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Inhibitive Properties Comparison of Different Polyetheramines in Water-Based Drilling Fluid

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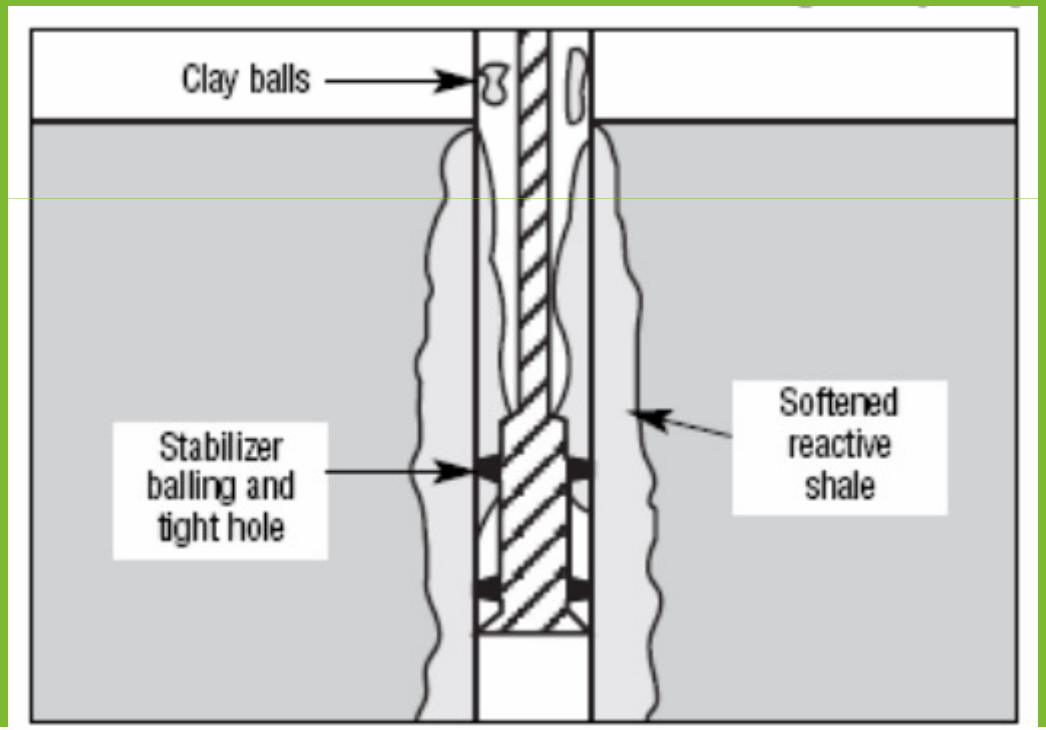
2014-10-27

Outline

- Introduction
- Inhibitive properties of different polyetheramines
- Interaction between polyetheramines and clay
- Mechanism analysis
- Conclusions

Introduction

Shale makes up 75% of drilled formations and causes 90% of wellbore instabilities.



Introduction

Shale hydration and dispersion, causing

- **Bit balling**
- **Borehole washout**
- **Disintegration of cuttings**
- **High torque and drag**
- **Wellbore instability**
- **Stuck pipe**
- **Etc.**

Introduction

Generally, the performance of oil based drilling fluids (OBM) is regarded as superior to water based drilling fluids due to:

- Inhibition mechanisms
- Lubricity, coefficient of friction
- Temperature stability
- Corrosion
- Wellbore stability

Environmental regulations and high cost restrict the wide application of OBM!

High performance water-based drilling fluid performing like OBM is required.

Introduction

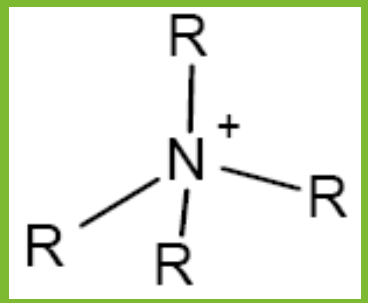
A number of approaches have been employed to alleviate or solve the problems of shale hydration and dispersion with various mechanisms:

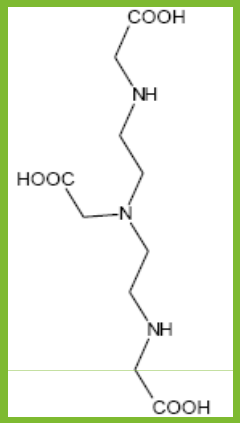
- Inorganic salts(KCl, NaCl, $CaCl_2$)
- Formates
- Asphaltene
- Methyl glucoside
- Polglycols
- Silicates
- Amine compounds
- Nanoparticles, etc.

Introduction

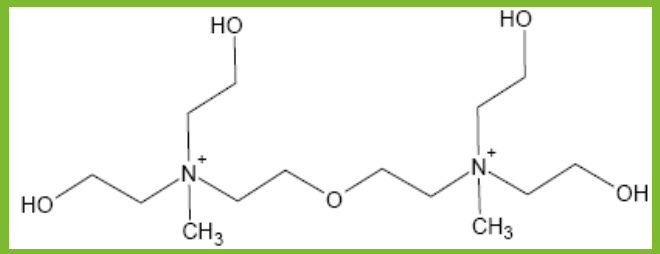
Amine compounds have been applied to stabilize shale for a long time.

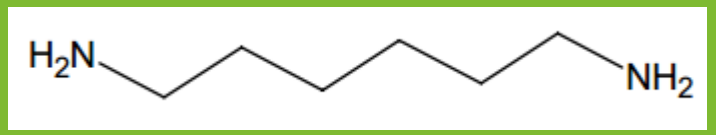
$NH^+_4A^-$





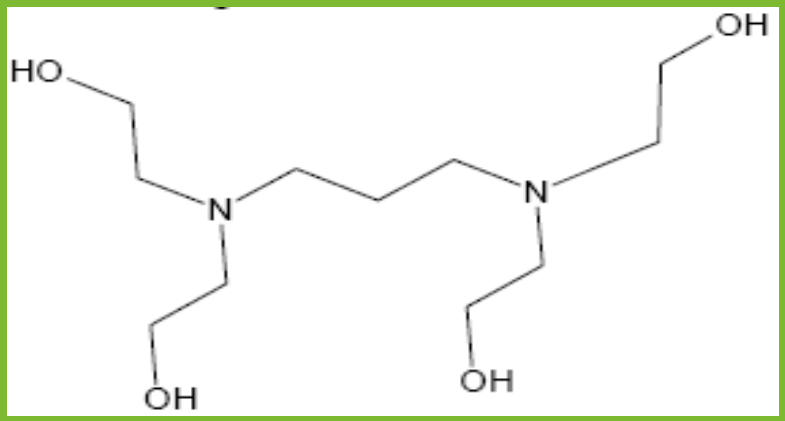
Ammonium chloride cation **Tetra alkyl ammonium salt** **Polyamino acid**



