



## Study on the design method of well completion screen pipe for carbonate reservoir

Syed Murtajiz Hussain Rizvi

Department of Petroleum Engineering, Master Degree, Petroleum Oil & Gas Engineering, Southwest Petroleum University, Chengdu, China

### Abstract

In the acid fracturing of naturally fractured carbonate reservoirs, excessive acid leak off is the main factor limiting fracture propagation and live acid penetration distance. To reduce acid leakage and enhance the stimulation effect, ceramsite loss control agents have been widely applied in acid fracturing. However, the leak off reduction behavior of ceramsite has not yet been systematically investigated. Therefore, a conventional core-flooding acidizing system with a hollowed-out Hastelloy cylinder was used to perform a series of acid leak off experiments. Experimental results show that 1. The smaller the size of the ceramsite, the better the filtration reduction effect; 2. The higher the injection rate, the greater the acid carrying capacity, which is conducive to the loss of the control agent entering the fracture and acid-etched grooves; and 3. Under laboratory conditions, the optimal ceramsite dosage is 4 g. This study deepens the understanding of acid leak off in carbonate reservoirs and provides fundamental information for field acid fracturing design.

**Keywords:** Acid leak off, loss control, agent ceramsite core-flooding

### Introduction

As an vital strategic resource, petroleum plays a significant role in the development of national economies. With the steady growth of China's economy and the ever-increasing demand for fuels, naturally fractured carbonate reservoirs represented by the Tahe oilfield have attracted worldwide attention in the petroleum industry. They have become one of the main areas for China's oil industry to stabilize the East and develop the West. The Tahe reservoir medium is generally composed of karst caves, natural fractures, and solution pores. Furthermore, these reservoir bodies have poor connectivity. Undoubtedly, this reservoir type with no or low natural productivity needs to be stimulated before production.

### Core samples

The core samples in this study were limestone mined from the outcrop of the Tahe carbonate reservoir in northwest China. As the samples were drilled and polished into experimental cores with a 2.5 cm diameter and an approximately 7.8 cm length. Micro-fractures are well developed, and the matrix is relatively tight in the Tahe oilfield. To simulate the fluid loss under natural fracture conditions, the polished core samples were split into two parts using the Brazilian split device. The split cores and device are shown in respectively.

### Gelled acid

The gelled acid formula primarily consists of 20 wt% hydrochloric acid, 0.6–1 wt% thickener (dosage determined by the formation temperature), 1 wt% cleanup additive, 1 wt% clay stabilizer, 2 wt% corrosion inhibitor, and 1 wt% ferric ion stabilizer. The thickener was fully swollen after 20 min, indicating its excellent swelling performance. Furthermore, the hanging and drawing phenomena illustrate that the thickener also has a favorable thickening property.

### Rheometer

The rheological performance of an acid has significant effects on fluid leakage. Hence, the HAAKE RS6000 acid-

resistant rheometer concentric cylinder test system was introduced to evaluate the apparent viscosity and shear thinning properties of gelled acid. The setup consists of a measuring rotor, temperature control system, data acquisition system, etc.

### Core-flooding acidizing system

In this study, the HPHT core-flooding acidizing system was used to investigate the filtration reduction properties of ceramsite. The system includes a displacement pump and a confining pressure pump, three Hastelloy intermediate containers, a pressure differential gauge, a Hastelloy core-holder, a back-pressure regulator, a collector, and a balance. In addition, because the loss control agent (ceramsite) is a solid particle, it is easy to block the pipeline when directly added to the acid during core-flooding experiments.

### Experimental procedure

The acid leak off experiment procedure is as follows:

1. Place the loss control agent in the hollowed-out Hastelloy cylinder; then, connect it to the split core in series and put it into the core holder.
2. Prepare working fluids, including gelled acid and 2 wt% KCl brine. Pour them into different intermediate containers.
3. Install the core-flooding acidizing system and connect the pipeline. Perform evacuation and leak detection. Heat the experimental system to set value.
4. Conduct the acid leak off experiments. Meanwhile, monitor the differential pressure drop across the core sample.
5. Stop pumping when acid breaks through the core sample when the differential pressure is lower than 0.1 MPa.
6. Take out of the core sample and clean the setup. Differential pressure change with time for different ceramsite sizes.

The intergranular pores for the 40/70 mesh ceramsite are large; thus, the plugging effect of the fractures and acid-

etched wormhole is poor. For the 40/70 and 100 mesh ceramsite, the 100 mesh ceramsite fills the pores between the large-sized ceramsite and reduces permeability. Moreover, the 100 mesh ceramsite easily enters the natural fracture entrance, forming a dense shielding layer to prevent acid from flowing into the fracture. Pure 100 mesh ceramsite can enter the fracture with acid, plugging the acid-etched grooves; hence, its plugging effect was optimal.

