SYNTHESIS OF SODIUMCARBOXYMETHYLGUAR USING CHLOROACETIC ACID FOR HYDROFRACKING TECHNOLOGY

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ABSTRACT

As the demand of fossil fuel and other energy sources is increasing day by day with a gradual decrease in their levels, the attention is now shifted towards the shale gas exploration and production. The method and the procedure is described for the synthesis of Guar gum derivative used in Hydraulic Fracturing Technique (HFT) which is used in Oil and Natural Gas Production. The technique is routinely used in the oil and gas industry to improve or stimulate the recovery of hydrocarbons from underground formations. HFT is typically employed to stimulate wells which produce from low permeability underground formations. Guar gum is a natural polymer with a high viscosity and used as a thickener in number of fields which includes textile, paint, food and others. It is found that the viscosity of Guar gum powder can be gradually increased with the substitution of hydroxyl groups in its structure. The derivative prepared is used in simulating those wells for effectively increasing the production of oil and gas, most importantly Shale gas. The derivative was prepared and the yield was compared with the standard Guar gum sample and waSs found to be in agreement with the literature.

Keywords - Guar Gum; Hydro Fracking Technology.

1. INTRODUCTION

Shale gas is natural gas which is obtained within the shale formations in trapped conditions inside the rocks[1]. Shale gas is typically a dry gas primarily composed of methane in terms of its chemical constitution. Three factors have contributed to its quick and rapid development: improved horizontal drilling, advances in hydraulic fracturing, and, perhaps the most important one, rapid increment in natural gas prices in the last several years as a result of significant supply and demand pressure [2]. The primary differences between modern shale gas development and conventional natural gas development are the extensive uses of horizontal drilling and high-volume hydraulic fracturing. According to a recent DOE report, the use of horizontal drilling has not introduced any new environmental problems. A hydraulic fracture is formed when a fluid is pumped down the well at high pressures for short periods of time. The high pressure fluid exceeds the rock strength and opens a fracture in the rock. Proppant, usually sand or other coarse particles carried by the high viscosity fluid, which is the Guar gum derivative in this case, is pumped into the fractures, and the mixture fills the fracture.

The viscosity of the mixture must be sufficient at this point in the process to prevent the settling of the proppant particles. The pressure is then released, allowing closure of the fracture onto the fluid/proppant mixture. After the treatment, the proppant remains in the created fracture in the form of permeable pack that serves to keep the fracture open.[3] These proppant packs form conductive pathways for the hydrocarbons to flow into the wellbore, which will allow more extensive production at higher flow rates than otherwise possible. Leaving the gel in the fracture zone would cause formation damage by decreasing oil or gas production. To complete the process, the fracturing fluid must be recovered from the formation.

A well-known method used to recover or remove the fracturing fluids from the created fracture is to degrade the fluid chemically or/and thermally, then to flush it from the fracture back to the surface by the clean-up step (flowing back the well) [4].

Carboxymethyl guar (CMG) is typically formed by derivatizing the guar seed endosperm (referred to as split)[5]. Guar splits are prepared directly by separating the seed coats from beans. The splits are typically covered with aqueous caustic solution to form an alkoxy guar intermediate, which is treated with Sodium Hydroxide and Chloroacetic Acid in an amount necessary to get a desired NaCMG. NaCMG is very efficient derivative over natural guar gum powder. Apart from oil and gas industries it can have many applications in fields like textiles, paint and gardening.

2. Experimental Procedures

2.1 Preparation of Sodium Carboxymethyl Guar (NaCMG) from Chloroacetic Acid

Chemicals required :- Guar gum, chloroacetic acid, propanol , sodium hydroxide, methanol were purchased from Piyush chemicals ,Ahmedabad.

Apparatus like mechanical stirrer, oven ,weighing balance and glasswares required were also purchased from Piyush chemicals, Ahmedabad.

The guar gum had an average molecular weight (Mw) of 1.053×106 g/mol. NaCMG was first synthesized from guar gum and CAA under heterogeneous conditions following a slight modification of the method reported by T. Schult for the synthesis of carboxymethyl cellulose. 7.5 g of Guar gum was swollen in 125 mL of 2-propanol/water (87wt% 2-propanol) for 30 min with constant stirring at 100 rpm at room temperature of 28 ˚C under atmospheric pressure . After adding 1 g of NaOH dissolved in 25ml of DI water over a period 30 min at atmospheric conditions, the mixture was allowed to react for 1h at room temperature. Then a solution of 0.67 g chloroacetic acid was added which can be varied depending upon the Degree of Substitution desired, in 7 ml of 2-propanol and left for 1 h to react. The temperature of the reaction was then raised to 70°C during 1 h. The reaction was then allowed to proceed for another hour at 70°C. The mixture was allowed to cool to room temperature before it was filtered. The solid was washed with 80% (v/v) methanol/water and then was soaked in 80% (v/v) methanol solution for 30 min to remove inorganic salts. Then the pale yellow colour product was isolated by filtration, washed with bulk methanol, and dried in an oven at 60°C overnight. The yield found to be 4.18 g in an appreciable amount. Further the product can be characterised using spectroscopic methods.

Fig 1a) Guar gum powder b) Experimental setup c) NaCMG pellets

3. Conclusion

The above procedure describes a method for synthesis of NaCMG from Guar gum using Chloroacetic Acid. The same can also be prepared with the help of Sodium Chloroacetate. In both the cases the hydroxyl group of guar gum is being substituted with the acetate group. Replacing the hydroxyl group with the acetate group can increase the viscosity of the powder to up to 10 times which finds a very useful application to simulate low pressure shale gas wells or to increase its productivity. The viscosity of the prepared sample can be measured using Redwood Viscometer and the degree of substitution or the extent to which substitution has taken place can be measured using a) by first acidifying the solution and then titrating against a proper base, b) by Nuclear Magnetic Resonance test, c) by FT-IR technique and others. The derivative is also utilized to simulate oil wells to recover oil from secondary or tertiary wells.

4. REFERENCES

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