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ANALYSIS OF COMPARABLE AMOUNTS OF HYDRAULIC FRACTURE OIL RESERVOIR AND PROPPANT PUMPED INTO THEM

POMASHEV ONAL PARMANKULOVICH, MUSABAYEV MALIK OMAROVICH, SARYBAYEV MADIYAR ABDULLAEVICH*, KAZYBAYEVA SAULE SAGYNDYKOVNA, AKASHEV BAUYRZHAN TURSUNBEKOVICH and KAZANGAPOV ADIL ENSEBAEVICH

Institute of Geology and Oil Gas Business after K. Turysova, Kazakh National Technical University after Name of K. I. Satpayev, ALMATY, REPUBLIC OF KAZAKHSTAN

ABSTRACT

At present, hydraulic fracturing of horizontal wells has become a widely used technology in stimulating tight oil reservoirs. However, the treatment of hydraulic fractures in numerical simulation of multi-fractured horizontal wells in tight oil is excessively ideal. Effects of some fracture properties on numerical simulation of tight oil are usually not taken into consideration. Actually, fracture geometry in the reservoir is complex and fracture permeability is not a constant value. Numerical model without these factors may lead to a significant error in forecasting the reservoir response. Hydraulic fracturing and horizontal wells are not new tools for the oil and gas industry. The first fracturing experiment was in 1947 and the process was accepted as commercial by 1950. The first horizontal well was in the 1930's and horizontal wells were common by the late 1970's. Even shale gas, especially from the Devonian shales, is not new producing intervals.

Key words: Hydraulic fracturing, Horizontal wells, Cracks and oil reservoir.

INTRODUCTION

Hydraulic fracturing is presently the primary stimulation technique for oil and gas production in low-permeability, unconventional reservoirs. Comprehensive, published, and publicly available information regarding the extent, location, and character of hydraulic

*Author for correspondence; E-mail: sarybayevmadiyar@yahoo.com

fracturing in the United States is scarce. This national spatial and temporal analysis of data on nearly 1 million hydraulically fractured wells and 1.8 million fracturing treatment records from 1947 through 2010 (aggregated in Data Series 868) is used to identify hydraulic fracturing trends in drilling methods and use of proppants, treatment fluids, additives, and water in the United States. These trends are compared to the literature in an effort to establish a common understanding of the differences in drilling methods, treatment fluids, and chemical additives and of how the newer technology has affected the water use volumes and areal distribution of hydraulic fracturing. Historically, Texas has had the highest number of records of hydraulic fracturing treatments and associated wells in the United States documented in the datasets described herein. Water-intensive horizontal/directional drilling has also increased from 6 percent of new hydraulically fractured wells drilled in the United States in 2000 to 42 percent of new wells drilled in 2010. Increases in horizontal drilling also coincided with the emergence of water-based "slick water" fracturing fluids. As such, the most current hydraulic fracturing materials and methods are notably different from those used in previous decades and have contributed to the development of previously inaccessible unconventional oil and gas production target areas, namely in shale and tight-sand reservoirs. Publicly available derivative datasets and locations developed from these analyses are described[1].

Currently, many oil and gas industry researchers devote their work "fractured oil reservoir", which is performed after the completion of drilling wells to enhance oil recovery (or gas recovery) formation. It is known that hydraulic fracturing is performed in the vertical and horizontal wells. Injected with the fluid proppant (or sand) of various sizes to proppant in the fracture pausing, hampered by the closing of cracks formed. Many papers are: the mass of injected proppant; parameters (supposedly measured) formed cracks; horizontal or vertical cracks about the axis of the borehole; and (in very rare cases) the number of cracks of 1 to 5, which are formed by fracturing[1].

Hydraulic fracturing is a safe, proven and government-regulated technology that has been used in Canada for more than 60 years. In hydraulic fracturing, fluids are injected at pressures that exceed the natural stresses on the rock and cause it to crack, or fracture. Creating these fractures in hydrocarbon-bearing rock layers deep underground is not enough to allow oil and gas to flow into the wellbore.

Once the fractured reservoir rock is held open with fluid pressure, proppant, usually sand or ceramics, is introduced into the fluid to prop open the fractures. After the hydraulic fracturing process, the fracturing fluids are recovered and the fractures remain held open by proppant. The hydrocarbons trapped inside the rocks can now flow more easily through the cracks to the wellbore[1].

The problem of hydraulic fracturing experimenters performing their work under natural conditions; theorists, such as G. I. Barenblatt, A. M. Linkov, P. A. Martynyuk, A. V. Panov, E. N. Sher et al. As well as fans of the simulation of complex processes that are running a simulation in the field of hydraulic fracturing nothing significant in itself does not contain.

In our previously published article noted that in compressed on all sides by rocks formed grooves with EMG, not crack "fracturing". The length of the grooves, i.e. "fracture half-length" from the well can grow as much as necessary, until the pump is running, the injected fluid, so in the literature are "half-length" grooves, reaching up to 1000 meters and more.

