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The Study on Sand Consolidation Agent Formula System of H Block

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Abstract

The cemented type between particles in H block is mainly pore-contact, which belongs to medium porosity, medium or low permeability reservoir, and the quality of oil belongs to thin oil. Since H block was put into production in 1988, the changes of formation pressure, erosion of water on formation and other reasons had caused sand production problem in H block. In order to reduce the disadvantages of sand production in oil and gas well and according to the analysis of sand production reasons in H block, this paper puts forward a kind of sand consolidating system that is suitable for H block. By indoor experiment, this paper optimizes the curing agent amount, thinner agent content, softener dosage, coupling agent and glass fiber content, also sand consolidating agent content. In addition, considering the two indicators of compressive strength and water permeability, this paper optimizes the composition of this sand consolidating agent, namely using epoxy resin as main agent; curing agent amount is 6.4%; softener dosage is 15%; thinner content is 22%; content of coupling agent is 2%; fiber dosage is 10%; appropriate injecting amount of sand consolidating agent is 1 pv.

Key words: Sand consolidating agent; Epoxy resin; Compressive strength; Permeability

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INTRODUCTION

The most formations of H blocks belong to medium tight sandstone type, particle diameter is generally between 0.12 mm and 1.00 mm, few diameters is between 2.0 mm and 4.0 mm and relatively fine. The maximum porosity value is 30%. The main cementation is contact pore cementation, which is lower than the basal cementation strength. The shear stress of fluid will destroy the aggregate force of sand and gravel in the production process, resulting in sand production of oil well and gas well. If the viscosity of crude oil in the production process is very high, the shear of rock surface will be great[1]. It is easy to cause sand aggravate. Therefore, it is urgent to prevent sand production of H block.

Abrasive sand makes the underground and ground equipment have serious erosion or abrasion, the service life of the equipment has been shorten[2-3]. Sand prevention of oil well and gas well should focus on early prevention and control. In addition, once the formation sand flow out of the wellbore, it will cause pollution to the surrounding environment, especially the coastal oil and gas fields are more restricted by environmental protection regulations[4-6]. Therefore, the sand control of oil well and gas well is not only the need of oil and gas field exploitation, but also the need of protecting the environment[7-8].

This paper mainly determines the impact of epoxy resin, curing agent, diluent, softener, coupling agent and fibers dosage on the compressive strength of sand-consolidating agent and permeability parameters through the indoor experiment. This paper also determines the formulation system of sand consolidating agent, which is suit for H block oilfield.

1. EXPERIMENTAL PROGRAM

1.1 The Optimizing of Curing Agent Dosage

The dosage of curing agent will be changed (taking epoxy resin as the main agent, curing agent dosage is 6.1%, 6.2%, 6.3%, 6.4% and 6.5%). Other chemical dosage is fixed, sand consolidation agent with 1 pv is injected into sand filled tube sequentially. The sand filling tube is placed in the thermostatic water bath with 75 ℃ and cured for 72 hours. Then the cured induration is taken out to test compressive strength and water permeability. The relationship curve between the dosage of the curing agent and the compressive strength and water permeability is drawn.

1.2 The Optimizing of Softener Dosage

The dosage of softener will be changed (taking epoxy resin as the main agent, softener dosage is 14%, 15% and 16%). Other chemical dosage is fixed, sand consolidation agent with 1 pv is injected into sand filled tube sequentially. The sand filling tube is placed in the thermostatic water bath with 75 ℃ and cured for 72 hours. Then the cured induration is taken out to test compressive strength and water permeability. The relationship curve between the dosage of the softener and the compressive strength and water permeability is drawn.

1.3 The Optimizing of Thinning Agent Dosage

The dosage of thinning agent will be changed (taking epoxy resin as the main agent, curing agent dosage is 20%, 21%, 22%, 23%, 24% and 25%). Other chemical dosage is fixed, sand consolidation agent with 1 pv is injected into sand filled tube sequentially. The sand filling tube is placed in the thermostatic water bath with 75 ℃ and cured for 72 hours. Then the cured induration is taken out to test compressive strength and water permeability. The relationship curve between the dosage of the thinning agent and the compressive strength and water permeability is drawn.

