ABSTRACT

With the development of petroleum exploration and development to the deep land and ocean, the contradiction between low pressure and easy loss in the upper part of the long open hole and high temperature and pressure in the lower part of the cementing is increasingly prominent. A 1.20 g/cm³ low friction and ultra-low density cement slurry system was developed to solve the problem of full sealing in long open hole sections. Three Wells were applied in the field, with an average pass rate of 88.0%. The application effect is good, which provides technical support for the safe and efficient development of deep and ultra-deep reservoirs and has broad application prospects.

KEY WORDS: Cementing; loss; ultra-low density; slurry; low friction

INTRODUCTION

With the development of petroleum exploration and development to the deep land and ocean, the contradiction between low pressure and easy loss in the upper part of the long open hole and high temperature and pressure in the lower part of the cementing is increasingly prominent. For example, the platform basin block of Tarim Oilfield is developed for the Ordovician carbonate reservoir [XIE Huiwen, 2004]. The reservoir depth in this area is deep (7200~8000m), and the three-hole well structure is adopted. The two-hole technology casing depth is 5000~7000m, and the three-hole formation is open hole completion. The Permian strata of the Biopen Permian system are developed with igneous rocks (about 2500~5000m depth) [HE Faqi, 2004]. Low leakage pressure coefficient (generally 1.30~1.40g/cm³) and large leakage thickness (about 600~800mm thickness), which makes it difficult to plug the leakage, frequent leakage during cementing and casing running, and extremely difficult to seal the whole well. This requires extremely high construction performance and mechanical properties of ultra-low density cement slurry system. The existing 1.20 g/cm³ ultra-low density cement slurry is prepared by directly adding microbeads under the hollow glass beads-microsilicon system. There are some problems such as poor rheological properties (consistency k > 1Pa·s²), poor settling stability (density difference > 0.05 g/cm³), large water loss (> 50 mL/30min), and slow development of top strength (72h compressive strength < 3.5 MPa). In order to solve the sealing problem of long open hole section, a 1.20 g/cm³ low friction and ultra-low density cement slurry system was formed by developing reinforcement agent, selecting pressure resistant hollow glass beads for close packing design, and selecting comb structure drag reducing agent, low viscosity water loss reducing agent and other auxiliary admixture. The system is suitable for 30~160 °C, slurry consistency coefficient K < 0.5Pa·s², the compressive strength of the top 72h is > 3.5 MPa, the compressive strength of the bottom 24h is > 20 MPa, the compressive strength of the bottom 7d is > 21 MPa, and the long-term strength does not decline, the density change rate of slurry at 90 MPa is less than 1%. At the same time, the construction performance is good, the thickening rate is adjustable, the water loss is low, the stability is good (0.01 g/cm³). It can meet the requirements of full sealing performance in one return of long open hole cementing.

EXPERIMENTAL INSTRUMENTS AND METHODS

Experimental Instruments

8240 High Pressure/High Temperature (HPHT) Consistometers, 7204 Compressive Strength Tester, HTD 7169 fluid loss tester, Fanns (ZNN-D6B) Six Speed Rotary viscometer, Winner100D dynamic particle image analyzer.

Experimental Method


ULTRA-LOW DENSITY CEMENT SLURRY SYSTEM DESIGN

Problems in Ultra-low Density Cement Slurry

The characteristics of long sealing section, easy leakage, high temperature and pressure (circulation temperature up to 110 °C, pressure > 80 MPa) and production casing require ultra-low density cement slurry to have good construction performance and compressive strength. At present, the ordinary ultra-low density cement slurry is a ternary system of cement-microsilicon-hollow glass beads. The overall performance is difficult to meet the requirements of single-stage one-time up-return cementing construction in long open hole section. The main reasons are as follows: the low pressure bearing capacity of hollow glass beads is easy to be damaged in the downhole high pressure environment, resulting in the increase of cement slurry density.