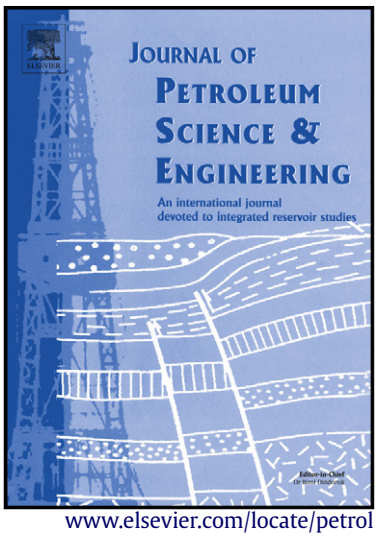


www.elsevier.com/locate/petrol

# Hyperbolic rheological model with shear stress limit for acrylamide polymer modified bentonite drilling Muds

C. Vipulanandan, Ahmed Mohammed

PII: S0920-4105(14)00253-8
DOI: http://dx.doi.org/10.1016/j.petrol.2014.08.004
Reference: PETROL2758

To appear in: *Journal of Petroleum Science and Engineering*

Received date: 16 February 2014
Revised date: 22 July 2014
Accepted date: 5 August 2014

Cite this article as: C. Vipulanandan, Ahmed Mohammed, Hyperbolic rheological model with shear stress limit for acrylamide polymer modified bentonite drilling Muds, *Journal of Petroleum Science and Engineering,* http://dx.doi.org/10.1016/j.petrol.2014.08.004

# Hyperbolic Rheological Model with Shear Stress Limit for Acrylamide Polymer Modified Bentonite Drilling Muds

C. Vipulanandan and Ahmed Mohammed

**Abstract:**

The effects of additives on the flow characteristics of the drilling muds used in various drilling operations including oil and gas wells must be better quantified. In this study, acrylamide polymer was used to modify the water based bentonite mud to reduce the yield point and maximum shear stress produced by the mud during the drilling operation. The bentonite content in the drilling mud was varied up to 6% (by weight). Based on the X-ray diffraction (XRD) analyses the major constituents of the bentonite were montmorillonite (MMT, $(Na,Ca)_{0.33}(Al,Mg)_2(Si_4O_{10})(OH)_2 \cdot nH_2O$), feldspar (Albite, $NaAlSi_3O_8$), kaolinite ($Al_2Si_2O_5(OH_4)$), Beidellite ($(Na,Ca_{0.5})_{0.3}Al_2((Si,Al)_4O_{10})(OH)_2.nH_2O$) and quartz ($SiO_2$). The bentonite was modified using a water soluble polymer solution before using it in the drilling mud. The rheological properties of bentonite were characterized from very low strain rate to relatively high strain rate to determine the nonlinear behavior of the shear thinning drilling mud. The polymer modification reduced the yield point by 26% to 66% based on the bentonite content in the drilling mud. The polymer treatment also reduced the apparent viscosity of the drilling muds. The shear thinning behavior of the bentonite drilling mud with and without polymer has been quantified using the new hyperbolic model and compared with two other constitutive models, Herschel-Bulkley and Casson models. While Casson model had two material parameters the other two models had three parameters. The results showed that the hyperbolic model predicated the shear thinning relationship between the shear stress and shear strain rate of the polymer modified bentonite drilling mud very well. Also the hyperbolic model has a maximum shear stress limit were as the other two models did not have a limit on the maximum shear stress.