1.4 The Optimizing of Coupling Agent Dosage

The dosage of coupling agent will be changed (taking epoxy resin as the main agent, curing agent dosage is 0, 1%, 2% and 3%). Other chemical dosage is fixed, sand consolidation agent with 1 pv is injected into sand filled tube sequentially. The sand filling tube is placed in the thermostatic water bath with 75 ℃ and cured for 72 hours. Then the cured induration is taken out to test compressive strength and water permeability. The relationship curve between the dosage of the coupling agent and the compressive strength and water permeability is drawn.

1.5 The Optimizing of Fiber Dosage

The dosage of fiber will be changed (taking epoxy resin as the main agent, curing agent dosage is 5%, 8%, 10%, 12% and 3%). Other chemical dosage is fixed, sand consolidation agent with 1 pv is injected into sand filled tube sequentially. The sand filling tube is placed in the thermostatic water bath with 75 ℃ and cured for 72 hours. Then the cured induration is taken out to test compressive strength and water permeability. The relationship curve between the dosage of the fiber and the compressive strength and water permeability is drawn.

1.6 The Optimizing of Sand Consolidating Agent

The dosage of sand consolidating agent will be changed (taking epoxy resin as the main agent, curing agent dosage is 0.8, 1.0, 1.2 and 1.5). Other chemical dosage is fixed, sand consolidation agent with 1 pv is injected into sand filled tube sequentially. The sand filling tube is placed in the thermostatic water bath with 75 ℃ and cured for 72 hours. Then the cured induration is taken out to test compressive strength and water permeability. The relationship curve between the dosage of sand consolidating agent and the compressive strength and water permeability is drawn.

2. EXPERIMENTAL CONDITION

Experimental apparatus include TC-201 electro thermostatic water bath and FY-3 thermostat, 2XZ-2 vacuum pump, JA2003N electronic balance, high temperature and high pressure rheometer, NYL-300 type pressure experiment machine and anti sand device.

Experimental pharmacy contains Epoxy resin, curing agent, diluent, softening agent, coupling agent and grinding fiber.

Experimental sand is selected from simulant grain compositionof formation sand in H Block.

3. EXPERIMENTAL RESULTS AND ANALYSIS

3.1 Effect of the Curing Agent Dosage

The dosage of experimental sand is 100 g, which simulates formation sand. The epoxy resin is taken as the main agent and the dosage is 10 g (10% of the formation sand). The dosage of curing agent is 6.1%-6.5% of resin, 20% of thinner, 15% of softener, 2% of coupling agent and 10% of fiber. The effect of curing agent on consolidation compressive strength and water permeability is studied and the result is shown in Figure 1.

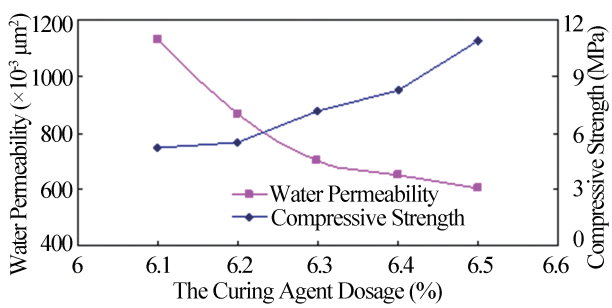

Figure 1
The Optimizing of Curing Agent Dosage

As shown in Figure 1, with the increase of the curing agent dosage, the compressive strength of the solidified body increased, water permeability decreased. When the dosage of the curing agent is 6.1%, the compressive strength is 5.19 MPa and water measuring permeability is 1,132.89×10^{-3} μm^2. When the dosage of the curing agent is 6.2%, the compressive strength is 5.50 MPa and water measuring permeability is 865.23×10^{-3} μm^2. When the dosage of the curing agent is 6.3%, the compressive strength is 7.14 MPa and water measuring permeability is 700.15×10^{-3} μm^2. When the dosage of the curing agent is 6.4%, the compressive strength is 8.23 MPa and water measuring permeability is 650.49×10^{-3} μm^2. When the dosage of the curing agent is 6.5%, the compressive strength is 10.87 MPa and water measuring permeability is 602.88×10^{-3} μm^2. Therefore, considering the two indexes of compressive strength and water permeability, the appropriate curing agent dosage is 6.4%.

