Exploration and Practice of Cementing Technology in Complex Salt-paste Layer
Kangwei Ao1,2,3, Siqi Tu1,2,3, Tianyi Zhang1,2,3, Ziyue Dong1,2,3, Yingjie Li1,2,3, Baohui Zhao1,2,3, Yuanbo Xia1,2,3
1 CNPC Tianjin Bo-Xing Engineering Science&Technology Limited Company, Tianjin, China
2 CNPC Key Laboratory of Drilling Engineering, Tianjin, China
3 National Engineering Research Center of Oil & Gas Drilling and Completion Technology, Tianjin, China

ABSTRACT
Salt-paste cementing has long faced several challenges including narrow density window, high eccentricity of pipe string, small displacement rate, which make it difficult to ensure an adequate cementing quality. Research has been conducted on reaming technology, small collar casing and managed pressure cementing to alleviate these problems. In this work, research in the use of reaming mode, reaming size, casing collar size, managed pressure cementing mode and application has been carried out to develop a set of complex salt paste cementing techniques. This technology was then successfully applied for the first time in well BZ-X in the Kuqa Piedmont, achieving a great breakthrough in the cementing quality of salt-paste layer in this area, and providing a strong reference for similar complex salt-paste cementing at home and abroad.

KEY WORDS: Cementing; Salt-paste; Reaming while drilling; Managed pressure cementing; Kuqa piedmont

INTRODUCTION
The salt-paste layer is a type of high-quality cap layer of oil and gas reservoir, widely distributed in Santos Basin of Brazil, Gulf of Mexico of the United States, Missan oilfield of Iraq, and Kuqa piedmont of Tarim oilfield of China (Zhang, 2018; Wang, 2019; Tian, 2021; Zou, 2021). The salt-paste layer has strong creep property and complex lithology composition, high pressure brine layer and weak layer coexist, resulting in frequent complications, such as stuck drilling, leakage, and overflow. Due to the influence of these geological features, the salt-paste cementing has long been faced with challenges such as narrow density window, high eccentricity of pipe string, small displacement rate and easy channeling in annulus, which make it difficult to guarantee the cementing quality, especially in the Kuqa piedmont.

The salt-paste layer in the Kuqa piedmont has a depth of 3000~6000 m, a thickness of 400~1000 m and has a fast creep rate. High pressure brine layer (pressure coefficient 2.10~2.55 g/cm³) and weak layer (pressure bearing capacity between 2.05~2.20 g/cm³) coexist in the salt-paste layer (Zhou, 2017). The no-collar casing is usually used to seal the salt-paste layer. However, the centralizers cannot be matched in this type of casing, resulting in severe eccentricity and poor displacement environment. In addition, the salt-paste cementing also faces other problems such as small slurry density difference (≤0.05g/cm³) and low annular velocity (0.6~0.8 m/s), that conventional cementing technical measures are difficult to effectively solve. Between 2017 and 2021, the rate of cementing quality of salt-paste layer in the Kuqa piedmont has been less than 50%.

To resolve the problems of complex salt-paste cementing, especially in the salt-paste layer in the Kuqa piedmont, relevant researches in reaming technology, small collar casing, and managed pressure cementing technology were carried out. A set of complex salt-paste cementing techniques was proposed (Table 1). This technique was first applied in well BZ-X in the Kuqa piedmont successfully achieving good cementing quality. The technique has since been widely applied to more than 10 wells.

Table 1. Complex salt-paste cementing techniques

<table>
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<tr>
<th>Technical composition</th>
<th>Technical characteristics and application purpose</th>
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<tr>
<td>Reaming technique</td>
<td>By optimizing the reaming size and reaming mode, the annular clearance is increased to solve the problem that the centralizer cannot be placed under the condition of narrow clearance</td>
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<tr>
<td>Small collar casing</td>
<td>Through scientific design of the size and strength of the collar, a new type of small collar casing is developed to solve the problem that the centralizer cannot be placed in the casing without the collar</td>
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<td>Managed pressure cementing</td>
<td>The application condition and mode of managed pressure cementing technology are clarified, and the complicated problem of leakage and overflow under narrow density window condition is solved by adopting process pressure control technology</td>
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PROJECT OVERVIEW AND CEMENTING DIFFICULTIES

Project Overview
The Kuqa piedmont strata are generally divided into three sets: supra-salt layers, salt-paste layers and sub-salt layers. The fifth-section unconventional well structure (Fig. 1) in Tarim Standard II series (TS-II) is widely used in the Kuqa piedmont and the parameter is: Φ26” (20") × Φ17-1/2” (14-3/8") × Φ13-1/8” (10-3/4") × Φ9-1/2” (8-1/8") × Φ6-