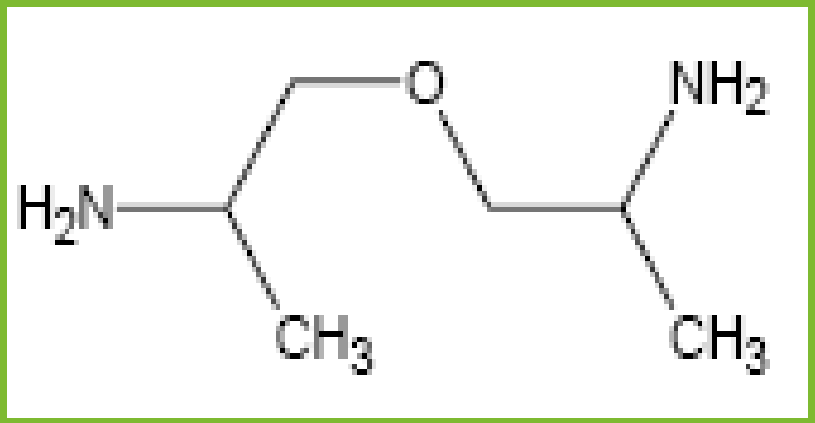


Polyhydroxylated alkyl ammonium salt **Hexamethylendiamine**

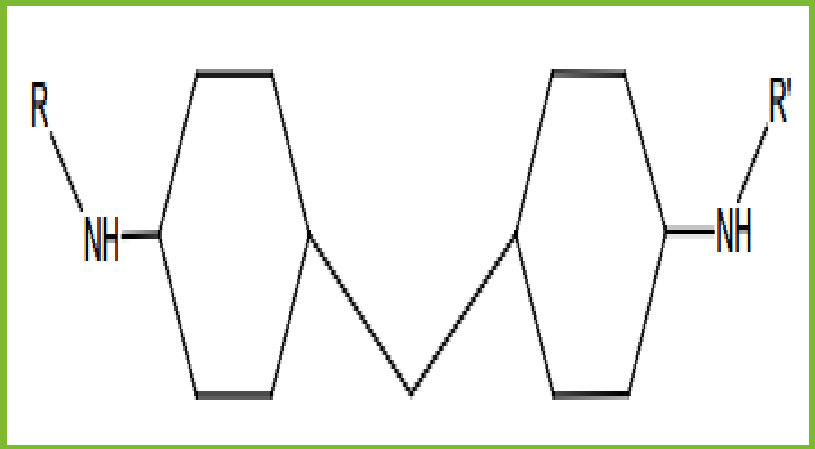
Introduction



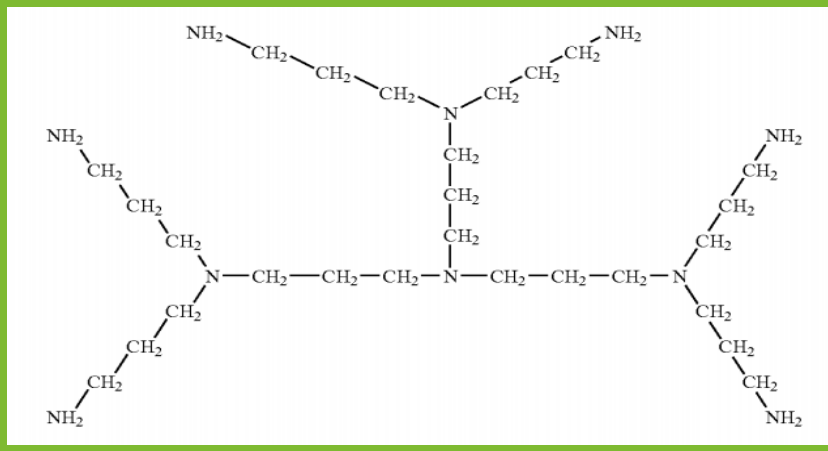
Ethoxylated diamine



Polyether diamine



Lipophilic amine



Poly(propyleneimine) dendrimer

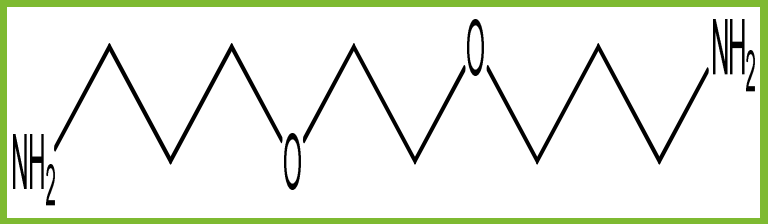
Introduction

Based on the concept of **“triple inhibition”**, HPWBM was introduced.

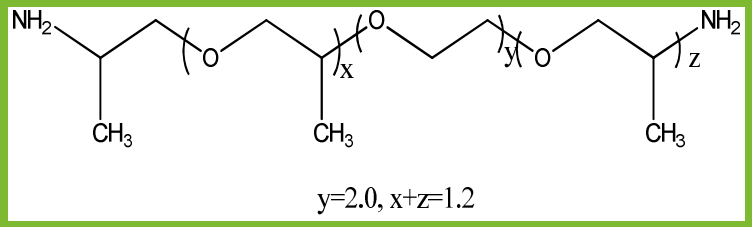
- Shale hydration inhibitor- Polyamine
- Shale dispersion inhibitor-Low molecular CPAM
- Accretion suppressant
- Rheological modifier-XC
- Filtrate reducer-PAC-L