The positive effect of providing a groove reaching the "pillars of oil," i.e., the authors here do not deny the positive effect produced by hydraulic fracturing. The only thing we want researchers have moved from the terminology of fracturing the formation of radial length of the grooves, and the publishing articles about pseudoscientific "fracture parameters; Among them on; its width from 1 to 10 mm; its half-length, ""the development of different types of proppants", which differ from each other by various physical and mechanical properties, etc.

In this paper, the authors reveal the many absurdities in the publications of researchers, where these are related to absurdity: a mass of injected proppant in micro cracks; half-length "fracturing"; width "cracks (from 1 mm to 20 mm)"; the number of images "micro cracks (from 1 to 5 units)," etc.

We use materials of hydraulic fracturing, containing the size of the above values. The authors of this article have selected calculation method, which is easier to understand and clearly shows the inconsistency of the results of individual publications associated with marked performance hydraulic fracturing.

For example, the review article from the Internet "Hydraulic fracturing" contains that "was designed crack half-length of 120 m and a total height of 36.6 meters." After fracturing in the Bazhenov Formation wells began to gush (1988). Thus pumped "from one to tens of tonnes of proppant." In this example, the mass of proppant take approximately equal to 30 m, and perform the following calculations:

$\frac{30\ \text{m}}{2.5\ \text{m/M}^3} = 12\ \text{M}^3$ - This volume covers the entire mass of proppant;

$(120 \cdot 36.6) \cdot 2 \cdot 0.002 = 17.568\ (\text{M}^3)$ - This volume has a "fracture".

In this example, the constant 2.5 - Adopted (average) share of proppant

t/m^3; 2-takes into account both the crack propagation in the opposite directions from the wellbore; 0.002 m-crack width, adopted from the literature (from 1 to 20 mm). These values are used in subsequent calculations.

From[2] performed calculations show that the amount equal to one horizontal cracks $V_{mp} = \pi \cdot r^2 \cdot b = 3.14 \cdot (305)^2 \cdot 0.002 \cong 876.3\ (\text{M}^3)$, and the volume of injected proppant is 544.309 м^3, which can be distributed through cracks: 544.309/876.3 ≅ 0.621 ≅ 0.6 (cracks).

From the same paper[1] the second example of the calculation gives the following results: $V_{mp} = 3.14 \cdot (30)^2 \cdot 0.002 \cong 5.65\ (\text{M}^3)$; $V_{npon} = 45/2.5 = 18\ (\text{M}^3)$, and the volume of proppant is distributed along the cracks:18/5.65 ≅ 3.2 (cracks).

In[3] from the data we have an average fracture half-length equal to (40+50+100)/3 ≅ 63 (м); volume of one crack $3.14 \cdot (63)^2 \cdot 0.002 \cong 25\ (\text{M}^3)$; the volume of proppant 100/2.5 = 40 (м^3). This volume is distributed over the proppant 40/25 ≅ 1.6 (cracks).

In[4,5] is a long "cracks" in the form of a saw tooth. Such forms may have only grooves which, skirting the natural structural blocks, grow and branch out when the pump is pumped fracturing fluid into the well.

In[6] wrote that studies on models shown fixed fracture half-length of 40 m and a width of 5-20 mm" Here crack width equal to 20 mm - obviously inflated value, as in natural groundwater conditions cheeks cracks cannot be separated by a distance of 2 cm. These absurd results leads, namely, modeling of complex processes in the subsurface fracturing of core or other materials.

In[7] the authors has a volume of one crack $3.14 \cdot (30)^2 \cdot 0.002 = 5.652\ (\text{M}^3)$, а закачанный проппант – 21/2.5 = 8.4 (м^3). The distribution of this volume of proppant through cracks gives the number of cracks: 8.4/5.652 ≅ 1.5 ≅ 2 (шт.). In this example, it must be assumed that the mass of proppant that spans the grooves is chosen correctly, despite the expected distribution of his "reservoir fracture."

In volume[8] shows that in one well uploaded 400/6 ≅ 66.7 (т) proppant that the screen will 66,7/2.5 ≅ 26.7 (м^3). One crack of this work has a volume equal to $3.14 \cdot (25)^2 \cdot 0.002 = 3.925$ (M^3). Define how many cracks can accommodate the volume of proppant 26.7 м^3? i.e. 26.7/3.925 ≅ 6.8 ≅ 7 (cracks). Here I must say that a lot of real flutes and they completely absorb the reduced volume of proppant and formation of 7 "cracks" EMG unrealistic.

From Review[9], we have that in Germany there have been several tens of massive hydraulic fracturing. Proppant flow 100 t / well. A third of cases - 200 tons/well. And during major operations reached 400 ... 650 t / well. The crack length was varied from 100 to 550 m, height of 10 to 115 m ". In terms of the first magnitude of these parameters can be calculated: the amount of crack $V_{mp} = 100 \cdot 10 \cdot 0{,}002 = 20(м^3)$; proppant $V_{npon} = 100/2{,}5 = 40(м^3)$. V_{npon}/V_{mp} gives the value of 40/20=2 (cracks). Assuming a real education grooves and unreal education "fracture" in rocks oil reservoir, we believe that 100 tons of proppant is distributed in a variety of radially extending grooves from the well.

