Improve Fracturing Fluid Recovery to Reduce Environmental Contamination

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Abstract. Hydraulic fracturing is one of the most important stimulation for our unconventional reservoir development. In this article, we analyze environmental impact from fracturing fluid. We also give measures to control contaminations. It contains enhancing recovery of fracturing fluid and strictly treatment of fluids.

Introduction

Recently, oil development converts to unconventional reservoir. The permeability of this type of reservoir is usually less than 1mD. In order to get more oil and gas, we must use hydraulic fracturing. Horizontal well is popular used in the development of unconventional reservoir. It is discharge capacity and liquid level is more than five times of conventional reservoir. In the process of fracturing, large amounts of fluids are injected to formation. After fracturing is finished, some of fluids are flow back to ground, and others still reserved in the formation. If we don’t managed carefully, our environment will be polluted. So we should focus on the treatment of fluids after fracturing.

Environmental Impact from Fracturing Fluid

Increase Waste Liquids

Hydraulic fracturing is one of the most important stimulation for unconventional reservoir development. After drilling in unconventional reservoir, only some wells which have abundant natural fractures can product directly. More than 90% wells can reach expected production through fracturing. Horizontal well is popular used in the development of unconventional reservoir. It is discharge capacity and liquid level is more than five times of conventional reservoir. Because of that, fracturing fluids increase dramatically. So we get much more backflow fracturing fluids with complex components than before. Now the impact from hydraulic fracturing is more and more obvious.

Contamination to Underground Water and Environment

After fracturing, flow-back not on time or low recovery of fracturing fluid both can leave some fracturing fluids in the earth. If there is underground water resource near in the oil and gas reservoir, fracturing can communicate underground water. It will lead to serious pollution.

There are a variety of additives with complicated compounds. Different fracturing fluid systems have different ingredients. If we can’t handle them with appropriate method, contaminations from fracturing fluid will seep into underground. The quality of underground water can be affected severely. Besides, the pollutions from recovery fracturing fluids may spread to a river with the scour of the rainstorm. It will pollute water on the ground [9]. There are also some kinds of heavy metal element in the recovery fracturing fluids. Because of stable property, heavy metal elements are hard to be removed if they absorbed by soiled. The effect is not obvious in a short time that to ground water and plants. But more and more heavy metal elements accumulate in soil, the fertility of soil will be declined. It’s bad for the grown of crops and vegetations. After that, the environment is destroyed.
All compounds from recovery fracturing fluids can affect the terrestrial animals and plants, so our health will be harmed ultimately [10].

According to the report from Environmental Protection Agency (EPA) in Nov 2011, Naphthalene; phenol; mixture with gas and diesel were found in underground water in Wyoming (refer with: Fig. 1). It was proved the source of pollution from hydraulic fracturing by Encana, which is an energy company from Canada. From 2008 to 2012, there were more than 1000 times of water pollution near in the fracturing well in America. In America, the boom of hydraulic fracturing to develop the gas had resulted in water pollution, air pollution and disease. Bill Mckibben, who is a Climate change campaigner and research scholar of living conditions in Vt.- Middlebury College, said that hydraulic fracturing had resulted in some serious environmental problems. These problems include underground water pollution and river pollution resulted from recovery fracturing fluid.

Figure 1. Operation of hydraulic fracturing in North Dakota.

The Backflow and Treatment Situation of Fracturing Fluids

The Backflow Situation of Fracturing Fluids

Hydraulic fracturing is one of the most important stimulation for unconventional reservoir development [1]. According to the practice: flow back rate of fracturing fluids closely related to geologic characteristics of reservoir. By stratum energy's influence, the minimum recovery of fracturing fluids is only about 10%. It is an important problem to solve for unconventional reservoir development.

The Treatment Situation of Recovery Fracturing Fluid

Because of a large number of additives, recovery fluid has high viscosity and high stability after the fracturing [2]. Many types of additives, which contain some hydrophilic organic additives, lead to the high value of COD (chemical oxygen demand). It’s hard to decline the COD (chemical oxygen demand). If these fluids emission untreated, our environment will be polluted seriously. There are several methods to handle with our recovery fracturing fluids. Chemical coagulation method is a common pretreatment method. It’s main mechanism includes absorption and bridge, charge neutrality, the double layer electric field and sediment capture. After treatment by coagulation, the value of COD (chemical oxygen demand) can decline to 73% [3]. Chemical oxidation is also used popularly. Through strong oxidant, the organic and inorganic matter from recovery fluid can be oxidized or decomposed. This method can decline the content of COD (chemical oxygen demand). By sodium hypochlorite, Li-Ping Wan [4] pretreated the recovery fluids of tan 23 well in Nan-Yang oilfield, the value of COD (chemical oxygen demand) can decline 48%. AOP (advanced oxidation technology) is a new technology appeared in 1990 [5]. It is a process of organic degradation under the action of physico-chemical treatment. So this popular method can be controlled easily. It can be used alone or together with other similar technologies. Besides, there are some other methods to handle
with our recovery fracturing fluid, including internal electrolysis, activated carbon adsorption process, biology method, solidified method and so on [6,7,8].

