1 Introduction

The relatively high-quality tight sandstones reservoirs is the emphasis of oil exploration phase. Generally dense cases with high pore throat may gather a lot of oil. The quality of high-quality reservoirs is not only determined by the rock size, sedimentary environment and so on, clay minerals also affects the distribution of high quality reservoirs in great degree. The formation and distribution of authigenic illite has strong control function on reservoir physical properties. Authigenic illite is one of common clay minerals, which is generally formed in rich potassium water medium (Yu et al, 2009). The formation of authigenic illite can cause the jams of rock throat (Du et al, 2006; Huang et al, 2009). At the same time, the formation of authigenic illite can cause the dissolution of potassium feldspar (Song et al, 2006; Zhao et al, 2001). Large number of secondary porosity has greatly improved the reservoir property. Accordingly, it can be concluded that the formation, distribution and occurrence of authigenic illite has great significance on relatively high-quality tight sandstone reservoirs.

The study area is the 4th member of Quantou Formation in Daan oilfield. It is the low permeability reservoirs. Reservoir in the study area belongs to feldspar lithic sandstone and lithic feldspar sandstone. It mainly has fine sandstone and siltstone. The clay minerals in the study area mainly have illite, chlorite and illite mixed layer. Most of the clay minerals is illite. The authigenic illite exists in the pore throat. It narrowed the effective pore radius, increase bending degree of the reservoir throat. At the same time, the feldspar secondary dissolution pores formed, which increased the reservoir pore space.

2 Occurrence Characteristics of Authigenic Illite

Clay minerals in the study area are mainly illite, chlorite and illite mixed layer (Jiao et al, 2008). Accounted for 67.4% of clay mineral is illite. Chlorite is 1%. Illite mixed layer is 31.6%. Illite has the highest content, which is one of the key factors that affects the reservoir physical property. It is also one of the important characteristics of Quantou Formation.

Through SEM photomicrographs, we found that the authigenic illite in the study area mainly has three kinds of occurrence. The first one is honeycomb illite. It exists on the surface of rock particle and has the characteristics of illite mixed layer. It is considered to be transformed from montmorillonite. The second one is filamentous illite. Some exists as the bridge between rock particles, some shaped around other clay minerals. It is considered to be transformed from kaolinite. The third one is flaky illite filling between rock particles. It may transformed from montmorillonite or directly crystalized of illite.

Different occurrence of illite exist in the research area. It has few honeycomb illite. Filamentous illite and flaky illite are common. Overall, authigenic illite is widespread in the 4th member of Quantou Formation in Daan oilfield.

3 The Formation Analysis of Authigenic Illite

Authigenic illite usually transformed from other clay mineral (Yang et al, 1988; Tian et al, 2013). Smectite and kaolinite often formed in the precocious diagenetic stage, and they began turn into illite in the middle diagenetic stage. Feldspar is important mineral which is needed for the formation of illite. It is the early formation of the mineral generated into large quantities of illite in the study area.

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3.1 Honeycomb illite

Honeycomb illite wrapped on surface of rock particles in the study area (Fig. 1. (a)). It is not completely packaged, secondary quartz may exists on the surface without illite. Honeycomb illite is considered to be transformed from montmorillonite., It may be the process of the transformation of illite mixed layer. Smectite begin turn into illite in the environment of potassium at 60 °C. Potassium supplied by potassium feldspar. The reaction exists until 120 °C.

3.2 Filamentous illite

Filamentous illite is considered to be transformed from kaolinite. It usually exists between rock particles (Fig. 1. (b)). It must formed in the environment of high temperature and high concentration of potassium. Potassium is generated by potassium feldspar in acidic environment. Hydrogen ions in this kind of acid environment can be generated by kaolinite in high concentration of potassium environment. The combination of two reaction process consist the reaction of kaolinite and feldspar.
3.3 Flaky illite

Flaky illite in the study area has two formation paths (Fig. 1. (c)). The first one is the path of smectite. This reaction still needs a lot of potassium. It is formed in the open environment, which is different from honeycomb illite. Another path is potassium feldspar. It can transform into illite in high temperature acid environment. The acidic fluid mainly comes from the outside world.

4 The Effection of Authigenic Illite on Reservoir

Clay mineral is negatively related to reservoir physical property. Authigenic illite have a different aspect of the impact on reservoir property. It plays the positive role on reservoir property, especially has a great contribution on the formation of secondary porosity.

4.1 The effection of authigenic illite on reservoir property

Tight sandstone reservoir physical properties are important for petroleum exploration and development process. In late diagenetic stage, pore jams can easily form seepage channel connected with poor, forming the heterogeneity microcosmic reservoir, making a lot of remaining oil. The distribution of effective reservoir pore throat decided the oil displacement efficiency in the process.

On the surface, regardless of filamentous or flaky illite can increase the degree of curvature of rock pore, reduce the permeability of reservoir. But the related data in the study area shows that, with the increase of the content of illite, permeability appeared the tendency of increase. The reason is that the formation of illite needs a large number of potassium ion, it will promote the dissolution of potassium feldspar (Fig. 1. (d)). It provides a fairly reservoir throat space, making up the negative impact of authigenic illite on the reservoir physical properties (Fig. 2). Through SEM photomicrographs, we found illite is widespread in rock pore throat. On the other hand, we can also see a lot of dissolution of potassium feldspar who provides extra seepage channel.

Overall, reservoir porosity increases with the increase of illite content. Authigenic illite has complex control function on reservoir porosity. On the one hand, the illite coated on the surface of rock particles can effectively protect the pore space, reduce the number of secondary quartz. Authigenic illite has certain protective effect on rock porosity, but its protective effect may be small relative to the pore space occupied secondary quartz. On the other hand, authigenic illite promote the formation of secondary pore. Although the formation of authigenic illite will occupy some pore space, it requires large amounts of potassium ions to generate the authigenic illite. The potassium ion mostly provided by the dissolution of potassium feldspar, forming a large number of secondary porosity. The generation of illite will not cause apparently reduced porosity. On the contrary, a large number generation of authigenic illite is likely to the increased porosity.

4.2 The effection of authigenic illite on reservoir distribution

Because of the high tight sandstone compaction degree, the low pore space, relatively high-quality reservoir is the important exploration research. Authigenic illite can improve tight sandstone reservoir porosity, it can promote the development of relatively high-quality reservoir.

From the vertical, reservoir property and illite and potassium feldspar has a good corresponding relation. The
study area has a high permeability zone which one corresponds to the high content of illite and low content of potassium feldspar (-2150m--2170m). The study area also has a low permeability zone which one corresponds to the low content of illite and high content of potassium feldspar (-2190m--2210m). Thus it can be seen that secondary pore occupies certain proportion in the study area reservoir, and it mostly associated with illite (Fig. 3.). At the same time, it can be found under the increasing of the illite, potash feldspar content gradually reduced. In the rock pore space, with rise content of potassium feldspar, rock porosity and permeability are decreased. In the process of the formation of authigenic illite, potassium ion is mainly provided by potassium feldspar. Thus we can predict the distribution of high quality reservoirs in the study area according to the content of illite or potassium feldspar. Local secondary pore zone is the key of tight reservoir exploration.

This article is mainly describe the above three issues.

References