3.2 Effect of the Softener Dosage

The brittle of induration generated by Epoxy resin and curing agent is big and compressive strength is small. The softener makes induration brittle smaller and increases the flexibility, but the amount of softener also should not be too much, otherwise it will be not completely cured phenomenon. The dosage of experimental sand is 100 g. The epoxy resin is taken as the main agent and the dosage is 10 g (10% of the formation sand). The dosage of curing agent is 6.4% of resin, 20% of thinner, 14%-16% of softener, 2% of coupling agent and 10% of fiber. The effect of softener on consolidation compressive strength and water permeability is studied and the result is shown in Figure 2.

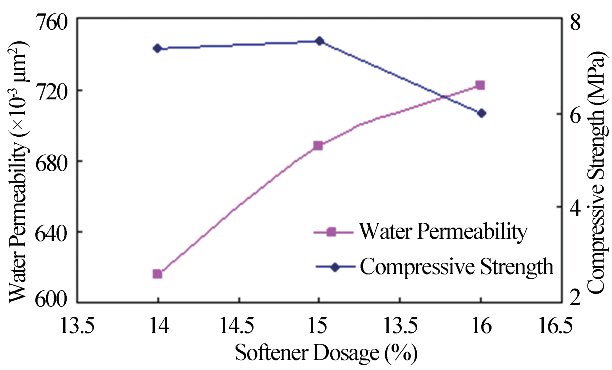

Figure 2
The Optimizing of Softener Dosage

As shown in Figure 2, with the increase of the softener dosage, the compressive strength of the solidified body decreased, water permeability increased. When the dosage of the softener is 14%, the compressive strength is 7.36 MPa and water measuring permeability is 615.46 ×10^{-3} μm^2. When the dosage of the softener is 15%, the compressive strength is 7.50 MPa and water measuring permeability is 688.22×10^{-3} μm^2. When the dosage of the softener is 16%, the compressive strength is 5.98MPa and water measuring permeability is 722.35×10^{-3} μm^2. Therefore, considering the two indexes of compressive strength and water permeability, the appropriate softener dosage is 15%.

3.3 Effect of the Thinning Agent Dosage

The dosage of experimental sand is 100 g, which simulates formation sand. The epoxy resin is taken as the main agent and the dosage is 10 g (10% of the formation sand). The dosage of curing agent is 6.4% of resin, 20%-25% of thinner, 15% of softener, 2% of coupling agent and 10% of fiber. The effect of curing agent on consolidation compressive strength and water permeability is studied and the result is shown in Figure 3.

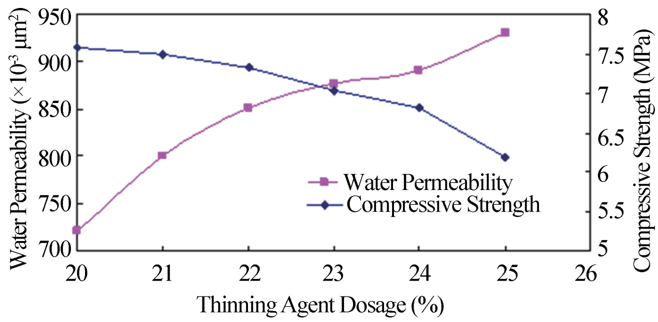

Figure 3
The Optimizing of Thinning Agent Dosage

As shown in Figure 3, with the increase of the thinning agent dosage, the compressive strength of the solidified body decreased, water permeability increased. When the dosage of the thinning agent is 20%, the compressive strength is 7.57 MPa and water measuring permeability is 720.65×10^{-3} μm^2. When the dosage of the thinning agent is 21%, the compressive strength is 7.49 MPa and water measuring permeability is 800.89×10^{-3} μm^2. When the dosage of the thinning agent is 22%, the compressive strength is 7.32 MPa and water measuring permeability is 850.47×10^{-3} μm^2. When the dosage of the thinning agent is 23%, the compressive strength is 7.04 MPa and water measuring permeability is 876.92×10^{-3} μm^2. When the dosage of the thinning agent is 24%, the compressive strength is 6.82 MPa and water measuring permeability is 890.66×10^{-3} μm^2. When the dosage of the thinning agent is 25%, the compressive strength is 6.19 MPa and water measuring permeability is 930.14×10^{-3} μm^2. Therefore, considering the two indexes of compressive strength and water permeability, the appropriate thinning agent dosage is 22%.