Introduction

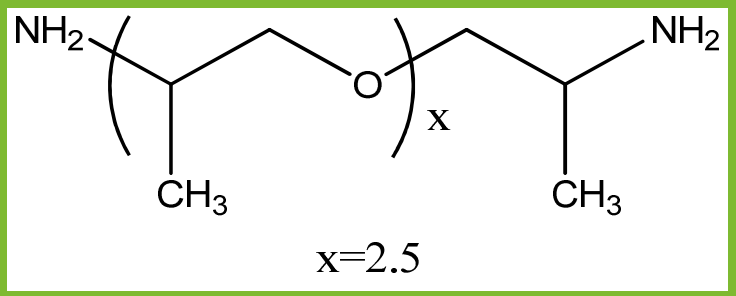
PEA-1



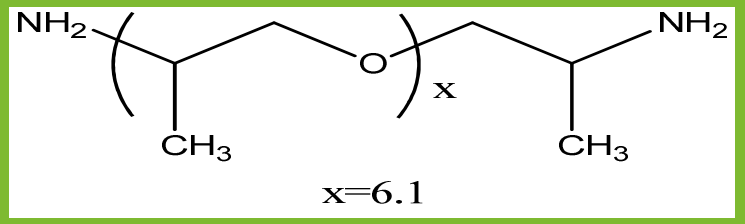
PEA-2



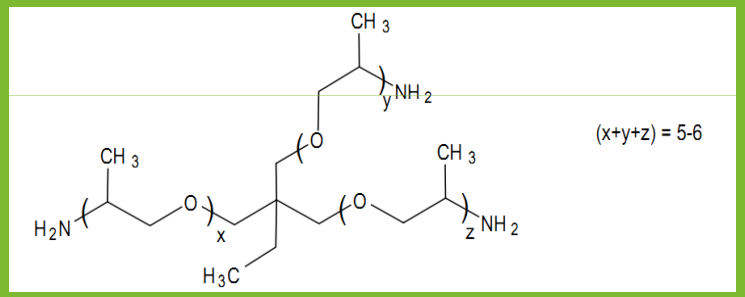
PEA-3



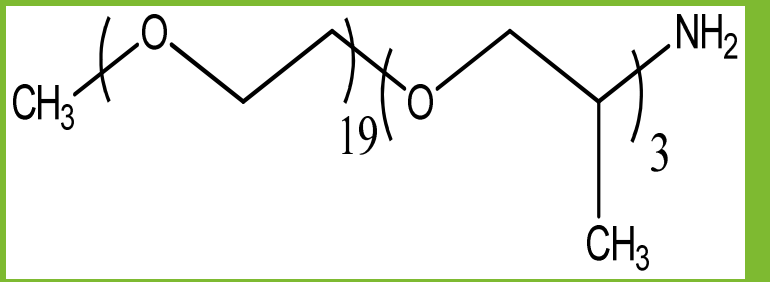
PEA-4



PEA-5

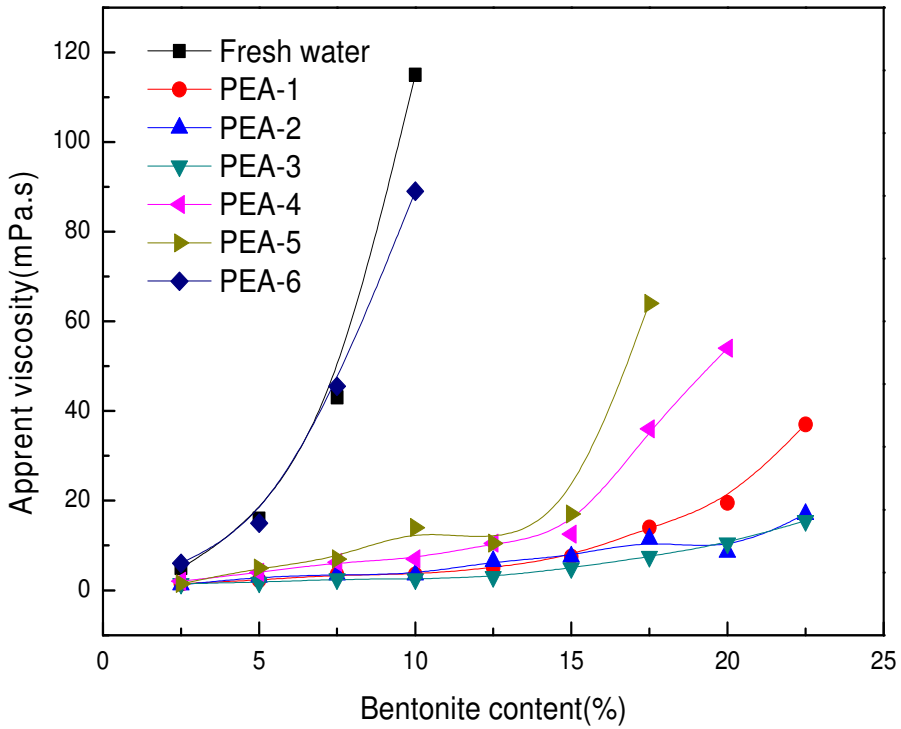


