Study on Staged Acid Fracturing Technology for Horizontal Wells in Deep Carbonate Rocks

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Abstract

Conventional and general reconstruction is the main way for carbonating horizontal wells, and the communication between acid fracturing and reservoir is limited. The horizontal well section is long, the filtration loss is huge, the acid-rock reaction speed is fast, and the acid loss is serious. Therefore, it is necessary to study the staged acidizing and fracturing technology for horizontal wells and start with the development of staged reconstruction tools to form a series of staged acidizing and fracturing technology for horizontal wells in deep carbonate rocks.

Keywords

Carbonate rocks, Horizontal well, Deep acid fracturing, Acidizing fracturing

Introduction

Because of the strong heterogeneity of carbonate reservoirs, most reservoirs need to transform and communicate with the effective reservoirs near the well zone by acid fracturing to obtain industrial oil and gas flow [1]. In the past, conventional acid fracturing was used in carbonate reservoir reconstruction process, and the type of acid used was mainly gelled acid (surface viscosity 40mPa.s). Conventional acid fracturing technology has three main shortcomings: first, the effective action distance of acid is limited, and the communication ability of acid etching fractures to reservoirs is weak; Second, the acid distribution in the long section of deep well is uneven, and the degree of acid corrosion in the middle and low permeability and high pollution sections that need to be reformed most is low; Third, the vertical directional transformation is difficult. When there is a water layer near the reservoir, artificial fractures are easy to communicate with the water layer, which leads to the failure of transformation. Therefore, it is urgent to explore the deep reconstruction technology suitable for carbonate reservoirs, improve the communication ability between acid fracturing and reservoirs, and improve the single well productivity [2,3].

Deep acid fracturing model of carbonate reservoir

Penetration research and development of deep acid fracturing liquid and the matching of deep acid fracturing technology, a diversified supporting technology for carbonate reservoir reconstruction with the goal of communicating fracture-cavity development zone is formed: drilling the borehole to the top of fracture-cavity and showing good oil and gas, dredging the flow channel and communicating fracture-cavity body by vertical acidification or acid fracturing technology, and the acid type is mainly gelled acid; When the borehole is drilled near the strong reflection zone, and the oil and gas show poorly, and the direction of the maximum principal stress is consistent with the direction of the fractures and caves, the deep penetration acid fracturing technology is adopted to make long fractures, and the effective acid etching

fracture length is increased to communicate the fractures and caves. The main types of acid used are temperature-controlled viscous acid and cross-linked acid, and new acid liquid systems such as authigenic acid and solid acid are explored [4,5]. When the borehole is drilled near the strong reflection area, the oil and gas display is poor, and the direction of the maximum principal stress is not consistent with the direction of the fracture and cave, then the turning joint is made by turning to acid fracturing technology to communicate the fracture and cave body, and the turning technology adopts clean self-turning acid fracturing or fiber forced turning acid fracturing; When the borehole encounters a fractured porous reservoir with random reflection, but the oil and gas display is not good, the main goal is to establish a flow channel with high conductivity, and the transformation process adopts sand fracturing or cross-linked acid with sand acid fracturing (Table 1).

Table 1. Depth Reconstruction Model of Carbonate Reservoir.

Drilling situation	Transform the dominant thinking	Technique
Direct drilling meats “beading” and oil and gas show well	To relieve injury, the medium and small-scale acid fracturing process is optimized	Vertical acidification (pressure)
Drilling the strong reflection area shows poor display, and the fracture matches well with the in-situ stress direction	A long acid corrosion crack is formed, considering the high conductivity of the crack	Deep penetration acid fracturing
Drilling to strong reflection area, poor display, mismatching in eustress direction	Turn to acid fracturing and use diverting agent to forcibly turn to communicate with reservoirs	Steering acid pressure
Borehole drilling encounters fractured and porous reservoirs with random reflection, but the oil and gas display are not good	The main goal is to establish a flow channel with high conductivity	Sand fracturing, cross-linking acid carrying sand and acid fracturing

Investigation and optimization of mechanical sectional transformation tools

Through the investigation and optimization of reconstruction tools, the technologies suitable for staged reconstruction of deep carbonated reservoirs are multi-stage packer technology and hydraulic injection induction technology. It has the following technical advantages and disadvantages.

(1) From the perspective of tool technology, the multi-stage packer technology has the advantage of safety, and the hydraulic jet induction technology has certain well control risks because it needs to replenish or inject fluid from the casing, so it needs to be further improved to adapt to the carbonate rock subsection transformation of ultra-deep horizontal wells [6].

(2) Post-production problem: In the open hole reconstruction by force injection induction technology, because there is no isolation between layers, only multi-layer combined production can be adopted in the case of heavy completion production string; For the multi-stage packer technology, if the fracturing sliding sleeve can’t be closed after opening, it can only be produced jointly, and once the water comes out of the first layer, it will bring great influence to production [7-10].

This situation not only reduces the flexibility of reservoir management but also limits the ability to implement targeted stimulation measures for individual layers.

Conclusion

Through the development of high temperature resistant open hole packer and fracturing sliding

sleeve, the open hole packer sliding sleeve is configured to transform the pipe string in sections; Through the development of full-diameter pressure-controlled screen pipe, the full-diameter sectional reconstruction pipe string is configured; By developing a hydraulic jet sectional tool suitable for deep well operation, a hydraulic jet sectional acid fracturing string is formed, which supports the efficient development of carbonate horizontal wells in platform basin area.

Funding

This work was not supported by any funds.

Acknowledgements

The authors would like to show sincere thanks to those techniques who have contributed to this research.

Conflicts of Interest

The authors declare no conflict of interest.

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