Egyptian Journal of Petroleum (2014) xxx, xxx–xxx

Egyptian Petroleum Research Institute

Egyptian Journal of Petroleum

www.elsevier.com/locate/egyjp
www.sciencedirect.com

FULL LENGTH ARTICLE

Investigation of some locally water-soluble natural polymers as circulation loss control agents during oil fields drilling

A.M. Alsabagh [a], M.I. Abdou [a], A.A. Khalil [b], H.E. Ahmed [a], A.A. Aboulrous [a,*]

[a] *Egyptian Petroleum Research Institute, Nasr City, Cairo, Egypt*
[b] *Faculty of Science, Banha University, Egypt*

Received 6 January 2013; accepted 28 March 2013

KEYWORDS

Natural cellulosic polymer;
Permeability plugging tester;
Spurt loss;
Rheological properties

Abstract Eliminating or controlling lost circulation during drilling process is costly and time-consuming. Polymers play an important role in mud loss control for their viscosity due to their high molecular weight. In this paper, three natural cellulosic polymers (carboxymethyl cellulose, guar gum and potato starch) were investigated as lost circulation control material by measuring different filtration parameters such as; spurt loss, fluid loss and permeability plugging tester value according to the American Petroleum Institute (API) standard. The experiments were conducted in a permeability plugging apparatus (PPA) at a differential pressure of 100 and 300 psi, using 10, 60 and 90 ceramic discs. From the obtained data, it was found that the 0.1% from the carboxymethyl cellulose exhibited the best results in the filtration parameters among 0.3% guar gum and 0.6% potato starch. At the same time the carboxymethyl cellulose (CMC) enhanced the rheological properties of the drilling mud better than the two other used natural polymers in the term of gel strength, thixotropy, plastic and apparent viscosity. These results were discussed in the light of the adsorption and micellar formation.

1. Introduction

Oil-drilling fluids, more commonly known as drilling muds, are complex chemical systems that are essential for oil-drilling excavation. Among other functions, an oil-drilling fluid needs to carry drill cuttings to the surface of the well [1], support the walls of the well bore, protect the producing formation from damage, cool and lubricate the drill bit, prevent drill-pipe corrosion, facilitate the acquisition of information about the formation being drilled [2].

During the drilling of highly permeable, highly fractured and low pressured zones; loss of the drilling fluid because of the migration through formation is known as lost of circulation [3]. Trouble cost for mud losses, wasted rig time, ineffective remediation materials and techniques, and in the worst cases – for lost hole side tracks, bypassed reserves, abandoned wells, relief wells and lost petroleum reserves have continued in this century [4,5]. The risk of drilling wells in areas known to contain these problematic formations is a key factor in

* Corresponding author.
E-mail address: amany.aboulrous@yahoo.com (A.A. Aboulrous).

Peer review under responsibility of Egyptian Petroleum Research Institute.

ELSEVIER Production and hosting by Elsevier

1110-0621 © 2014 Production and hosting by Elsevier B.V. on behalf of Egyptian Petroleum Research Institute.
http://dx.doi.org/10.1016/j.ejpe.2014.02.005

decisions to approve or cancel exploration and development projects [6,7]. A wide variety of materials can be added to the drilling fluid to seal off the lost circulation zones [8,9].

Polymeric materials can reduce loss of circulation during drilling due to their viscosity as superabsorbent materials and rubber [10,11]. Cellulosic polymeric materials (as carboxymethyl cellulose, guar gum and starch) are available in abundance and low in cost [12]. **The carboxymethyl cellulose** (CMC) is a cellulose derivative with carboxymethyl groups ($-CH_2-COOH$) bound to some of the hydroxyl groups of the glucopyranose monomers that make up the cellulose backbone [13]. **The guar gum** is a polysaccharide composed of the sugars galactose and mannose. The backbone is a linear chain of β 1,4-linked mannose residues to which galactose residues are 1,6-linked at every second mannose, forming short side-branches [14]. **Starch** is a naturally occurring polymer of anhydroglucose units having α-1, 4 linkages [15]. It is the second most abundant biomass found in nature, next to cellulose [16], and consists of two major weight components. Chemically, it contains amylose linear polymer and amylopectin highly branched [17]. Physically, it has both amorphous and crystalline regions.

