Potential of Welan Gum as mud thickener

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Abstract Welan Gum (WLG) is a biopolymer employed in food industry as thickener. This paper evaluates its performance as mud thickener and filtrate loss additive. Tests revealed that WLG, even at low concentrations, effectively boosted mud viscosity and yield point. Tests were also conducted on carboxymethyl cellulose (CMC), a commonly used mud thickener. Compared with CMC, WLG is more effective as mud thickener, but WLG has no effect on mud filtrate loss. WLG mud was also tested at elevated temperature. The viscosity of WLG mud was stable under short-term and long-term heating. Sodium chloride and calcium chloride were added into WLG mud. Test results showed WLG mud was resilient to sodium and calcium contamination. WLG has good potential as mud thickener under high temperature and high salinity conditions.

Keywords Welan Gum · Drilling mud · Thickener · Salinity

Introduction

Drilling mud plays a critical role in the success of oil and gas drilling operations. It cools and lubricates drill bit, controls well pressure, transports and suspends cuttings. Mud must have a relatively high viscosity to effectively suspend cuttings. Therefore, mud thickeners are often added into mud to boost mud viscosity. The most widely used mud thickeners are carboxy methyl cellulose (CMC) and hydroxy ethyl cellulose (HEC) (Rabia 1985).

Welan Gum (WLG) is produced by fermentation of sugar by bacteria of the genus *Alcaligenes*. The molecule consists of repeating tetrasaccharide units with single branches of L-mannose or L-rhamnose (Rakitsky and Richey 1992). The molecular structure is presented in Fig. 1. It was reported that WLG exhibits good viscosity retention at elevated temperature, as well as in the presence of sodium chloride (Chen 2007). WLG was patented to be used as cement additive (Allen et al. 1991), as well as water shutoff chemical (Hoskin et al. 1991). However, limited research has been conducted to investigate its effect on mud properties. The objective of this study was to unveil potential of WLG as a mud additive.

Material and method

Welan Gum was provided by BDL Chemical Company in China. CMC (medium viscosity) was produced by Gumpro Chemical Company in India. Other materials included Bentonite clay, NaCl, CaCl₂, and tap water. Mud viscosity was measured with OFITE 8-speed viscometer. It measures the torque under 8 different rotational speeds, ranging from 600 to 3 rpm. The readings can be easily translated into mud plastic viscosity, mud yield point, and mud apparent viscosity. Mud filtrate was measured with OFITE Model 14030 filter press. Mud passes through a filter paper under 100 psi of pressure, and the filtrate volume after 7.5 min of filtration is recorded. Pressure is provided by a cartridge containing pressurized carbon dioxide. Mud was prepared with high-speed mixer. The mud viscometer, filter press and mud mixer are all industry-standard devices.

Totally, 23 tests were conducted. The detailed test matrix is given in Tables 1 and 2. First, a base mud was

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Fig. 2 Effect of shear rate and WLG concentration on mud viscosity

Fig. 4 Comparison of WLG mud and CMC mud

Fig. 3 Effect of WLG concentration on mud properties

was also conducted on WLG mud. Excessive filtrate loss during drilling can result in wellbore instability. Mud filtrate is often incompatible with formation fluid and can cause formation damage. The base mud without WLG had a filtrate of 10 mL after 7.5 min, while the mud containing 1 g/L WLG had a filtrate of 9 mL. WLG has no significant effect on filtrate loss.

The mud containing 1 g/L WLG was heated to 70 °C for 30 min, to test the stability of WLG at elevated temperature. The test data in Fig. 5 show good stability of WLG at high temperature. The mud properties after heating remained almost unchanged.

The mud samples were also tested for long-term stability under high temperature. The mud samples aged at 85 °C for 6 h, then cooled down to room temperature and mud properties were measured. The test data are presented in Table 3. For the mud containing WLG, both mud YP and AV increased after aging. This is probably due to the formation of weak gel at high temperature. On the other hand, the mud containing CMC showed reduction in YP and AV after aging. Comparison shows WLG is resilient to long-term heating.

Fig. 5 Behavior of WLG mud at elevated temperature

Table 3 Properties of mud after aging tests

Tested fluid	Test condition	PV (cP)	YP (lb/100 ft ²)	AV (cP)
Base mud + 0.5 g WLG	25 °C	9	28	23
Base mud + 0.5 g WLG	Aged at 85 °C for 6 h then cool to 25 °C	9	39	29
Base mud + 0.5 g CMC	25 °C	9	12	15
Base mud + 0.5 g CMC	Aged at 85 °C for 6 h then cool to 25 °C	8	8	12

A good mud thickener must maintain stable viscosity under the attack of sodium and calcium ions. NaCl and CaCl₂ were mixed into WLG mud and the mud properties were measured. The test results are shown in Figs. 6 and 7. It can be seen that WLG is resilient to both sodium and calcium ions. The key parameters (YP, AV and PV) all remained quite stable after addition of salts.

Fig. 6 Stability of WLG mud at varied concentrations of NaCl

Fig. 7 Stability of WLG mud under varied concentrations of CaCl₂

Conclusions

Welan Gum is excellent as mud thickener, but not effective in reducing mud filtrate loss. Compared with CMC, WLG is

more effective in boosting mud viscosity. WLG mud maintains stable viscosity under high temperature and long-term heating. Sodium and calcium ions have minor influence on WLG mud viscosity.

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