### Conclusions

In this study, a core-flooding acidizing system with a hollowed-out Hastelloy cylinder was used to conduct a series of core-flooding experiments to investigate the acid leak off reduction behavior of ceramsite. Based on the experimental results and theoretical analysis, the following conclusions can be drawn:

1. Pure gelled acid has a certain filtration loss reduction performance but cannot meet the current field requirements.
2. The smaller the size of the ceramsite, the better the filtration reduction effect. The 100 mesh ceramsite had the best plugging effect.
3. The higher the injection rate, the greater the acid carrying capacity, conducive to the loss of the control agent entering the fracture and acid-etched grooves.
4. Under laboratory conditions, the optimal ceramsite dosage was 4g.

### References

1. Sabry Abd, Chao Chin, Ayhan Ashqar, Moudi Al-Ajmi, Rick Mauro, Mohamed Nada, *et al.* A cohesive technique to optimize an openhole multistage acid frac in unconventional oil reservoir - North Kuwait [R]. SPE 188473, 2017.
2. Han Huifen. Technological measures for improving single-well productivity of gas reservoirs of Upper Sinian Deng 4 Member in the Sichuan Basin [J]. Natural Gas, 2017:37(8):40-47.
3. Dilip Kumar Sarma, Tej Pal, Dileep Kumar, Gopal Lahiri, V V Manchalwar. Application of Closed Fracture Acidizing for Stimulation of Tight Carbonate Reservoir in Mumbai Offshore [R]. SPE 185344, 2017.
4. Arjun Ravikumar, Matteo Marongiu-Porcu, Adrian Morales. Optimization of Acid Fracturing with Unified Fracture Design [R]. SPE 177486, 2015.
5. Shen Hua, Kang Rukun, Wang Xin, Cai Bo, Wu Gang, Lu Haibing. Study on carbonate and complex lithologic reservoir acidizing treatment in Huabei oilfield [J]. DRILLING FLUID & COMPLETION FLUID, 2011:28(1):59-62.
6. Prasad Karadkar, Mohammed Bataweel, Aslan Bulekbay, Mohammed Alabdrabalnabi. Recent Advances in Foamed Acid Fracturing [R]. SPE 192392, 2018.
7. Liu Naizhen, Wang Guoyong, Xiong Xiaolin. Practice and prospect of geology-engineering integration technology in the efficient development of shale gas in Weiyuan block [J]. China Petroleum Exploration, 2018:23(2):59-68
8. Zhang Yang, Yang Xiangtong, Teng Qi, Xu Yonghui, Xue Yanpeng, Xu Guowei, *et al.* Practice and cognition of geology-engineering integration for the production increasing of HTHP ultra-deep tight gas reservoir in Tarim oilfield [J]. China Petroleum Exploration, 2018:23(2):43-50.
9. Zhang Jing, Luo Zhao, Xu Mingqiang, Jiang Hong, Chen Xianjiang, Wang Tengfei, *et al.* Application of geology-engineering integration in development of tight oil in Xinjiang Oilfield [J]. China Petroleum Exploration, 2017:22(1):12-20.
10. Liu Tao, Shi Shanzhi, Zheng Zijun, Ji Yongjun, Wang Lei. Application of geology-engineering integration for developing tight oil in glutenite reservoir by horizontal wells in Mahu sag [J]. China Petroleum Exploration, 2018:23(2):90-103.
11. Zhang Yiming, Cai Bo, He Chunming, Zhang Ruifeng, Li Yongjun, Sun Hailin, *et al.* Volume fracture technology based on geo-engineering integration for ultra-high temperature and ultra-deep heterogeneous carbonate reservoir [J]. Acta Petrolei Sinica, 2018:39(1):92-100.
12. Tanf Bangzhong, Shen Hua, Cai Bo, Wu Gang, Zhao Anjun, Wang Zhi. Study and Application of Stimulation Technology for Tight Oil and Gas Reservoir in Shulu [J]. DRILLING FLUID & COMPLETION FLUID, 2014:31(4):75-78.
13. Wu Qi, Liang Xing, Xian Chenggang, Li Xun. Geoscience-to-Production Integration Ensures Effective and Efficient South China Marine Shale Gas Development [J]. China Petroleum Exploration, 2015:20(4):1-23.
14. Cai Bo, Ding Yunhong, Jin Fengming, Lu Yongjun, Zheng Peifeng, Shenhua. Drilling/completion technologies and multi-stage fracturing optimization design of horizontal well in unconventional right oil/gas development [J]. Drilling & Production Technology, 2013:36(6):17-20.
15. Dai Yong, Hao Libo, Kang Keli, Chen Haiyu. Integrated design & application of drilling & completion and reservoir reconstruction for North Tluwa oilfield H814 well [J]. Xinjiang Oil & Gas (Edition of Natural Science), 2017:13(1):45-49.