3.4 Effect of the Coupling Agent Dosage

The dosage of experimental sand is 100 g, which simulates formation sand. The epoxy resin is taken as the main agent and the dosage is 10 g (10% of the formation sand). The dosage of curing agent is 6.4% of resin, 22% of thinner, 15% of softener, 0%-3% of coupling agent and 10% of fiber. The effect of curing agent on consolidation compressive strength and water permeability is studied and the result is shown in Figure 4.

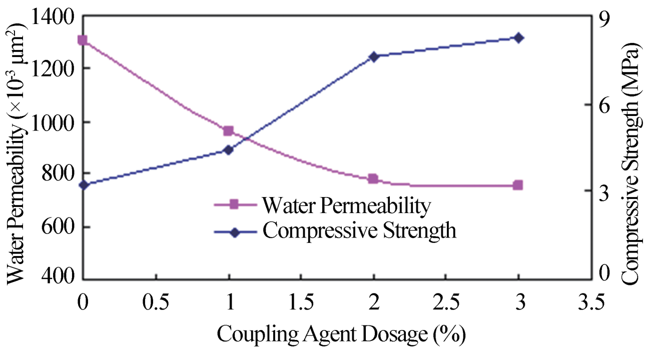

Figure 4
The Optimizing of Coupling Agent Dosage

As shown in Figure 4, with the increase of the coupling agent dosage, the compressive strength of the solidified body increased, water permeability decreased. When the dosage of the coupling agent is 0, the compressive strength is 3.25 MPa and water measuring permeability is 1,302.89×10^{-3} μm^2. When the dosage of the coupling agent is 1.0%, the compressive strength is 4.40 MPa and water measuring permeability is 965.23×10^{-3} μm^2. When the dosage of the coupling agent is 2.0%, the compressive strength is 7.60 MPa and water measuring permeability is 780.18×10^{-3} μm^2. When the dosage of the coupling agent is 3.0%, the compressive strength is 8.23 MPa and water measuring permeability is 750.49×10^{-3} μm^2. Therefore, considering the two indexes of compressive strength and water permeability, the appropriate coupling agent dosage is 2.0%.

3.5 Effect of the Fiber Dosage

The dosage of experimental sand is 100 g, which simulates formation sand. The epoxy resin is taken as the main agent and the dosage is 10 g (10% of the formation sand). The dosage of curing agent is 6.4% of resin, 22% of thinner, 15% of softener, 2% of coupling agent and 5%-15% of fiber. The effect of curing agent on consolidation compressive strength and water permeability is studied and the result is shown in Figure 5.

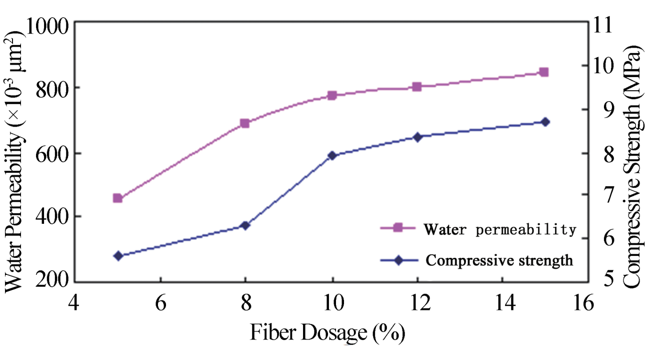

Figure 5
The Optimizing of Fiber Dosage

As shown in Figure 5, with the increase of the softener dosage, the compressive strength of the solidified body increased, water permeability increased. When the dosage of the fiber is 5%, the compressive strength is 5.62 MPa and water measuring permeability is 456.32×10^{-3} μm^2. When the dosage of the fiber is 8%, the compressive strength is 6.32 MPa and water measuring permeability is 688.44×10^{-3} μm^2. When the dosage of the fiber is 10%, the compressive strength is 7.90 MPa and water measuring permeability is 769.96×10^{-3} μm^2. When the dosage of the fiber is 12%, the compressive strength is 8.35 MPa and water measuring permeability is 796.78×10^{-3} μm^2. Therefore, considering the two indexes of compressive strength and water permeability, the appropriate fiber dosage is 10%.

