High-performance amine-functionalized activated carbon for water-based drilling mud modification to improve shale inhibition features

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■ Water
■ Unmodified mud
■ DETA-AC
■ KCl
■ Commercial shale inhibitor

Overview

Introduction

- Shales are sedimentary rocks that mainly consist of mica crystals having tetrahedral or octahedral sheets.
- Weak Van Der Waal forces hold these layers together.
- The clay with either limited or no water intake is denoted as “Passive clay”.
- If the clay uptakes a large quantity of water due to its humid surroundings it is called “active clay”.
- The water molecules adjust between the platelets to cause swelling and dispersion of the shales.

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Clay Swelling

- Swelling of the clays that can be divided into three key steps.
 - The water molecule enter the space between the sheets of the clay minerals and the clay swelling was observed to be the same as the diameter of the water molecules.
 - The next stage is known as hydration swelling in which the interlayer ions are hydrated and dehydrated.
 - Lastly, free swelling happens, where the interlayer forces of attraction such as van der Waal's and the electrostatic forces play a crucial role. At this level of swelling, the clay sheets are far enough apart that the interlayer forces cannot hold them together.

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Drilling muds

- The drilling muds are employed for
 - Cleaning the wellbore
 - Conveying the drill cuttings
 - Chilling and greasing the drill bit
 - Monitoring the formation pressure
 - Avoiding reservoir fluid loss
 - Formation of thin and impermeable filter cakes
 - Sustaining wellbore stability
- Oil-based muds (OBMs)
- Synthetic based muds (SBMs)
- Water-based muds (WBM)

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Shale inhibitors

- Shale formation is primary cause of wellbore instability.
- Physical, mechanical and chemical interaction with the drilling muds.
- Shale inhibitors decrease the swelling.
 - Shale inhibitor should have well-defined hydrophilic and hydrophobic area in its structure.
 - Shale inhibitor must have the ability to replace the hydrated interlayer cations.
 - Shale inhibitor should possess well-dispersed multiple functional groups.
- Widely used shale inhibitors
 - KCl, nanomaterials, polymers, graphene, ionic liquids, natural products, composite materials.

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Objectives

- Synthesize diethylenetriamine modified activated carbon
- Characterization of the enhanced nanomaterials
- While developing new shale inhibitor material, we kept in mind
 - *Nanomaterials*
 - *Novel*
 - *Cost-effective*
 - *Efficient*
 - *Functionalities*
 - *Environmental profile*
 - *Natural products or compounds derived from natural resources*

Characterization

FE-SEM images of shale (a), DETA-AC (b), and shale modified with DETA-AC (c) and (d).

FTIR spectra of shale, DETA-AC, and shale modified with DETA-AC.

TGA data of shale, DETA-AC, and shale modified with DETA-AC.

Linear Swelling

Improved swelling inhibition capacity of the DETA-AC-WBM

Inhibition Study

Stability of bentonite pellet in DETA-AC

Conclusion

Better inhibition features of the DETA-AC-WBM

DETA-AC-WBM plugs the pores of the shale and hinder the water molecules to invade the surface

Surface of shale become hydrophobic

DETA-AC helps to maintain the rheological properties at higher temperature

Low-cost, efficient, and better environmental features

Thanks for your Attention