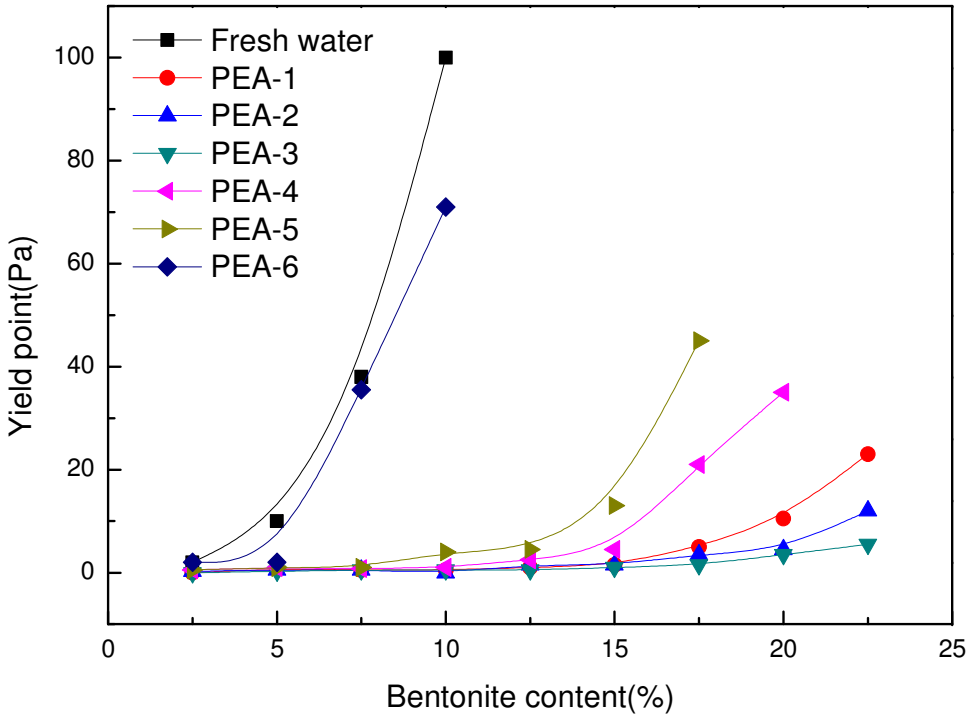
PEA-6



Inhibitive properties of different polyether amines

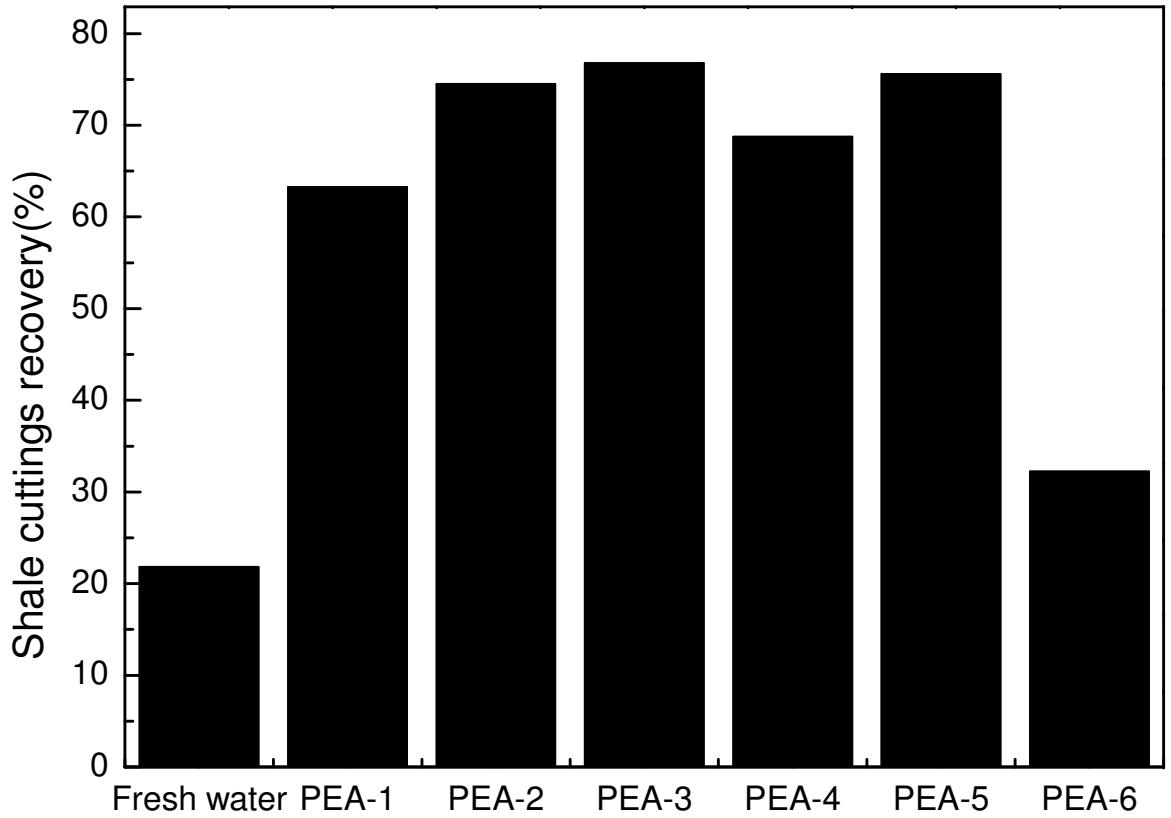
Bentonite inhibition test





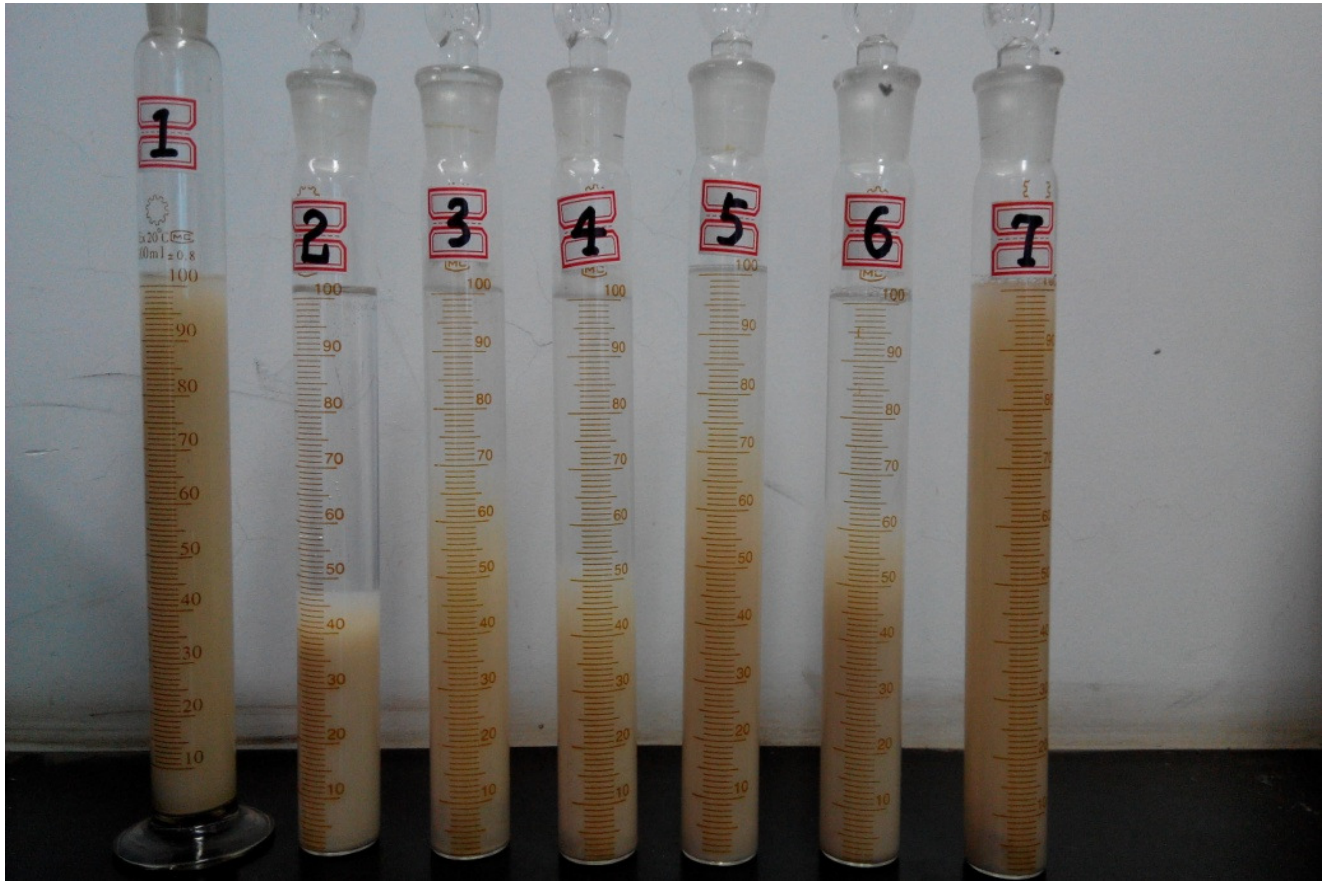
Inhibitive properties of different polyether amines

