Introduction

The Keshen block is a fractured tight sandstone gas reservoir in Tarim Oilfield. The porosity is around 6% to 10%. The permeability varies from 0.1 to 1mD. The fractures of sandstone are developed (Fig. 1). During development of this block, 49 wells have sand samples (Figure 2) collected, which accounts for 53% of existing wells. Due to sanding, 9 wells have had to be shut-in for a long term, which is 34.6% of sand production wells. Moreover, there are more production wells in the Keshen block that face sand production issues every year. Early research has found that excessive production pressure difference is the direct cause of sand production (Wang, H. and Sharma, M. M., 2016; Wang, H. and Sharma, M. M., 2017; Wang, H., Cardiff, P., and Sharma, M. M., 2016; Wang, H., Gala, D. P., and Sharma, M. M., 2017). Based on this, through analysing production data of more than 40 wells in the block, comparing rock mechanical parameters (Tronvoll, J., SkjRstein, A., & Papamichos, E., 1997; Kooijman, A. P., Halleck, P. M., de Bree, P., Veeken, C. A. M., & Kenter, C. J., 1992), and numerical simulation, this paper uncovers the main influencing factors of sand production pressure difference: development of natural fractures, reservoir stimulation, and tail pipe material.

![Imaging logging of fractures](image1.png) ![Laser copolymerization to observe fractures](image2.png)

*Figure 1 Development of fractures in the Keshen area*

![Sand samples obtained in the Keshen area](image3.png)

*Figure 2 Sand samples obtained in the Keshen area*

Development of natural fractures

In rock mechanics experiment, the UCS and elastic modulus of the cores with fractures is significantly lower than that of the cores without fractures (Figure 3). The existence of fractures can cause the reducing of rock strength. The formation with fractures more likely damages than general tight sandstone reservoir (Krieger, K. D., & Pucknell, J. K., 2003; Junmano, T., Lee, B., Grant, G., Raipairi, P., Viriyasomboon, N., & Nopsiri, N., 2016). Moreover, due to the existence of natural fractures, the gas production in layers is unevenly. Through the single-well gas production profile test (Figure 4), the main production zone is 5102-5110m. By numerical simulation, the main production zone can cause an additional pressure difference which is up to 11MPa (Figure 5). The additional pressure difference would increase the risk of sand production in the reservoir.
Figure 3 Comparison of core (with or without fracture) elastic modulus and UCS

Figure 4 Noise Logging (the main production zone is 5102-5110m)

Figure 5 The numerical simulation of an additional pressure which caused by uneven production

Reservoir stimulation
Before production in the Keshen area, the reservoir is generally necessary to be stimulated to create artificial fractures and activate natural fractures for increasing productivity. Observing the core which was fractured by the Brazilian split method in laboratory, a large number of falling sand particles were found on the fracture wall surface (Figure 6). Based on the classification and statistics of 49 sand production wells, the proportion of sand production wells is clearly positively correlated with the scale of stimulation (Figure 7). According to the above two points, it can be exposed the larger the scale of stimulation, the larger the surface area of artificial fractures, the more particles, result in a large amount of sand production. In addition, reservoir stimulation improves the density of fractures and further reduces the overall strength of the rock mass.

![Figure 6 Scanning electron microscope image of crack wall in Keshen area](image)

![Figure 7 Percentage of sanding wells under different reservoir stimulation](image)

**Tail pipe material**

The well intervention was performed on Well XX in the block, the tubing erosion perforation was found at the depth corresponding to the perforation position (Figure 8). According to the analysis, the tail pipe used in the Keshen block is made of ordinary carbon steel. This tail pipe cannot resist the corrosion of acid gases downhole, and the erosion of the production fluid with sand. After a period of time of production, the pipe's support for the cement ring and the open hole gradually becomes invalid (Figure 9), eventually leading to sand production and even the collapse of the borehole wall (Veeken, C.A.M., Davies, D.R., Kenter, C.J., and Kooijman, A.P., 1991; Vásquez H., A. R., Sánchez D., M. S., Yánez, R. L., Poquiamo, W., Rampazzo, M., & El Chirity, K., 1999).

![Figure 8 Tubing erosion of well XX in Keshen area](image)

![Figure 9 Schematic diagram of sand production caused by tail pipe corrosion](image)
Conclusions

Influencing factors of sand production pressure difference in fractured tight sandstone reservoirs:

1. Natural fractures reduce the strength of the rock mass, and cause uneven production which leading to a high additional production pressure difference.

2. Reservoir stimulation increases the fracture area with a large amount of sand particles falling off the fracture wall surface. It also increases rock fragmentation, fracture density, and decreases rock strength.

3. The tail pipe is made of ordinary carbon steel. During production, the perforations are enlarged due to corrosion and erosion, and the casing support to the well wall is reduced.

References