In this paper, three locally water-soluble cellulosic polymers were investigated as lost circulation control material depending on their rheological properties with water-drilling mud. Chemical composition of the three polymers should be used to discuss the obtained results.

2. Materials and techniques

2.1. Materials

The carboxymethyl cellulose and potato starch were purchased from Egyptian Morgan Company for chemicals. Guar Gum was purchased from MP Biomedical, Inc. The abbreviations and the chemical compositions for the used materials in this paper are shown in Fig. 1.

2.2. Preparation of water-based drilling fluids

The base component of the water-based mud was prepared by adding 350 ml of fresh water into a laboratory barrel then 22.5 g of bentonite was measured and poured into the fresh water while mixing using high-speed mixer for 20 min [18]. At the end of the mixing, the different investigated materials were added by different concentrations. When high permeable formations, with mean pore throat diameter of 10, 60 and 90 micron, are drilled with this local mud, a seepage loss occurs. The results are shown in Table 1.

2.3. Permeability plugging test (PPT test)

Lost circulation materials were evaluated by using fann permeability plugging apparatus [18,19]. The laboratory studies discussed here were carried out using the ceramic discs with mean pore throat diameter of 10, 60 and 90 micron as a filter medium at differential pressures 100 and 300 psi. The filtration parameters can be made from the data collected at 7.5 and 30 min intervals according to the following formulas [18]:

$$\textbf{PPT} = 2 \times V_{30\ \text{min}} \quad (1)$$

$$\textbf{SL} = 2 \times [V_{7.5\ \text{min}} - (V_{30\ \text{min}} - V_{7.5\ \text{min}})] \quad (2)$$

$$\textbf{SFR} = 2 \times [V_{30\ \text{min}} - V_{7.5\ \text{min}}]/2.739 \quad (3)$$

where; PPT is the permeability plugging tester value(ml); $V_{30\ \text{min}}$ (ml) is the total filtrate collected in 30 min.; **SL** is the spurt loss (ml); $V_{7.5\ \text{min}}$ (ml) is the filtrate collected in 7.5 min; and the **SFR** is the static filtration rate (ml/min$^{1/2}$)

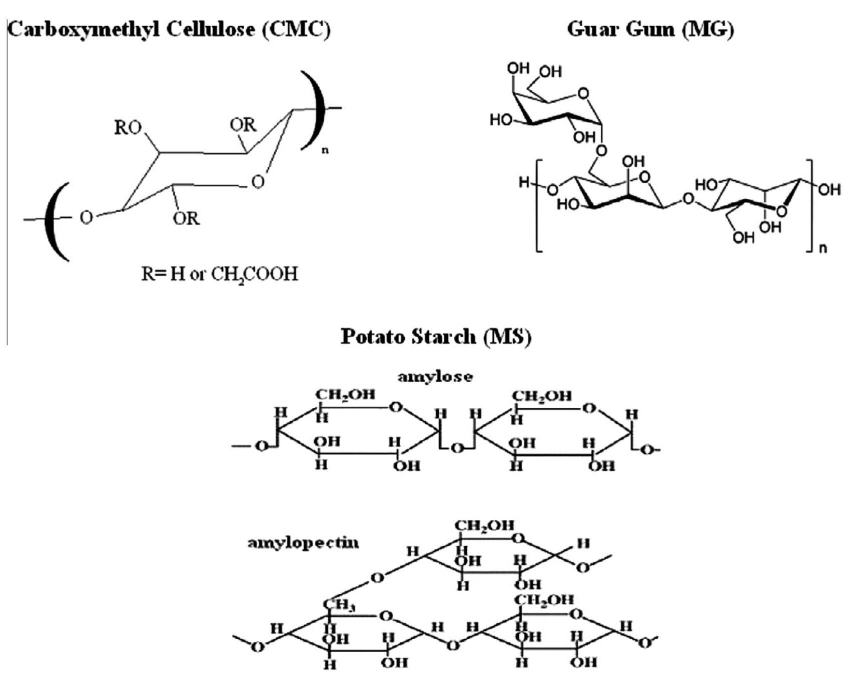

Figure 1 The abbreviations and the chemical structure of the used polymers.

Please cite this article in press as: A.M. Alsabagh et al., Investigation of some locally water-soluble natural polymers as circulation loss control agents during oil fields drilling, Egypt. J. Petrol. (2014), http://dx.doi.org/10.1016/j.ejpe.2014.02.005