Shale cuttings hot-rolling dispersion test



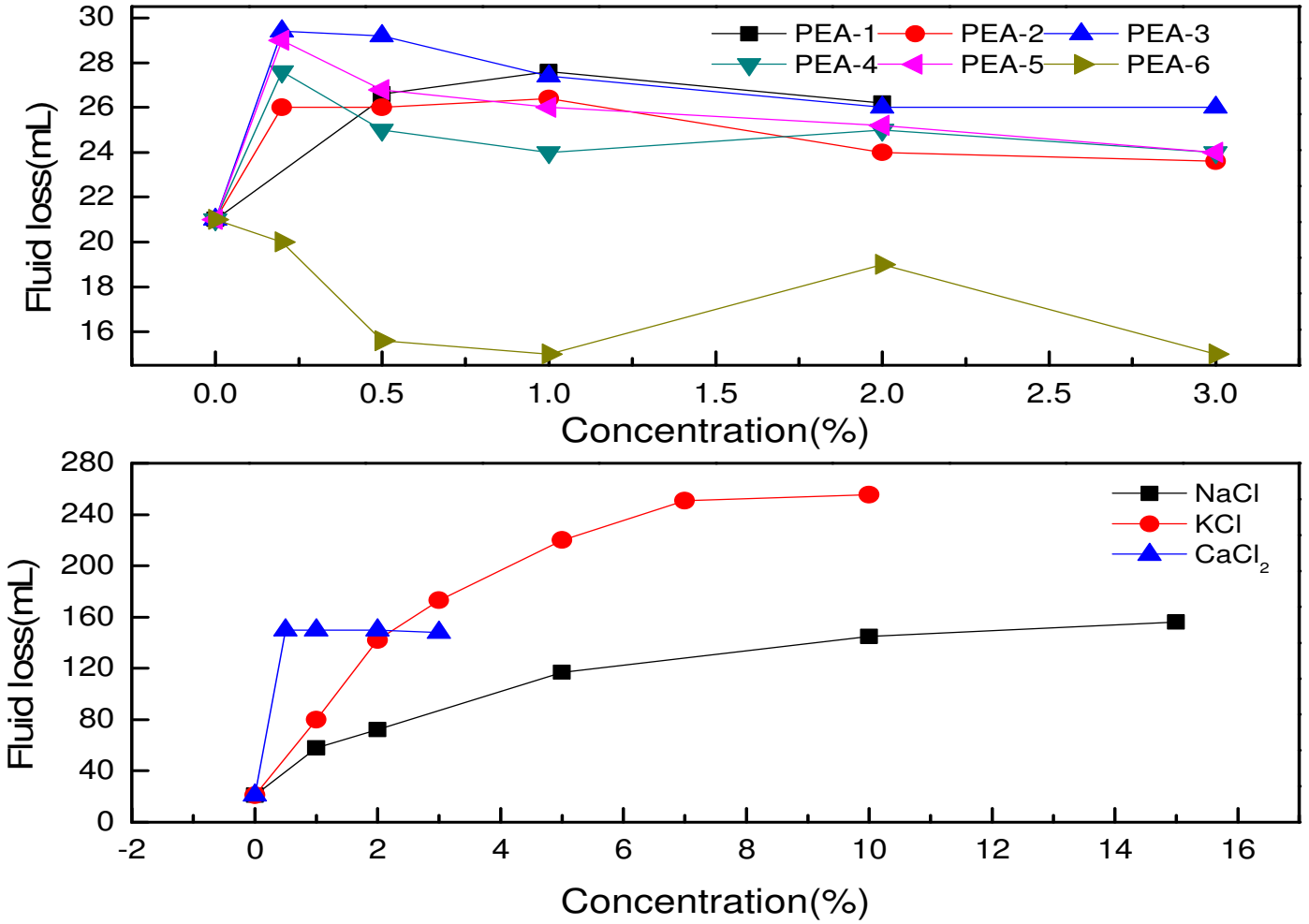
Inhibitive properties of different polyether amines

Sedimentation volume measurement



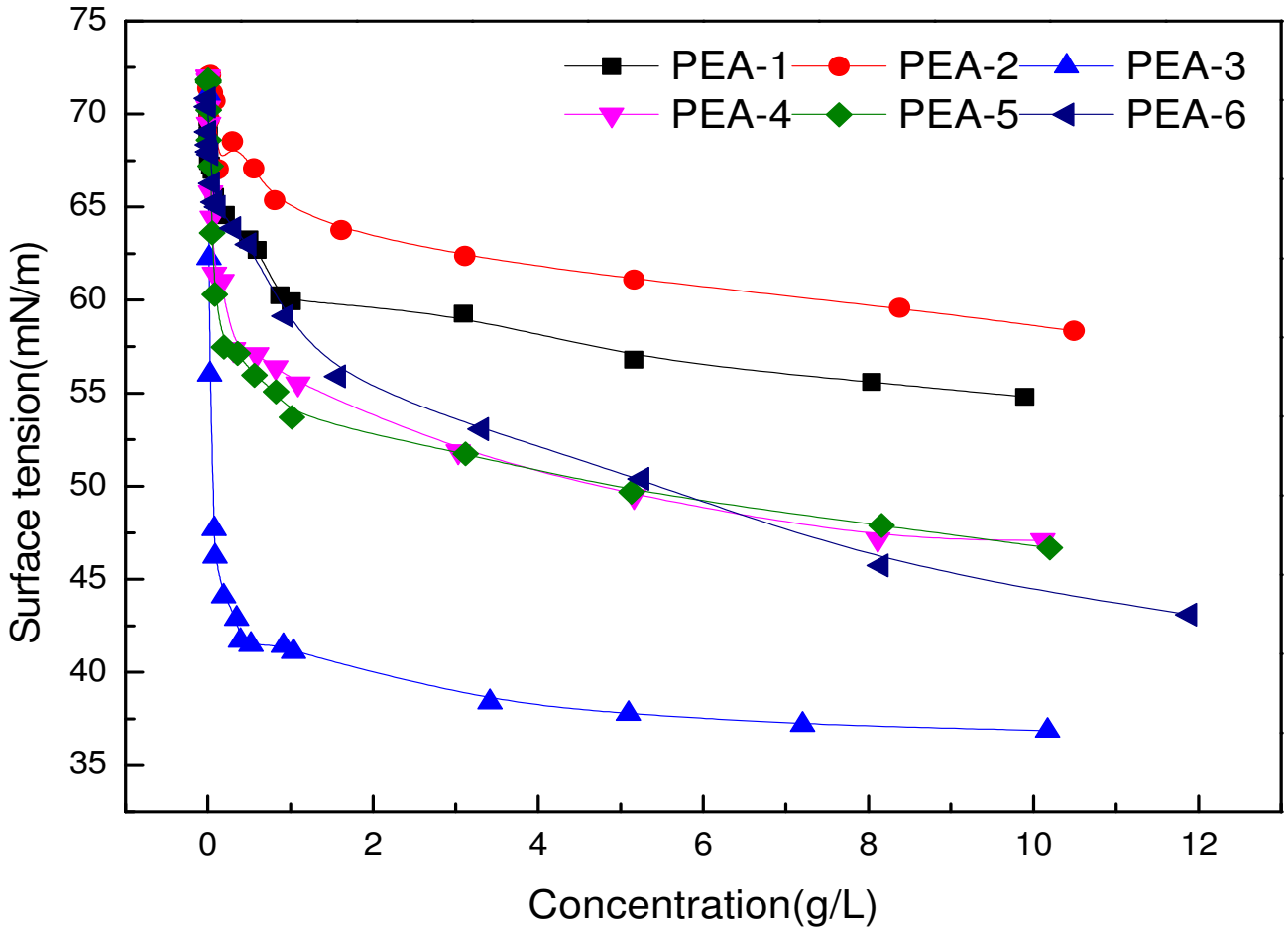
Inhibitive properties of different polyether amines

