Organic/Inorganic Hybrid Fluid Loss Agent for Geothermal Drilling Fluid

Shiwei Yang and Xiuhua Zheng
China University of Geosciences (Beijing), Beijing, China
xiuhuazh@cugb.edu.cn • blankyung@sina.cn

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ABSTRACT
The mechanism and advantage of a novel inorganic/organic hybrid alkali-activated high temperature resistant fluid loss agent are analyzed in this paper. Suggestions on novel lost-circulation control materials of geothermal drilling fluid were included.

Introduction
Tibet has developed Yangbajing high temperature geothermal field since 1970s. With about 24 MWe capacity, Yangbajing geothermal power plant supplies significant contributions to the electricity portfolio of Lhasa. Now Tibet is trying to exploit other high temperature geothermal fields, among which Yangyi is being drilled with proven 203 ºC temperature of shallow reservoir within 1000m depth and predicted about 250 ºC temperature of deep reservoir at depth around 1500m. Yangyi is located in the southern part of the Nagqu-Ngemo geothermal active belt, 45km southwest of Yangbajing and 75km west of Lhasa.[1], [2]

The geothermal field is one of the high-temperature convective hydrothermal geothermal systems with lithologic character of mainly granite and andesite in Tibet [3], [4]. The pressure analysis of ZK212 (one production well with 1508m) indicates that the formation and fracturing pressures are relatively low, 0.992 g/cm³ and 1.434 g/cm³ respectively at the depth of 1154m[5].

High temperature and low pressures of geothermal wells means that fluid loss is an important requirement for geothermal drilling fluids. So the drilling fluids must have a rheological stability and filtration characteristics that guarantee optimum operating conditions in high temperature environments.

Fluid Loss Agent for Geothermal Drilling Fluid
When fluid loss of drilling fluid is experienced in geothermal wells, fluid loss agent is needed such as HOE-2825 (copolymer of 2-acrylamido-2-methylpropane-propane-3- sulphonic acid AMPS and N-vinyl-N-methyl-acetamide, 200 ºC)[6], copolymer of AMPS, acrylic acid and itaconic acid (200 ºC) [7], copolymer of humic acid and primary amine with an alkyl radical of 10 to 20 carbon atoms (200 ºC) [8], copolymer of AMPS, vinylacrylamide and acrylamide (200 ºC) [9], NVP/IA/AM/AMPS (copolymer of AMPS, itaconic acid, acrylamide and N-vinyl-2-pyrrolidone, 220 ºC)[10], KEM-SEAL™ PLUS, PYRO-TROL™, CHEMTROL™ X (copolymer of AMPS and Am aqueous medium, 316 ºC) from Baker Hughes[11], Na-polyacrylates (cypan)[12], et al.

They have some disadvantages: 1) organic polymers or inorganic additives are used separately, or just blended, 2) the effect is unsatisfactory for deep drilling due to their single mechanism, 3) controllability is not ideal, 4) they have low temperature resistance on account of polymer degradation.

Analysis of Fluid Loss Agent PSA/Ca-MMT/ CaCl2@SiO2
Table 1 lists the effect of CaCO3, SMP, and PSA/Ca-MMT/CaCl2@SiO2[13] on the rheological and filtration properties in freshwater-based drilling fluid before and after aging tests (200 ºC). Formulation A is made up of 3% bentonite, 0.75% sodium hydroxide and water.

The filtration property of PSA/Ca-MMT/CaCl2@SiO2 is superior than CaCO3 and SMP at room temperature and at 200 ºC. The viscosity and yield point is just suitable for water-based drilling fluid.

The mechanism (Figure 1) is that: Na2SiO3 is produced by the chemical reaction of the outer layer SiO2 of PSA/Ca-MMT/CaCl2@SiO2 in aqueous alkaline solution, which was more intense with the increase in temperature. CaSiO3 was generated via the reaction between Na2SiO3 and inner calcium ion after SiO2 decreased to a certain extent. Graft polymer of PSA and Ca-MMT (occlusive filling effect and network effect of remaining long chain of polymer), CaSiO3 (filling effect) and Na2SiO3 (film effect) worked together to reduce the fluid loss.

Advantages of PSA/Ca-MMT/CaCl2@SiO2 are: 1) high temperature resistance because of inorganic material, 2) outstanding performance for multifunction of graft polymer, CaSiO3 and Na-
Suggestions on Novel Lost-Circulation Control Materials of Geothermal Drilling Fluid

Firstly, preparation of new fluid loss agent is most important: 1) introduce more chemicals but not just physically blending, 2) synthetize inorganic/organic hybrid additives, inorganic materials with different shape and size like calcium carbonate and SiO₂.

Secondly, extend field of vision and use biomimetic materials (imitation cells of polylactic acid–glycolide, imitation elastic membrane of mimosa pudica, bamboo-like fiber, et al) and smart materials (shape memory alloy, gel composite materials, etc).

Thirdly, fluid loss agents cooperate with drilling technology. For example, the system of sodium silicate/calcium chloride plug from Marita L. Allan require encapsulation of calcium chloride by polymers or hose for guiding to control the opportunity.

References