In[10], taking half-length "cracks" of 16 m and using the remaining data, you can perform the following calculations: 1) the volume of proppant 83/2,5=33,2 and 31/2,5=12,4 (м^3). The volume of one crack is: $3{,}14 \cdot (16)^2 \cdot 0{,}002 \cong 1{,}61(м^3)$. We calculate the number of cracks for placing proppant volumes 33,2 и 12,4 м^3. These numbers are the following: 33.2/1.61 ≅ 20.6 ≅ 21 и 12.4/1.61 ≅ 7,7 ≅ 8 (cracks). The results show that the formation of 21 and 8 pieces of "fracture" in one well is unrealistic, so it must be assumed that the entire proppant spread along the grooves formed by the radial directions from the wells in the oil reservoir rocks.

In a fairly large[11] material when calculating the number of cracks in terms of proppant pumped into the "fracture", lead to the following contradictory results. When the mass its proppant 20t distribution occurs in the fractures 6, i.e. $V_{npon} = 20/2.5 = 8$ (M^3); $V_{mp} = 3.14 \cdot (15)^2 \cdot 0.002 = 1.413$ (M^3) и 8/1.413 ≅ 5.7 ≅ 6 (cracks). In the second example of the same article, we have calculated values: $V_{npon} = 100/2.5 = 40$ (M^3); $V_{mp} = 3.14 \cdot (100)^2 \cdot 0.002 = 62.8$ (M^3) и 40/62.8 ≅ 0.64 (cracks). And in the third case, the crack width authors give equal ≈ 10 мм, so $V_{npon} = 100/2.5 = 40$ (M^3), $V_{mp} = 3.14 \cdot (100)^2 \cdot 0.009 = 282.6$ (M^3) and 40/282.6 ≅ 0.14 (cracks). That is, the number of calculations reveals cracks: 6; 0.64 and 0.14 pc. Such spreads show that the distribution of proppant happens is, according to numerous grooves formed during hydraulic fracturing[12].

In[13], the following data: the half-length "fracture" of 30 and 85 m; proppant mass of 100 and 300 m. Using these data, perform the following calculations: 1) $V_{npon} = 100/2.5 = 40$ (M^3), $V_{mp} = 3.14 \cdot (30)^2 \cdot 0.002 = 5.652$ (M^3). Their attitude gives the number of "fracture", i.e. $V_{npon}/ V_{mp} = 40/5.652 \cong 7.1$ (cracks); 2) $V_{npon} = 300/2.5 = 120$ (M^3); $V_{mp} = 3.14 \cdot (85)^2 \cdot 0.002 \cong 45.37$ (M^3) $V_{npon}/ V_{mp} = 120/45.37 \cong 2.6$ (cracks).

Summary analysis of the resulting numbers cracks with hydraulic fracturing, "obtained by calculation: 0.7; 0.6; 3.2; 1.6; 1.5; 6.8; 2; 2.6; 21; 7.7; 5.7; 0.6 and 0.1 units showed that researchers fracturing presumably take an equal number of expected cracking most often from 1 to 2, at least from 3 to 8, and their number is equal to 21 units, and 0.1 seem, unreal.

These analyses have demonstrated that hydraulic fracturing treatments are neither temporally nor spatially equivalent; therefore, comparisons and assumptions regarding attributes of individual applications should be made with caution. There have been significant advancements in both drilling and treatment fluids since their initial applications, most strikingly since 2000. The most recent hydraulic fracturing production methods have resulted in a dramatic increase in oil and gas development, particularly in shale reservoir rocks previously considered too impermeable or uneconomic for exploitation. Between 2000 and 2010, the greatest number of hydraulic fracturing treatments were applied to wells drilled within the Appalachian, Gulf Coast, and Permian Basins, but hydraulic fracturing is in widespread use for the development of unconventional, continuous oil, natural gas, and natural gas liquid accumulations in most of the major oil and gas basins within the United States. Development of these resources, made newly accessible by directional/horizontal drilling and hydraulic fracturing technologies, are contributing to energy reserves in the United States. Although hydraulic fracturing is still primarily applied in vertically drilled wells, the use of horizontal drilling has rapidly emerged and is requiring an increased use of water resources[1].

CONCLUSION

(i) Survey calculations showed that the injected volume of proppant is distributed over multiple radial grooves around the well, as should not receive too many cracks at some calculations and share the cracks - in other calculations.

(ii) Sources dedicated EMG very much, and confusion in these sources in determining the orientation of the non-existent "cracks", their width and other parameters of the crack.

(iii) A lot of ambiguity in the choice of proppant strength properties and particle size of the proppant. The article did not express the views of the new and "thinking" on the strength properties of the proppant due to their introduction into the grooves, proposed by the authors.

(iv) The results of numerous studies carried out on hydraulic fracturing simulation or in the laboratory it is better not to use at all but ignored as they lead to false information.

(v) The authors believe that it is time to stricter approach to publishing of fracturing position, as is quite obvious absurdity of the concept of "fracturing of rocks oil reservoir" that are compressed on all sides.

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