API filtration measurement



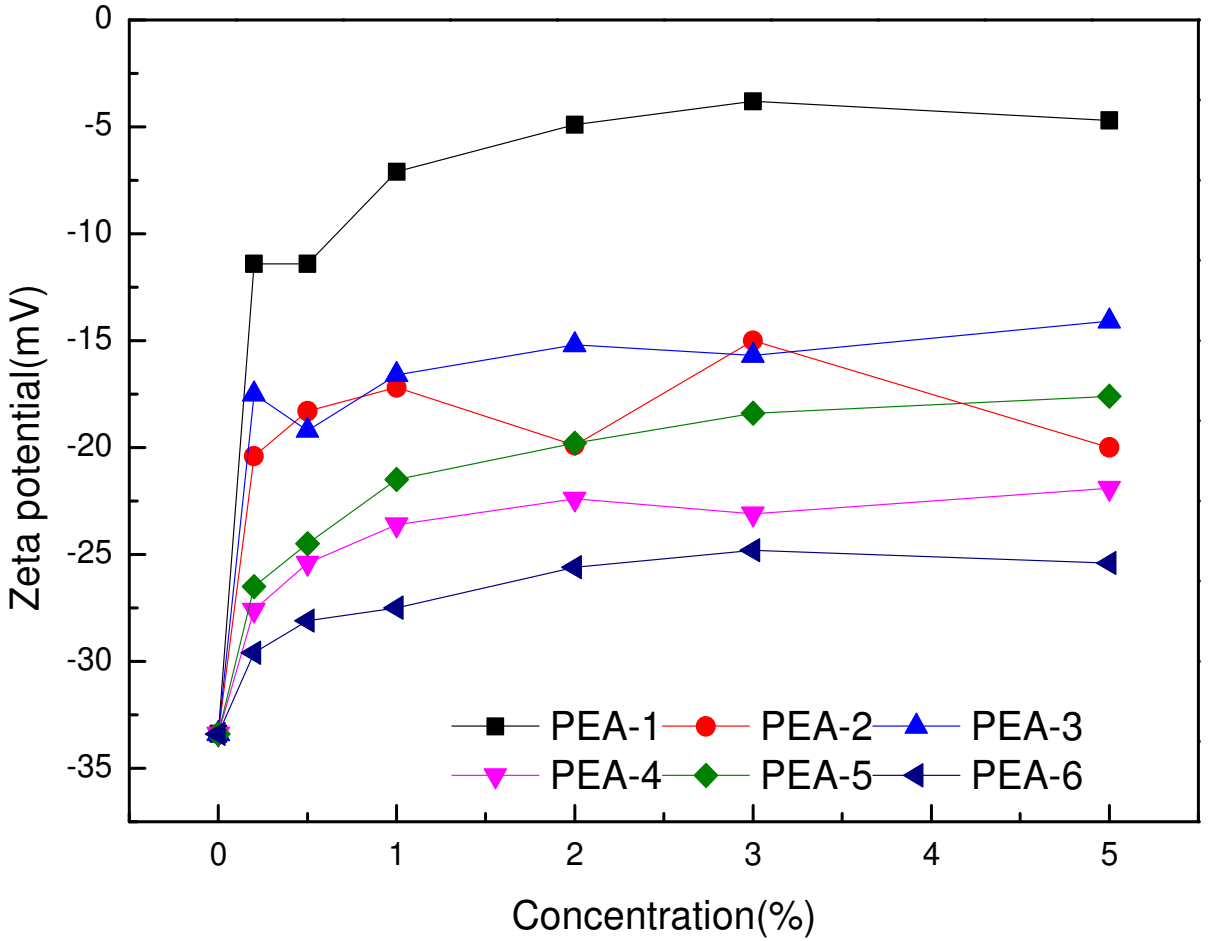
Interactions between polyether amines and clay

Surface activity of polyether amines



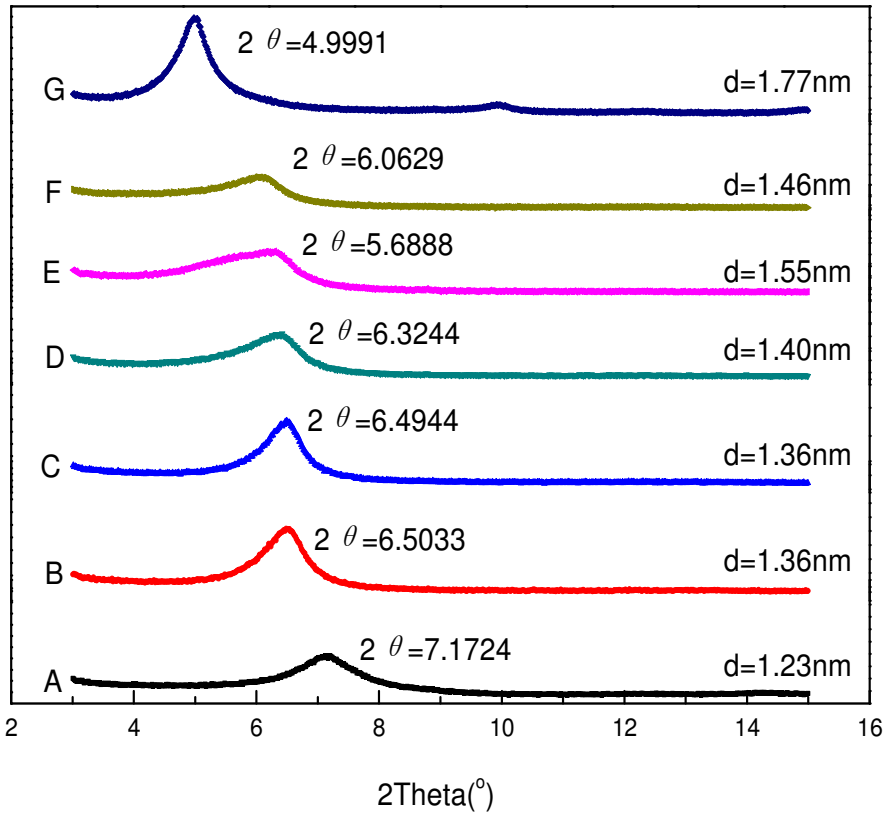
Interactions between polyether amines and clay

