CTE at a constant 0.69 m/s average annular fluid velocity. The results revealed that CTE increased with the increase of polymer bead concentrations and that PP is better compared to PE overall due to its low density. The highest CTE was recorded at a 5% concentration of water-based mud polypropylene (WBMPP), which is approximately 96% for cutting sizes of 0.50mm–0.99 mm.

## 1. Introduction

Drilling is one of the most important jump-start in any oil and gas industry. This stage has been characterized as being very challenging, risky and necessitating extremely high capital investment. In addition, pipe stacking which causes poor wellbore cleaning is also experienced, Costa et al. (2008) predicts that this challenge will continue despite good industry practices. Yu et al. (2004) further assert that an immediate remedy is required to avert this problem which increases operational costs and drilling time as well as reduced quality of directional, horizontal, extended reach and multilateral oil and gas wells. Experiments conducted by Massie et al. (1995) showed that approximately 70% of the time lost as a result of unexpected events was associated with stuck pipe. Additionally, Hopkins and Leicksenring (1995), presented that one-third of the problems of stuck pipe were due to inadequate hole cleaning. The movement or transportation of drilled cuttings during deviated and horizontal drilling is mainly influenced by the force of gravity. The solids tend to be transported with a lower velocity compared to fluids since solids are denser than fluids. This results in drilled cuttings depositing and building up at the bottom annulus space of the wellbore thus causing drilling problems. This deposition phenomenon is usually referred to as cuttings bed. A controversial debate on methods which optimize hole cleaning properties has recently evolved; Saasen and Loklingholm (2002). Onuoha et al. (2015) reported that water-based mud with PP beads increase more than 10% of CTE for small size drilled cuttings (1.0–1.2 mm). From this study the following questions were addressed; does PE perform better than PP in terms of cuttings transport efficiency? Is there any significant difference between PE and PP in the application drilling fluid for cuttings recovery? These questions thus form the basis of this study in effort to understand the effect of polymer concentration (PE and PP) towards cuttings transport efficiency.

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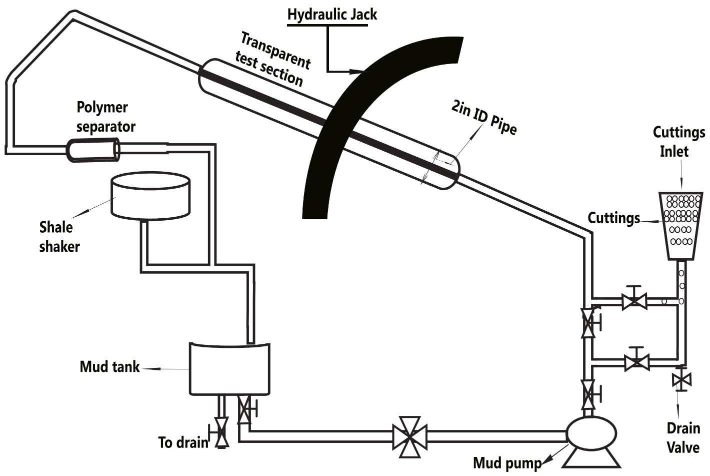
https://doi.org/10.1016/j.petrol.2018.01.075
Received 8 June 2017; Received in revised form 26 January 2018; Accepted 30 January 2018
Available online 5 February 2018
0920-4105/




(a) Schematic of the flow loop Rig Simulator

(b) Lay out of the Flow Loop Rig Simulator.

**Fig. 1.** Flow loop rig simulator.

## 2. Experimental set up and methods

### 2.1. Experimental flow loop

The experimental flow loop was designed to achieve the objective of this study, which was to investigate the performance of polyethylene and polypropylene beads in water-based muds on cuttings transport efficiency in a horizontal wellbore. The flow loop (Fig. 1) was built with a concentric annulus test section of 13 ft (3.96 m) long acrylic pipe, with 2 inch ID that acted as a simulated wellbore/casing. The non-rotating inner drilled pipe was built with 0.79 inch PVC and sealed at both ends.

The annulus test section was set at 90° throughout the experimental works. The mud was circulated using a 2-hp variable speed centrifugal pump with the capacity of about 200 L mud tank installed connected to the pump. At the separation tank, there were two separation systems incorporated in the flow loop simulator to separate polymer beads (2 mm mesh container) and cuttings (200 $\mu$m wire mesh) respectively. The transported cuttings were collected after seven minutes of circulation process and six minutes of recirculation to clean up any cuttings residue inside the flow pipes before a new run can be made.

### 2.2. Preparation of simulated drill cuttings

In this study, six sized of cuttings were used as solid particles or simulated drilled cuttings as shown in Table 1. The sands were taken from Desaru Beach, Johor Bahru and its size was in the range between 0.50 and 4.00 mm with irregular in shapes. The density of sands was about 2.56 g/cc, which was determined using the standard (ASTM D4253-00, 2006) testing method.

The preparation of the sand samples (simulated cuttings) started with cleaning it with tap water to ensure that no mud or other particles stuck around the sand particles. They were then sieved in a sieve shaker and dried in an oven.

### 2.3. Polymer beads

Two types of polymer beads, namely, polyethylene and polypropylene beads, were used in this study, as shown in Fig. 2. These polymer beads were added into the basic water-based mud respectively by percent volume in order to determine their effect on cuttings transport and to compare their performance on cuttings transport efficiency. Both types of polymer beads were sieved accordingly in the size range of 2.8–4.0 mm. The technical properties of both types of polymer beads are shown in Table 2.

**Table 1**
Simulated drilled cuttings size.

| Sand No | Size Diameter (mm) |
|---|---|
| Sand 1 | 0.50–0.99 |
| Sand 2 | 1.00–1.39 |
| Sand 3 | 1.40–1.69 |
| Sand 4 | 1.70–1.99 |
| Sand 5 | 2.00–2.79 |
| Sand 6 | 2.80–4.00 |

### 2.4. Measurement systems

During the experimentation process, the following instruments were used for obtaining a good and reliable data acquisition and these include; ultrasonic flow meter, mud viscometer, low pressure low temperature filter press, mud balance, electronic weighting balance, electronic vernier calliper and a rheometer which was used to measure the rheological properties of the drilling fluids.

### 2.5. Preparation of drilling fluids

The preparation of drilling mud and the measurement of mud rheological properties were done according to American Petroleum Institute (2009) recommended practices, before it was tested in the flow-loop rig simulator. The basic water-based mud (WBM) was prepared by mixing 15.0 g of bentonite (viscosities), 85.3 g of barite (weighting agent), 0.25 g of soda ash (pH control) and 1 g of starch into 350 ml of distilled water (continuous phase) based on the Scomi'[1] formulation. For the water-based mud with five different percentages of weight of polyethylene beads added, the similar mud formulation was used. However, the only thing that changes was the weight of barite added since the introduction of polymer beads has reduced the mixture of mud density due to its light weight i.e., less dense than water. The addition of barite has kept the density constant, which is 10 ppg. The resulted mud formulations and rheological properties for five different concentrations of polyethylene beads and polypropylene (based on % of volume) added were tabulated in Tables 3–5 respectively.

[1] http://www.scomigroup.com.my/GUI/pdf/drilling_fluid.pdf.