The use of a liquid destructor with flow into the stream during the injection of the fracturing mixture

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Abstract. For most modern development systems, hydraulic fracturing is the main method of intensification and maintenance of hydrocarbon production. Hydraulic fracturing is achieved with the volume of communicating voids between the granules of fractional proppant. The volume of voids should be maximized, which is achieved by selecting the optimal proppant fraction composition, and in addition, hydraulic fracturing fluid, the choice of which is based on a number of competing factors: high viscosity, which provides the necessary hydraulic width created at the buffer stage of the crack, as well as prediction of subsidence proppant in the fracture and subsequent premature stop of the injection, which creates additional costs. One of the new solutions, which will increase the efficiency and expand potential objects for hydraulic fracturing, is the use of a liquid destructor with a flow into the stream during the injection of the fracturing mixture.

1. Introduction

For most modern development systems, hydraulic fracturing is the main method of intensification and maintenance of hydrocarbon production. Non-traditional collectors are commissioned, the industrial development of which is not economically feasible without the use of relevant intensification methods. Proppant ones are distinguished among the types of hydraulic fracturing, the effectiveness of which is ensured by the proppant delivery to the fracture. Proppant stages can be both basic for traditional treatments of terrigenous strata and part of complex hybrid processes [1, 2].

The efficiency of a hydraulic fracture fixed by a proppant is achieved by creating a volume of communicating voids between the granules of fractional proppant. To achieve the greatest conductivity of the fracture, the volume of voids should be maximum, which is ensured by selecting the optimal fractional composition of proppant, as well as hydraulic fracturing fluid. Against the background of an obvious correlation between the conductivity and the fractional composition of the proppant, the significance of hydraulic fracturing fluid is often underestimated, which can lead to failure when trying to achieve the planned rates of flow rate growth. The conductivity is achieved by the proppant fixed in the formation and can be significantly reduced by the remains of the undamaged fluid.
2. Materials and methods
Hydraulic fracture fluid selection is based on a number of competing factors. So, to ensure the technological feasibility of using proppant of a larger fraction, it is necessary to use a more viscous liquid to prevent technological complications during work. Insufficient viscosity can lead to the loss of hydraulic width created at the buffer stage of the hydraulic fracture process, as well as to unpredictable proppant sedimentation in the fracture and subsequent premature injection stop. In this case, the planned proppant volume is not placed in the fracture, the proppant pumped into the formation is not efficiently fixed, and the proppant remaining in the technological tubing must be removed, which can lead to additional costs [3–5]. On the other hand, an unreasonably high viscosity of the fluid used can lead to the formation of a crack with non-optimal geometry. In particular, it can lead to a decrease in the residual conductivity due to an increase in the mass of the gel reaction products with the destructor, partially clogging the void space of the proppant crack (figure).

A tool for controlling the liquid viscosity is a way to control the concentration of applied chemicals, including a gelling agent. After creating, fixing, and closing the fracture, the fluid viscosity required for proppant transportation becomes a negative factor preventing the flow of fluid through the fracture created by hydraulic fracture. Slow destructors are used to “activate” the operation of the fracture, which allow the proppant to be transported into the fracture, and then release the pore space of the proppant pack for fluid flow. Increasing the load of the gelling agent leads to serious requirements for the quality of the destructor, which ultimately imposes a restriction on the use of hydraulic fracture technology in general.

![Figure 1](image.png)

**Figure 1.** The effect of non-destroyed gel on conductivity

3. Results and Discussion
Thus, the success of the hydraulic fracture process depends on the quality of the gel destruction. The aim of this work is to increase the efficiency of proppant hydraulic fracture by modernizing the breaker system.

Previously used breakers are solid. Adding a breaker to the gel is done by mixing a powdery destructor with a liquid gel. For mixing, a dry chemical reagent feeder was used, as a result of which the concentration of the reagent could not be properly controlled. We monitored the operation of the
mechanism, but the amount of reagent passing through the mechanism could not be fixed. In the absence of control, the actual breaker concentration could be either overstated or underestimated. A reduced concentration of the breaker leads to a significant decrease in the effect of hydraulic fracture, while an increased concentration can lead to technological complications during the process [6–8].

One of the new solutions that made it possible to increase the efficiency and expand potential objects for hydraulic fracture was the use of a liquid destructor with feeding into the stream during the injection of the fracturing mixture. To ensure correct control, as well as for uniform distribution of the reagent in the hydraulic fracture mixture, the use of a liquid destructor was introduced. The new destructor is also an oxidizing destructor, as well as a dry analogue. The effectiveness of its application is achieved due to a more correct and confirmed application during proppant hydraulic fracture.

The ready-to-use destructor is supplied as a liquid in a sealed container, which eliminates incorrect proportions when preparing the fluid at the well. Using a separate liquid chemical feed pump, the destructor is fed into the hydraulic fracture mixture stream. In this case, the flow control is carried out by direct measurement using flowmeters at the pump outlet, in front of the main line. The implemented solution allows not only to control the supply of the destructor in real time, but also to carry out claims or research work using digital data records.

Thus, we introduced a new tool for monitoring and controlling both classical and hybrid hydraulic fracture processes into the study. This technology is most relevant for traditional proppant hydraulic fracture in terrigenous reservoirs, where the conductivity of the created fracture is the main criterion for the success of the whole process.

The introduction of this technology allowed expanding the scope of well selection for hydraulic fracture. It became possible to ensure the destruction of a denser viscous gel with a high load of the gel-forming agent necessary for hydraulic fracture under conditions of increased geomechanical stresses. The sampling results indicate the successful cleansing of the created crack from the remnants of a highly viscous gel.

An important positive factor in the application of this technology is the additional control of hydraulic fracture contractors. Additional material is provided for the research, in the event of a flow decrease after hydraulic fracture. A common cause of this complication can be the absence or improper supply of the destructor [9–12].

4. Conclusion
Based on the results of technology implementation, the following conclusions are formulated:

1) for all proppant hydraulic fracture it is advisable to use chemical reagent systems involving the use of a liquid destructor with a feed into the stream;
2) it is necessary to develop breaker systems. Under conditions of controlled use of a liquid destructor, it becomes possible to select reagents with an increased reaction rate and even more complete destruction of the gel.

The search for the reasons for the failure of the geological and technical measures is one of the tools for improvement and further development, without which it is impossible to maintain production with the involvement of hydrocarbon reserves previously considered unconventional. Another important step has been taken towards the control of high-tech methods of well stimulation.

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