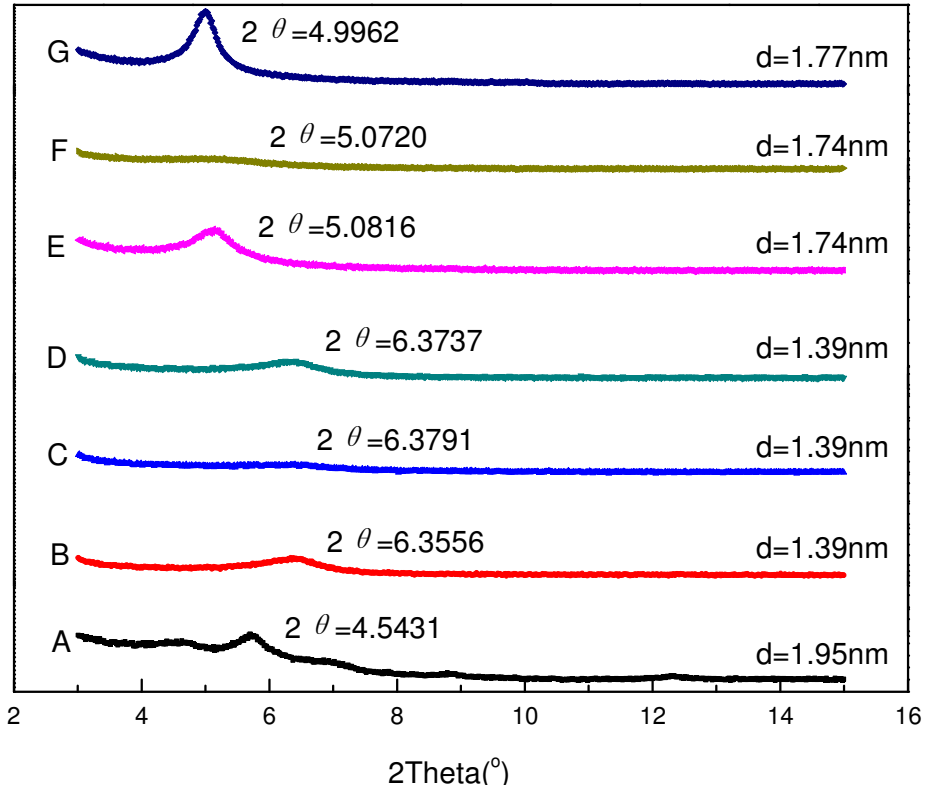
Zeta potential measurement



Interactions between polyether amines and clay

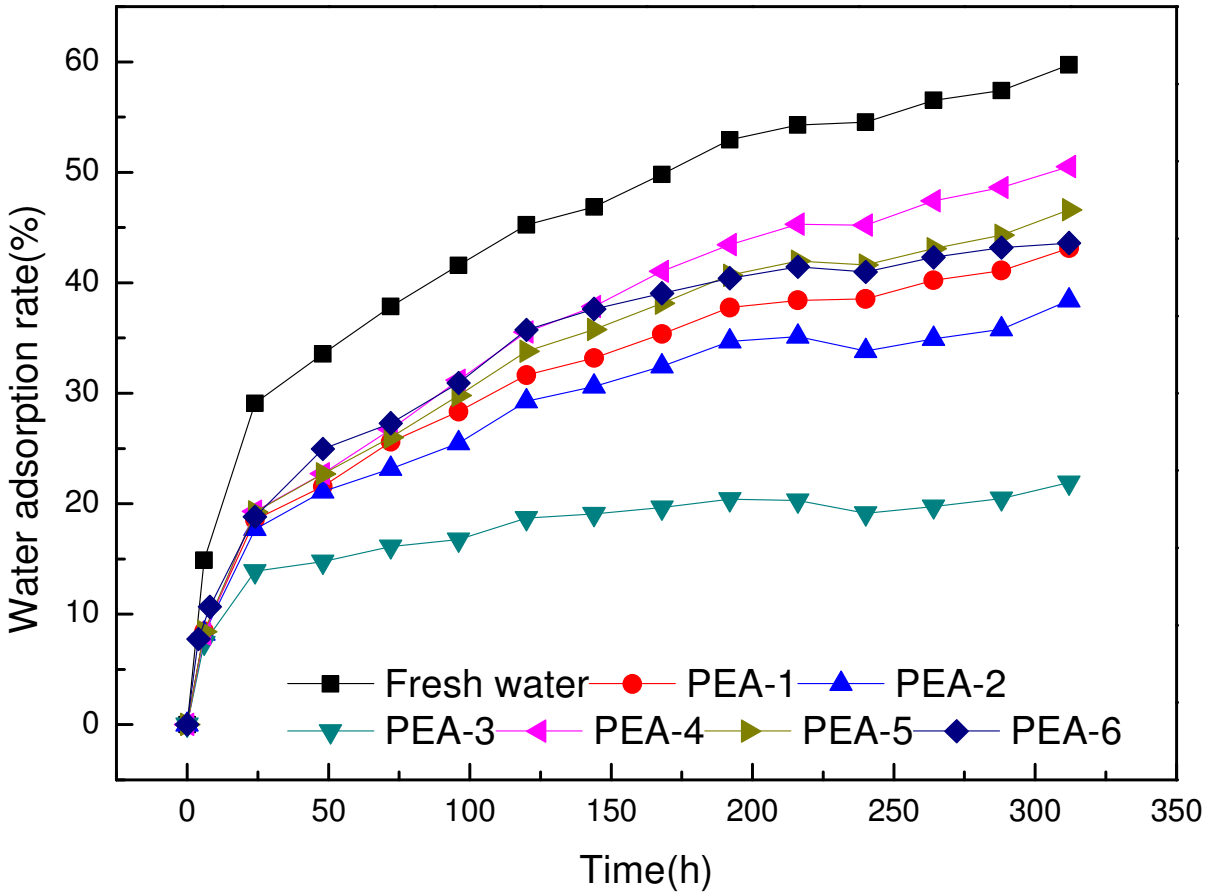
Reducing the hydrated interlayer space





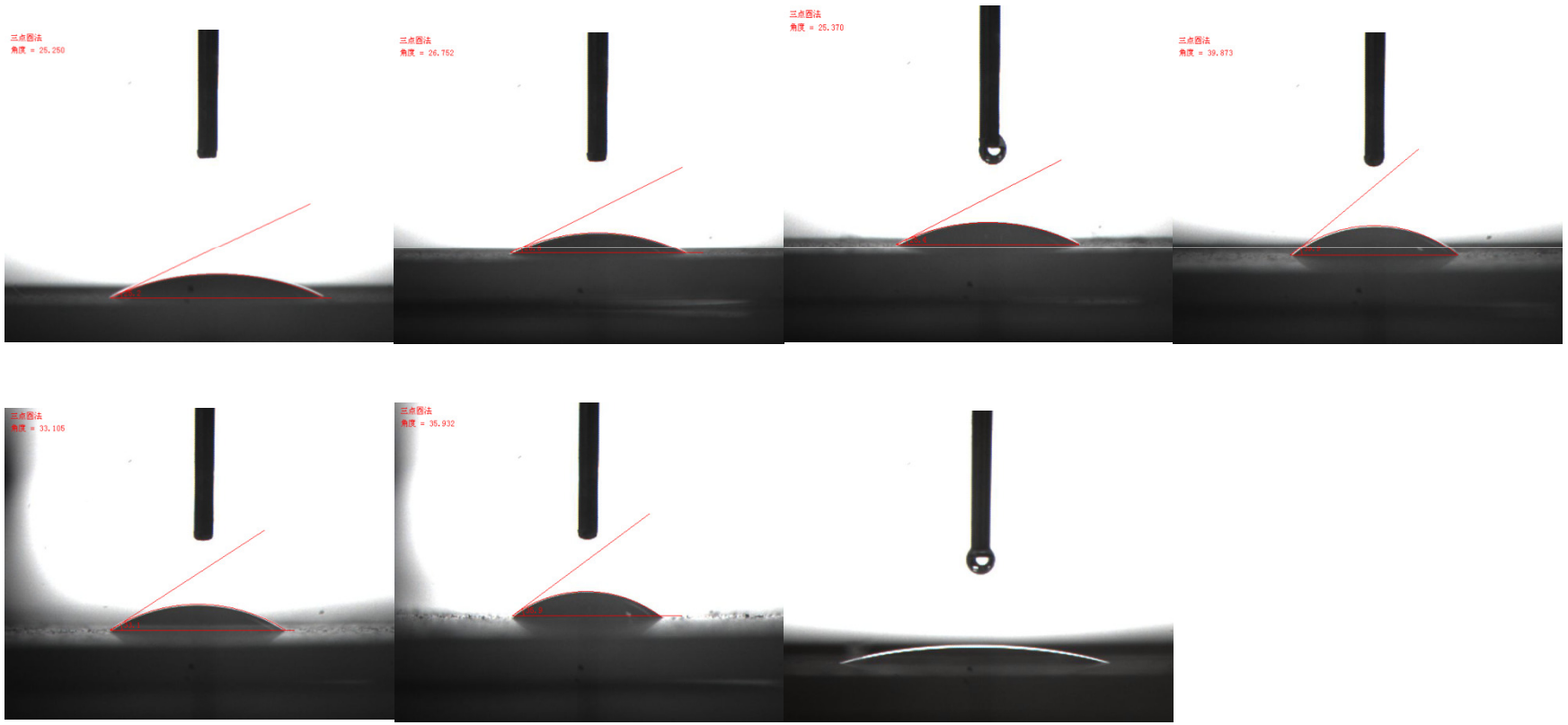
Interactions between polyether amines and clay

Water adsorption test

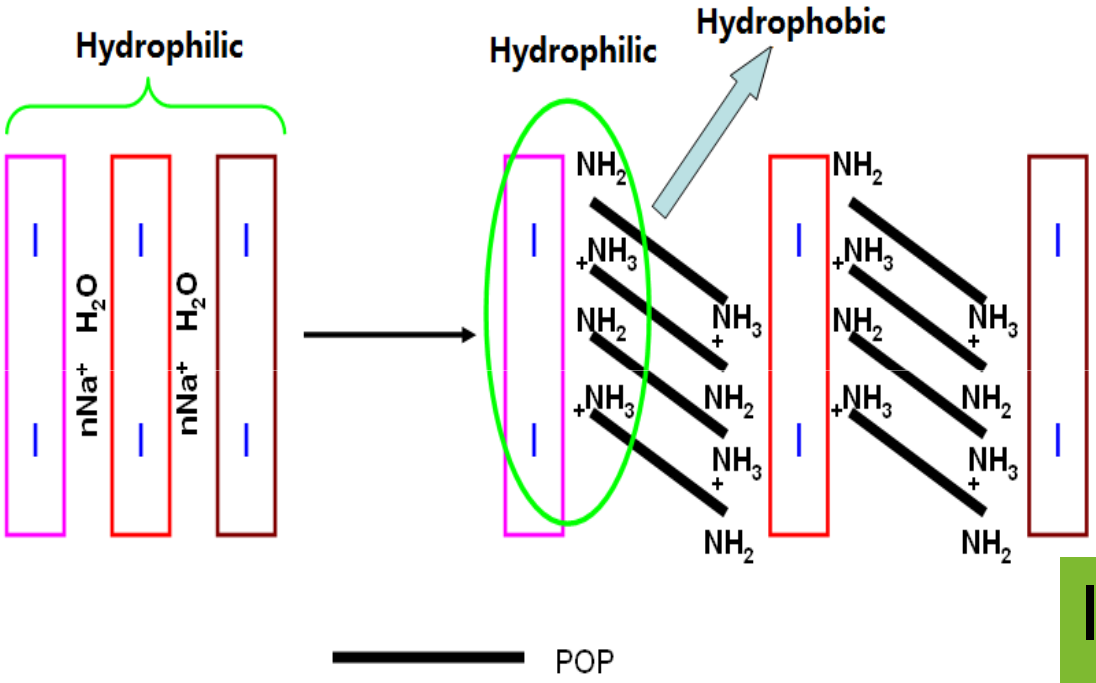


Interactions between polyether amines and clay

Contact angle measurement



Inhibitive mechanism of polyether amine



Inhibition mechanism

- Electrostatic interaction
- Hydrogen bonding
- Hydrophobic shielding effect

Conclusions

(1) PEA-3 was the best inhibitor, and PEA-6 was poor in inhibiting shale hydration and swelling.

(2) Electrostatic interaction, hydrogen bonding and hydrophobic shielding effect contributed to the excellent inhibitive properties of polyetheramines

(3) For polyetheramines, a ideal molecular structure existed, which may exhibit outstanding performance.

Acknowledgements

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Thanks for your attention!

Q/A Time!