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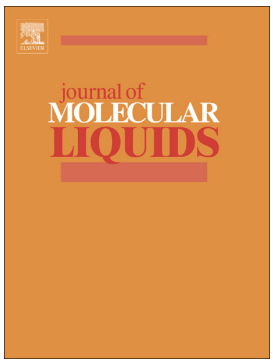

Effect of ionic strength on solution and drilling fluid properties of ionic polysaccharides: A comparative study between Na-carboxymethylcellulose and Na-kappa-carrageenan responses

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PII: S0167-7322(18)31295-9
DOI: doi:10.1016/j.molliq.2018.07.016
Reference: MOLLIQ 9337

To appear in: *Journal of Molecular Liquids*

Received date: 12 March 2018
Revised date: 2 July 2018
Accepted date: 3 July 2018

Please cite this article as: Liszt Y.C. Madruga, Paulo C.F. da Câmara, Nívia do N. Marques, Rosangela de C. Balaban , Effect of ionic strength on solution and drilling fluid properties of ionic polysaccharides: A comparative study between Na-carboxymethylcellulose and Na-kappa-carrageenan responses. Molliq (2018), doi:10.1016/j.molliq.2018.07.016

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Effect of ionic strength on solution and drilling fluid properties of ionic polysaccharides: a comparative study between Na-carboxymethylcellulose and Na-kappa-carrageenan responses

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Abstract

Natural polymers are widely used in different industries, mainly due to their hydrophilic features, which make it possible to solubilize them in water or absorb a large amount of it. Polysaccharides are the most widely used hydrophilic polymers, mainly because of their non-toxicity, biodegradability, compliance with environmental regulations and thickening behaviour in water. Knowledge of polymer performance in different aqueous media is essential to ensure optimal use in a desired application. In this study, the stability of sodium kappa-carrageenan and sodium carboxymethylcellulose stability was investigated in saline and basic aqueous media, as well as their applicability in drilling fluids. The ionic strength effects of the aqueous media containing Na^+, Mg^{2+} and Ca^{2+} on the rheological properties of the polymer solutions were evaluated by varying the salt concentration, pH and temperature. The rheological properties and drilling fluid filtrate volume were evaluated by varying salt concentration and pH. The kappa-carrageenan solutions and drilling fluids were scarcely influenced by ion addition, at pH 7 to 10, even at higher salt concentrations, but highly influenced at pH>11. On the other hand, carboxymethylcellulose solutions and their drilling fluids were more affected by the presence of salt and pH changes, with a greater decline in viscosity and increase in filtrate volume. This behaviour was interpreted as conformation adopted by the kappa-carrageenan chains in the presence of ions, indicating that this polymer is a good candidate for drilling fluids in oil well operations.

Keywords: Rheology; Ionic strength; Na-Kappa-carrageenan; Na-Carboxymethylcellulose; Drilling fluids.

1. Introduction

Polysaccharides are obtained largely from higher plants and algae, or by bacterial fermentation, such as cellulose derivatives and gums [1–4]. Carboxymethylcellulose (CMC) (**Fig. 1a**) is a widely applied polysaccharide in the biomedical, food and oil industries, primarily because it is biodegradable, nontoxic, and inexpensive. Moreover, CMC contains ionizable carboxyl groups, which may be in the form of carboxylates, depending on the pH of the medium. Upon ionization, the hydrodynamic volume increases and interacts with solids dispersed in the system, such as clays, thereby raising the viscosity of the solution [5–10].

CMC is commonly used in drilling fluids, but its interaction with salts in the aqueous medium can screen the ionic charges of this polymer, reducing its viscosity and filtration control. Rheological behaviour and filtration volume are two critical drilling fluid properties that determine the success of well operations. However, if they are unstable, these properties can cause problems during drilling operations, such as fluid loss to the rock formation, fracturing, kick or even total loss of the oil well; therefore, polymers that can resist salinity and maintain these properties are desirable [1,2,4,11].

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