Study and Application of Ultra-High Temperature Water-Based Drilling Fluid for Hot Dry Rock Well GR1

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As the exploration and development of oil/gas resources in deep strata and hot dry rock geothermal resource, the formation temperature in the bottom hole will be up to 240 °C, and the drilling fluids in the borehole will long be in a high temperature environment. The changes of clay and polymer additives take place under high temperature, such as high temperature dispersion or high temperature coalescence of bentonite and degradation of polymer additives, which results in a drastic change of water based drilling fluid performance. In order to meet the needs of high temperature drilling, it is urgent to develop a ultra-high temperature water-based drilling fluid technique.

Based on optimizing drilling fluid additives for high temperature condition, a water-based drilling fluid for ultra-high temperature was prepared. Its composition includes 4 % sodium bentonite, 2 % high temperature mud-made material HPS, 4 % high temperature filter loss reducer GCL-1, 4 % high temperature filter loss reducer SPNH, 4 % high temperature filter loss reducer GCL-2, 4 % high temperature filter loss reducer JSSJ, 1 % high temperature thinner, 0.5 % high temperature Viscosifier DDP and 1% high temperature stabilizer GBH. Research results indicate that the temperature resistance of optimized formulation is up to 240 °C, and has excellent high temperature stability and ideal rheology (see Table 1 and Fig.1).

Table1. the performance of ultra-high temperature water base drilling fluid at different condition

Test conditions	AV/mPa·s	PV/mPa·s	YP/Pa	FL/ mL	HTHP Filtrate/mL
25 °C for 16h	115	95	20	3.0	/
240℃ for 16h	93.5	75.5	15	3.6	20
240℃ for 32h	79	58.5	20.5	4.8	22
240℃ for 48h	69.5	53.5	16	5.6	22
240℃ for 72h	58.0	47	11	5.8	24

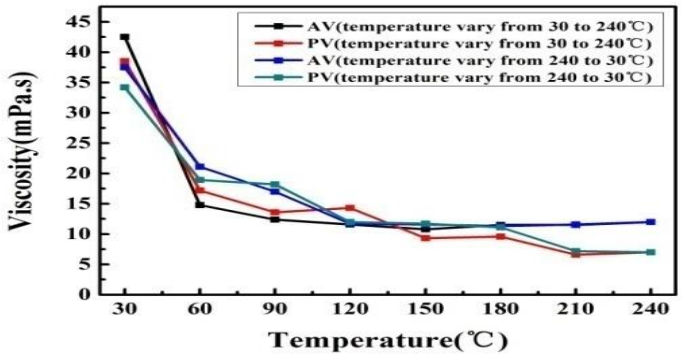

Figure 1. The rheological curve of ultra-high temperature water base drilling fluid which aged at 230℃ for 16h at different condition.

Well GR1 is located in the Gonghe basin of Qinghai Orovince, which is a dry and hot rock well with a completion depth of 3705 meters and bottom hole temperature of 236 °C. During drilling of the GR1 well, severely fractured rocks with altered granite were encountered, especially in the well section 2600-2800 m and 3000-3300 m, and a stuck pipe accident occurred when drilling to 3360 m. After converting the original drilling fluids into ultra-high temperature water-based drilling fluid, no problems occurred in drilling, logging and casing operations. The field test shows that the ultra-high temperature water-based drilling fluid has good high temperature stability, rheological property, and wall protective performance, and effectively solves the problem of wall instability with fractured and altered rocks in the high temperature well section.