3.6 Effect of the Sand Consolidating Agent Dosage

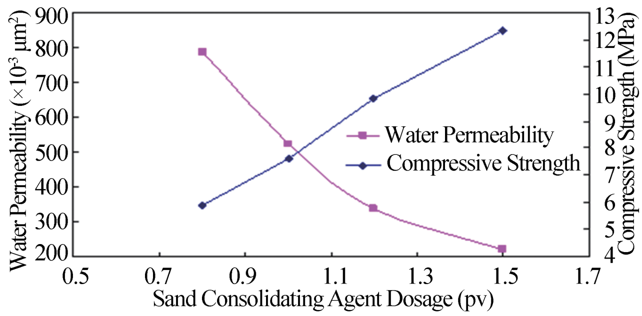

Figure 6
The Optimizing of Sand Consolidating Agent Dosage

As shown in Figure 6, with the increase of the sand consolidating agent dosage, the compressive strength of the solidified body decreased, water permeability increased. When the dosage of the sand consolidating agent is 0.8 pv, the compressive strength is 5.89 MPa and water measuring permeability is 787.96×10^{-3} μm^2. When the dosage of the sand consolidating agent is 1.0 pv, the compressive strength is 7.60 MPa and water measuring permeability is 520.87×10^{-3} μm^2. When the dosage of the sand consolidating agent is 1.2 pv, the compressive strength is 9.83 MPa and water measuring permeability is 338.65×10^{-3} μm^2. When the dosage of the sand consolidating agent is 1.5 pv, the compressive strength is 12.36 MPa and water measuring permeability is 220.47×10^{-3} μm^2. Therefore, considering the two indexes of compressive strength and water permeability, the appropriate sand consolidating agent dosage is 1 pv.

CONCLUSION

(a) With the increase of the curing agent dosage, the compressive strength of the solidified body increased, water permeability decreased.

(b) With the increase of the softener dosage, the compressive strength of the solidified body increase first and then decrease, water permeability increased.

(c) With the increase of the thinning agent dosage, the compressive strength of the solidified body decreased, water permeability increased.

(d) With the increase of the coupling agent dosage, the compressive strength of the solidified body increased, water permeability decreased.

(e) With the increase of the softener dosage, the compressive strength of the solidified body increased, water permeability increased.

(f) Screening of GS sand consolidation agent basic recipe is that epoxy resin is taken as the main agent, the curing agent dosage is 6.4%, softener dosage is 15%, thinning dosage is 22%, the coupling agent dosage is 2% and fiber dosage is 10%.

(g) Considering the two indexes of compressive strength and water permeability, the appropriate sand consolidating agent dosage is 1 pv.

REFERENCES

[1] Dai, C. L. (2001). Sand-consolidation effect of midele-low temperature oil and water wells. *College of Petroleum Engineering in the University of Petroleum*, *25*(4), 58-60.

[2] Zhang, Y. C., & Zhou, A. L. (2000). Research and application of silicate sand consolidation agent. *Drilling & Production Technology*, *23*(6), 60-62.

[3] Gillespie, G., Deem, C. K., & Malbrel, C. (2000, October). *Screen selection for sand control based on laboratory tests*. Paper presented at SPE Asia Pacific Oil and Gas Conference and Exhibition, Brisbane, Australia.

[4] He, S. H., & Zhang, Q. (2003). *The theory and application of sand control in oil well and gas well*. Beijing: China Petrochemical Press.

[5] Dong, C. Y. (2009). *Sand control technology for oil well and gas well*. Beijing: China Petrochemical Press.

[6] Shi, H. S. (2001). Composite perforating and sand control technology. *Explosion and Shock*, *21*(2), 144-149.

[7] Xue, F. (2001). Lease test study of new chemical sand control technique. *Fault-Block Oil & Gas Field, 8*(8), 61-64.

[8] El-Sayed, A. A. H., Al-Awad, M. N., & Al-Homadhi, E. (2001, March). *Two new chemical components for sand consolidation techniques*. Paper presented at SPE Middle East Oil Show, Manama, Bahrain.

