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## THE USE OF AN ACID SOLUTION USED IN ACIDIZING WELLS IN OIL AND GAS FIELDS

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**Abstract:** It is known that the productivity of oil and gas wells depends on the quality and correctness of well workovers. Therefore, one of the ways to carry out major repairs is acid treatment. Acidizing is mainly based on geological studies of the selected well and the identified formation. The article recommends the use of carbonate reservoirs discovered by wells in the Karatepa field to determine the effectiveness of acidizing in the well

**Key words:** horizon, deposits, acid, treatment carbonate, formation, terrigenous, wells, anhydrite, interval, depth concentration, rock, salt acid

### Introduction

The Karatepa deposit in territorial and administrative terms is located within the Karshi district of the Kashkadarya region of the Republic of Uzbekistan [8].

The deposit is located 25 km south-southeast of the regional center of Karshi, 48 km southeast of Kusan, east of the regional center of Beshkent and 32 km of the regional center of Beshkent. Guzar.

### The main part

#### Geological structure of the field

The geological characteristics of the Karatepa deposit are based on materials from published works, prospecting and exploration and design studies.

The geological section of the study area is represented by a cover of Meso-Cenozoic deposits unconformably overlying the dislocated rocks of the Paleozoic basement.

At the Karatepa field, wells have uncovered deposits of the Jurassic, Cretaceous, Paleogene and Neogene-Quaternary systems.

The maximum geological section of the field was penetrated by parametric well No. 1 to a depth of 3701 m, by a bottomhole in the rocks of the XVII horizon of the Middle Jurassic terrigenous formation. It is represented by formations of the carbonate-sulfate Jurassic, terrigenous Cretaceous, carbonate-terrigenous Paleogene and continental rocks of the Neogene-Quaternary age.

According to lithological and genetic characteristics, the Jurassic deposits are divided into terrigenous, carbonate and salt-anhydrite formations, overlapping the dislocated surface of the Paleozoic basement with angular and stratigraphic unconformities [8].

According to the unified stratigraphic scheme of the KF Bukharo - Khiva region and the southwestern spurs of the Gissar ridge [8] in the study area, the tops of the terrigenous formation identified under the name of the Baysun Formation - horizon XVII are dated to the stratigraphic range  $J_{2bt} + k-$  (Upper Bathonian - Lower Callovian sub-stages).

*Terrigenous formation  $J_{2bt} + k-$  (Upper Bathonian-Lower Callovian sub-stages)* - horizon XVII - the Baysun Formation in the study area was partially recovered at 26 m by parametric well No. 1 - Karatepa in the depth interval 3675-3701 m and is composed of gray, greenish-gray, medium and fine-grained, porous sandstones with interlayers of dark gray clays and siltstones.

*Carbonate formation  $J_{k2} + kt2$  (Middle Callovian-Upper Kimmeridgian podyaruses)* 2-3 in the area was penetrated up to horizon XVI - Kandym formation inclusively by parametric well No. 1, drilling of the remaining wells was stopped within horizon XV-P - Urtabulak formation, also not penetrated at full capacity by prospecting wells No. 1, 2, 3.

Horizon XVI - Kandym Formation  $J_{k2} 2$  (*Sredne-Callovia podlayer*) is recovered to the full 88 m thickness by Parametric well No. 1 in the depth interval 3587-3675 m. ...

Horizon XVa - the lower stratum of the Mubarek Formation  $J_{k2} 2$  (Upper Kelovevsky sublayer) consistently overlaps the deposits of horizon XVI and consists of detrital, organogenic-detrital, pelitomorphic, weakly clayey limestones. The horizon with a thickness of 20.6 m was penetrated by parametric well No. 1 in the depth interval of 3566.4-3587 m.

Horizon XV-PR - the upper strata of the Mubarek Formation  $J_{3o1-2}$  (Lower-Middle

Oxfordian pod-layers) is composed of gray, dark gray, dense, clayey, lumpy-algal, pelitomorphic limestones. The horizon at the full 127.9 m thickness was penetrated by parametric well No. 1 in the depth interval 3438.5-3566.4 m.

Horizon XV-P - Urtabulak Formation  $J_{km1}$  (Upper Oxfordian-Lower Kimmeridgian sub-stages) 3o3-represented by reef, biomorphic limestones and products of their destruction. Limestones are gray, light gray, cream, heterogeneous in strength, highly porous, cavernous. Algal organogenic-detrital and coral-algal varieties of limestone predominate.

The horizon was penetrated by parametric well No. 1 to the full 85.5 m thickness in the depth interval of 3353-3438.5 m.

Exploratory wells No. 1, 2, 3 partially penetrated the horizon at 29 m, 64 m and 96 m in the depth intervals of 3271-3300 m, 3266-3330 m and 3279-3375 m, respectively.

Horizon XV-HP - Kushab Formation  $J_{km1-2}$  (Lower-Upper Kimmeridgian sub-stages) 3 composed of algal, detrital, fine-grained, organogenic-detrital limestones and products of their destruction.

