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FULL LENGTH ARTICLE

Preparation and evaluation of some esteramides as synthetic based drilling fluids

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Abstract Some hexanamide-mono and di-linoleniate esters were prepared by the reaction of linolenic acid and hexanamide (derived from the reaction of hexanoic acid and diethanolamine). The chemical structure for the newly prepared hexanamide-mono and di-linoleniate esters were elucidated using elemental analysis, (FTIR), H ^{1}NMR and chemical ionization mass spectra (CI/Ms) spectroscopic techniques. The results of the spectroscopic analysis indicated that they were prepared through the right method and they have high purity. The new prepared esters have high biodegradability and lower toxicity (environmentally friendly) so they were evaluated as a synthetic-based mud (ester-based mud) for oil-well drilling fluids. The evaluation included study of the rheological properties, filtration and thermal properties of the ester based-muds formulated with the newly prepared esters compared to the reference commercial synthetic-based mud.

1. Introduction

Drilling for oil and gas in extreme condition is under considerable time and cost pressures and new technologies are constantly being developed. Recently, drilling fluids had to satisfy higher technical criteria and uphold safety standards and environmental protection [1]. Drilling fluids were used in large quantities by the oil and gas industry in order to optimize on-and-off-shore drilling operations, when wells such as (oil, gas and geothermal wells) were drilled using rotary well-drilling equipments. The flow of drilling mud performed a number of functions, the most important of which are transporting the cuttings to the surface, balancing the subsurface, cooling, lubricating & supporting part of the weight of the drill bit & the drill pipe, cement or seal the walls of the drill hole, holding the drilling cutting on suspension when the drilling is stopped and forming the hydrostatic head and thus serving to control the flow of high pressure gas, oil or water. Over a long history of on-land and off-shore drilling operations two types of drilling fluids had been used, water-based drilling fluids (WBDs), non-aqueous-based drilling fluids (NABDs) and/or oil-based drilling fluids (OBDs). Although principally due to the lower cost aqueous or water-based mud was most commonly used as drilling fluid. More costly oil-based muds were used which were usually more stable than the water-based mud (when drilling a deep well at high temperatures) [2]. Oil-based mud was

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more advantageous to use when drilling into subterranean formations which contain water swellable clays in as much as being damaged by water contact. Because of their comparatively lower cost and good availability, crude oil petroleum and diesel oil had been used in the formation of oil-based mud [3]. All such petroleum-based oils used for drilling mud contain relatively large amounts of aromatics and at least a substantial concentration of n-olefins both of which may be harmful or toxic to animal and plant life. The drilling industry had developed several types of synthetic-based muds (SBMs) that combine the desirable operating qualities of the oil-based mud, lower the toxicity and environmental impact qualities of the water-based mud. It could also, improve the drilling efficiency without polluting the subsurface structures.

Synthetic-based fluids are drilling fluids whose base fluid consisted of non-water soluble organic compounds and where neither the base fluid nor the additives were of petroleum origin. Thus, they are environmentally friendly, have high biodegradability and have lower toxicity. Synthetic based fluids were classified into four general categories: synthetic hydrocarbons, ethers, esters and acetals. Ester-based drilling fluids had been recognized for providing the best environmental performance of any synthetic based fluids and also they are fully biodegradable fluids. The rheological properties, the thermal stability and the filtration of the synthetic based mud were the most frequently used methods for selecting the best synthetic ester-based mud [4,5].

2. Material and experimental techniques

2.1. Preparation of hexanamide

Hexanoic acid (1 mol) was added to diethanolamine (1 mol) in a three necked flask equipped with Dean-Stark apparatus in the presence of (0.02 mol) sulfuric acid as a catalyst and xylene as a solvent. The temperature of the reaction was raised slowly up to 50 °C, nitrogen gas was passed in with continuous stirring. The reaction mixture was heated with continuous stirring until a theoretical amount of water was collected. The product was purified by washing with (5%) sodium bicarbonate solution followed by petroleum ether (b.p. 40–60 °C The product obtained was N,N-Bis(2 hydroxyethy) hexanamide or caproic diethanolamide (A) (Fig. 1) a yellow oily product obtained after collecting 18 g of water [6–8].

Infra-red spectrum of the product was carried out by Fourier transform infrared (FTIR) spectrophotometer ATI Mattsonm infinity series TM, Bench top 961 controlled by win first TM V 2.01 software. (Egyptian Petroleum Research Institute).

2.2. Estrification of N,N-Bis(2 hydroxyethy) hexanamide

1 mol of the prepared fatty amide (Hexanamide) (A) was added to linolenic acid (1 mol or 2 mol) in a three necked flask in the presence of (0.005 mol) solid p-toluene sulfonic acid as a catalyst and xylene as a solvent. The reaction mixture was heated with continuous stirring until a theoretical amount of water was collected in the Dean–Stark tube. The products were purified by washing with (5%) sodium bicarbonate solution then dissolved in petroleum ether (b.p. 40–60 °C). The organic layer was separated and the solvent was distilled off [9–11]. The products obtained were:

1. N-(2 hydroxy ethyl) N-(ethyl linolineate)hexanamide (T_1) (Fig. 1) a pale brown oily product was obtained after collecting 18 g of water from the reaction.
2. N,N-Bis(ethyl linolineate)hexanamide (T_2) (Fig. 1) a brown oily product was obtained after collecting 36 g of water.

Elemental analyses were determined on a Perkin-Elmer 240C micro-analyzer in (Micro analytical center, Cairo University); Infra-red spectra of products were carried out by Fourier transform infrared (FTIR) spectrophotometer ATI Mattsonm infinity series TM, Bench top 961 controlled by win first TM V 2.01 software. (Egyptian Petroleum Research Institute), Molecular weight determinations were conducted

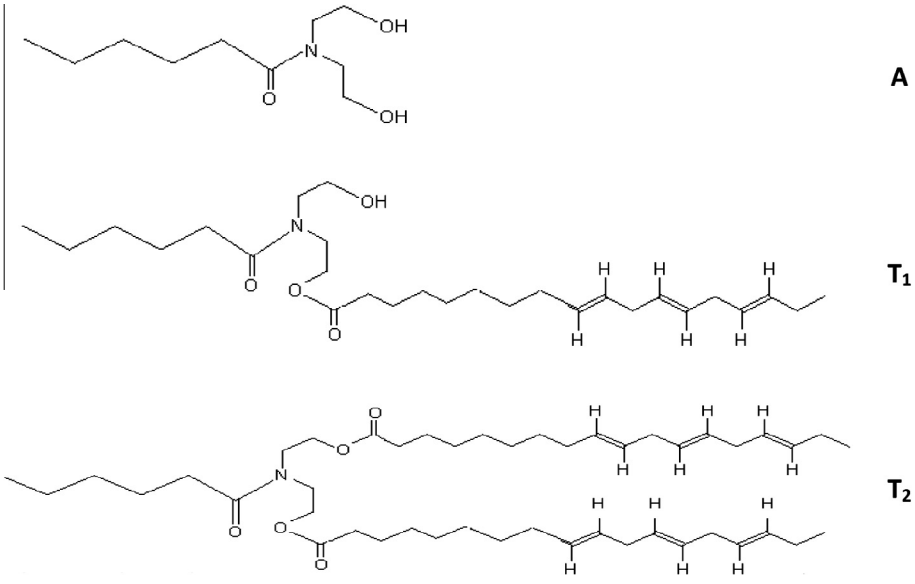

Figure 1 The chemical structures of the prepared compounds.