**The Existing Problems**

Now we usually combined several treatment technologies. So the content of pollution material will be reduced to satisfy the environmental protection standard. But the cost of this method is too high. It cannot achieve large-scale application. Once the fracturing fluid increased dramatically, the recent level of treatment cannot meet practical requirement.

**Reduce the Pollution to Environment**

**Increase the Recovery of Fracturing Fluids**

- **Research Environmental Friendly Fracturing Fluid and Exclusive Water Treatment Agent.**
  The additives of fracturing fluid contain complicated components and different types. In the process of research and development, it is best to choose the additives that can satisfy the environmental protection standards. It is also need to test strictly according to relative standards. In order to decline the content of pollution as much as possible, the property of gel breaking is need to be improved.

  Now, the research of water treatment agent has changed positively. At first, inorganic polymer was changed to organic polymer. Then natural organic polymer was changed to modified and synthetic organic polymer. These variations reflect that the water treatment agent developed in the direction of new type, high efficiency, clean and non-toxic gradually.

  **The Technology of the Liquid Nitrogen.** Wells with low pressure factor have not enough stratum energy, it can result to low recovery rate. The technology of the liquid nitrogen can improve this situation. On the one hand, the liquid nitrogen can prove the high pressure energy. It can enhance the recovery rate. On the other hand, the injection of liquid nitrogen can decline the damage to reservoir.

  Xin-Wen Wang[11] and some others recommend that the reasonable proportion is between 7% to 9%. Through the field test, the recovery can reach more than 40% in four hours when the proportion is up to 7%. In the field of LS32D well, two pump trucks were used to inject the liquid nitrogen (the proportion of nitrogen is about 7%). After fracturing, the recovery is nearly to 85%, which is much better than expected.

  **Inject Waterproof Lock Agent.** For the low permeability, waterproof usually exist in the whole process of fracturing [12]. For example, we do gas flooding experiments for different intensity of waterproof [11]. The result shows that the effective permeability of gas recover with the increase of cumulative gas, even bound water exists. When the mount of gas is little, the effective gas permeability is low. It reflects the impact to permeability from waterproof. The experiments choose the artificial core. the result shows that the waterproof remover rate can reach 81.2%. The waterproof damage will be prevented and removed effectively. (refer with: Fig.2)

![Figure 2. Permeability recovery test of core.](image-url)
Treat Recovery Fluids Strictly and Protect Environment

Manage the Emission of Fracturing Fluid. In the operation field, the relative environmental protection standards need to be executed strictly. Under big tanks and the pipeline, it is necessary to cover the thick anti-seepage cloth and absorbed the residual fluids on the anti-seepage cloth by automatic absorbing truck. This method can avoid land pollution from the leakage fluid from pipeline. After fracturing, the flow back fluids need to be putted in to specialized tanks. Then deal with them in combination station together. According to integrated wastewater discharge standard, test the main pollution indicator from recovery fluids strictly. It can be discharged only after meeting standard requirements.

Recycle the Recovery Fluids. With the development of shale gas in domestic, factory fracturing was scheduled. It means the operation will be fixed in a well site. So fracturing fluids and proppants will be pumped into target zone continuously. Through this way, we can save our operational time and reduce the cost. The advantages of factory fracturing are the convenience of recycling and centralized treatment so we can reduce the discharge of waste water and recycle the water resource. This mode provide referential experience of fracturing treatment in domestic. All fields are practicing this technology. Dagang oilfield has completed the field test now. It lays the foundation of recovery fracturing fluids treatment.

Summary

In the process of fracturing, low recovery of fracturing fluid and trouble treatment of recovery fluids are problems for us now.

The fracturing fluid not only damage the reservoir, but also pollute the underground water and ground crops.

We can use some measures to advance the recovery of fracturing fluids. For example, the research of new type of environmental protection fracturing fluids, the technology of liquid nitrogen and waterproof agent.

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