ABSTRACT

Oil and gas industry consumes a large quantity of water for preparing water-based drilling fluids. These drilling fluids play an essential role in safe and efficient drilling operations. The water-based drilling fluids are most commonly used in oil/gas well drilling which contain bentonite clay and other additives to control the rheological properties during the drilling operations.

After the end of recycling of the drilling fluids, large quantities of drill cuttings or solid materials are generated form the drilling fluid waste. Such wastes need to be treated before their final disposal. Mechanical separation of the drill cuttings in the drilling fluid waste can separate particles of sizes down to 5µm (5mm). After mechanical separation the dissolved fines as colloidal particles need further separation before the disposal of the drilling fluid wastes. The disposal of oilfield drilling fluid wastes has proven to be one of the most difficult environmental problems because oilfield drilling fluid wastes is made of minerals, clays, organic materials, and other solids. Efficient coagulation/flocculation can reduce/remove the total amount of solids present in the above waste. Coagulation by inorganic salts and flocculation by natural polysaccharides/synthetic polymeric flocculants are found to be very effective. Natural polysaccharides are inexpensive, fairly shear stable but biodegradable and not very efficient flocculants. On the other hand, polyacrylamide-based synthetic polymers are efficient flocculating agents, but they are shear degradable. Grafting of the synthetic polymer on a polysaccharide backbone is a convenient method to add new properties to a natural polymer with a minimum loss of the initial properties of the substrate.

This thesis focuses mainly on the graft copolymerization of acrylamide monomers onto the polysaccharide backbones (starch, guar gum and amylose) using potassium persulfate (KPS) as initiator solution. The physico-chemical and mineralogical properties of the bentonite clay and the synthesized graft copolymers are studied using various instrumental methods like X-Ray Fluorescence (XRF) spectrometer, X-Ray Diffraction (XRD), Fourier Transform Infrared (FTIR) spectrometer, Thermal Gravimetric Analysis (TGA), Scanning Electron Microscopy (SEM) and Energy-Dispersive Spectrometry (EDS). The coagulation and flocculation studies for the bentonite-based drilling suspension and drilling fluid waste are carried out using a commercial polyacrylamide and with the above synthesized graft copolymers. The effects of coagulant/flocculant dosages, salt (NaCl) and varying pH on

supernatant turbidity values of the bentonite-based drilling suspensions and drilling fluid waste are studied.

It is observed that the increase in coagulant/flocculant dosages reduces the supernatant turbidity values and also improves the settling rate of the flocculated particles. At higher pH conditions, bentonite clay and the drilling fluid waste samples are highly flocculated with high settling rates resulting in low supernatant turbidity. The combined effect of salt concentration and coagulant/flocculant dosages improves the overall flocculation efficiency of the above system. The rheological properties of drilling fluid play an important role in oil and gas drilling operations. Special additives are added to improve the rheological properties like viscosity and gel strength of a drilling fluid. The rheological properties of the prepared bennonite clay-water system are studied using RheolabQC rotational viscometer. Role of various additives like carboxymethyl cellulose, xanthan gum and synthesized graft copolymers, barite, NaCl and KCl under varying pH conditions on the rheological properties of bentonite suspensions is also studied. The rheograms for the above system have been very well fitted with Bingham plastic, Power-law and Herschel-Bulkley models under the above experimental conditions. It is observed that increase in the additives concentrations improve the rheological properties of the above fluid system. The effect of pH and salt concentrations is also found to be significantly affecting on the rheological properties of the fluids system.

Keywords: Bentonite clay suspension, Drilling fluid waste, Coagulation-Flocculation, Polyacrylamide, Synthesized graft copolymers, Rheological properties.