Studies on Mechanism of Coal Powder Suspending Agent and Evaluation of Its Performance

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Abstract

Coal formation has characteristics of soft, cleats development, low permeability, large surface area, strong adsorption, low pressure etc., during the coalbed methane exploration and stimulation process, due to tools grinding and pressure excitement, coal powder will be produced, which will result in powder sediment and jam issues, fracture and wellbore would be clogged. In previous research, this issue is resolved by “in-situ fixed” method, which use nano-particles or synthetic materials to increase the intersection force between coal powder and formation rock and/or proppant, thus, coal powder can be fixed on the coal rock and/or proppant, thus the migration is reduced, but this method is bad for the proppant conductivity, because the combination is not very form, coal powder would fall off from coal rock and/or proppant. According to adsorption and wetting mechanism of nonionic surfactant, a new Coal Powder Suspending Agent (CPSA) is developed. When the contraction of CPSA gets 0.5% in the fracturing fluid, the hydration shell is formed and coal powder wettability is switched from hydrophobic to hydrophilic, the contact angle between coal powder and 0.5%CPSA is reduced from 89.4°to 0°, therefore coal powder would disperse quickly and suspend longer in water, in the meanwhile, the surface tension is reduced from 73.75mN/m to 25.57mN/m, this is benefit for the fracturing fluid flowback. Suspending performance is evaluated by spectrophotometer, the suspended coal powder in 0.5%CPSA is 3 to 9 times more than that of tap water at the beginning, and is 5 to 60 times than that of tap water after 48 hours, which show that CPSA can effectively suspend coal powder longer. Coal powder flow experiments is conducted in simulated fracture and wellbore by a sand packed column, in the simulated fracture, a lot of coal powder is carried out of the horizontal tube by fracturing fluid containing 0.5%CPSA and the tube remains clear; in the simulated wellbore, coal powder is carried out of the vertical tube and the effluent is black, this show that CPSA in fracturing fluid is effective to suspend and carry coal powder out of the fracture and wellbore, this will improve the coal powder sediment and jam issues. The coal core damage of the new active water fracturing fluid system with CPSA is 9.45%, which is lower than that of the conventional active water fracturing fluid of 10-30%, and the flowback fluid can carry large amounts of coal powder, which can further reduce the damage.

Studies on Mechanism of Coal Powder Suspending Agent (CPSA) and Evaluation of Its Performance

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Introduction

Coal powder would transport and deposit due to tool grinding and pressure excitement, fracture and wellbore would be clogged, and this will lead to permanent damage for coal seam permeability.

According to adsorption and wetting mechanism of nonionic surfactant, a new Coal Powder Suspending Agent (CPSA) is developed. CPSA can change coal powder wettability, reduce the fracturing fluid surface tension, enhance coal powder suspending performance, improve coal powder flow performance in simulated fracture and wellbore, and reduce coal core damage.

Suspension performance

Fluid		Coal Sample: XiangShan Coal (mg/L)	JinCheng Coal (mg/L)	BaoDe Coal (mg/L)
Tap water	0 h	280.5	304.3	507.8
	48 h	199.8	23.1	101.0
0.5% CPSA	0 h	2079.3	2734.7	1814.1
	48 h	1118.6	1250.9	821.3

Coal powder concentration initially in 0.5%CPSA is 3 to 9 times than water, 5 to 60 times at 48 hours

Adsorption and wetting mechanism

(a) surfactant molecules laid on the face randomly
(b) coal surface is substantially covered by the lying adsorbed molecules
(c) The hydration shell will be formed when nonionic surfactant absorbs on coal powder surface

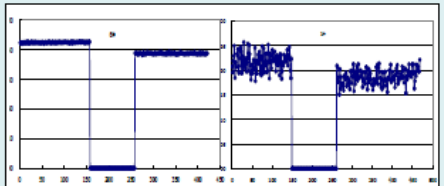
Coal powder flow performance

Wettability switch and adsorption performance

Formulation	Surface Tension (mN/m)
Tap water	73.75
Tap water +0.5%CPSA	28.54
Tap water +0.3%CPSA+0.5% Flowback Agent	27.91
Tap water +0.5%CPSA+0.5% Flowback Agent	25.57
Tap water +1.0%CPSA+0.5% Flowback Agent	25.13
Tap water +1.5%CPSA+0.5% Flowback Agent	27.06

Fluid	Contact Angle (°)	Adsorption Capacity (g)	Surface Tension (mN/m)
Tap water	89.4	0.0532	73.75
0.5% CPSA	0	0.0672	28.54

Core damage evaluation



Core damage of CPSA is 9.45%, lower than conventional active water (14.4%).

Conclusions

- A new CPSA is developed.
- The wettability of coal is changed from hydrophobic to hydrophilic by CPSA.
- Coal powder is more effectively suspended.
- The surface tension of 0.5% CPSA is 28.54mN/m.
- Core damage of new active water is lower than that of conventional active water.