Dense, fractured limestone varieties, fractures filled with calcite and impregnated with bitumen. The horizon was penetrated by parametric well No. 1, exploratory wells No. 1, 2, 3 at full capacity - 59 m, 34 m, 26 m and 23 m in depth intervals of 3294-3353 m, 3237-3271 m, 3240-3266 m and 3256- 3279 m respectively.

*Saline-anhydrite formation -  $J_{tt3}$*  - (Tigonsky stage) completes the section of the complex of the Upper Jurassic deposits. Being a regionally widespread formation of the Bukhara-Khiva oil and gas region, it plays the role of a cap of hydrocarbon deposits consisting

of three interbedded anhydrite packs and two salt packs separating them. Within the studied field, according to drilling data, the thickness of the salt-anhydrite formation ranges from 152 to 231 m.

The base of the section of the salt-anhydrite formation is composed of a member of the lower anhydrite. The member consists of anhydrite with rock salt inclusions in the top of the section. The rocks are dense, sugar-like, gray, dark gray and smoky in color.

The lower anhydrites are penetrated by all wells, their thickness is insignificant 15 m - 21 m.

The lower anhydrites are overlain by the lower member of salts consisting of coarse-crystalline white and pinkish halite with interlayers of clays and halopelites at the top of the section. The thickness of the unit is not maintained from 0 m in prospecting wells No. 1, 3 and up to 68 m in prospecting well No. 2 and 102 m in parametric well No. 1.

The unit of intermediate anhydrites was penetrated by parametric well No. 1 with a thickness of 30 m and prospecting well No. 2 with a thickness of 20 m. It consists of dense, transparent crystalline white anhydrites.

The member of the upper salts is composed of transparent to light gray halite in the upper part of the section with interlayers of clay and potassium salt. The thickness of the unit ranges from 73 m in parametric well No. 1 to 147 m in exploration well No. 3.

The upper anhydrite member is represented by sulfate-terrigenous rocks. They are dense, white, transparent crystalline anhydrites.

The thickness of the unit is 10 m in parametric well No. 1, 17 m, 13 m and 15 m in prospecting wells No. 1, 2, 3, respectively.

The total thickness of the salt-anhydrite strata ranges from 152 m in exploratory well No. 1, and up to 231 m in parametric well No. 1.

## **Methodology**

The preparation of the solution must be carried out at the base in the place of storage and preparation of acidic solutions in the following order:

1. The acid unit (AzINMASH-30A) is filled with pure industrial water in volume at the rate of adding concentrated acid to prepare a solution of the required concentration.

2. Concentrated hydrochloric acid is pumped by the unit in a thin stream into the acid tank with water.

3. If benzenesulfonic acid is used instead of hydrochloric acid, then the calculated amount of crushed crystalline benzenesulfonic acid is poured into the acid maker with a certain amount of pure industrial water and mixed well with the pump of the acid unit.

4. When preparing clay acid, a calculated amount of hydrofluoric acid is poured into a solution of hydrochloric acid or crushed ammonium bifluoride is poured, everything is well mixed with an acid pump.

5. The required amount of surfactant and acetic acid is poured into the prepared acid solution.

The recipe is selected according to the geological and technical data for the well, the plan-order. A special acid treatment plan is drawn up. The prepared solution is transported to the well in an acid unit, from which the acid solution is pumped into the reservoir by its own pump[4].

Concentrated hydrochloric acid is diluted to the HCl content specified for the working solution at the place of its storage (acid base) or directly at the well before processing it.

Since hydrochloric acid coming from factories can have different concentrations, it is necessary to accurately calculate how much water and acid must be mixed in order to obtain a solution of a given concentration and volume.

To prepare a solution of a given HCl concentration, the commercial acid is diluted in

containers, the volume of which is strictly calibrated.

According to the calculation, water is poured into the container, then concentrated commercial acid is poured and all the necessary additives (inhibitors, surfactants, etc.) are added in the summer.

The addition of inhibitor reagents and surfactants is usually so insignificant that corrections for the volumes of these reagents are not introduced.

When preparing working solutions of hydrochloric acid, the following order of adding various reagents should be adhered to: "water" - "corrosion inhibitor" - "stabilizers" (acetic and hydrofluoric acids) - "commercial hydrochloric acid" - "barium chloride" - "intensifier" (surfactant) ...

For pumping and mixing the acid, special acid-resistant centrifugal pumps are used.

The order of preparation of the HCl solution: water - inhibitors - stabilizers - conc. acid - barium chloride - intensifiers. The solution is mixed, settled for 2-3 hours.

### **Methodology for calculating the process of treating the bottomhole zone of a well with hydrochloric acid**

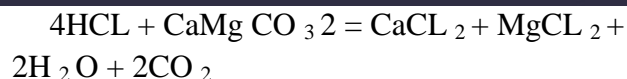
Wells operating low-permeable formations (sandstones cemented by clay facies, dense limestones) often turn out to be of low production rate. To increase their productivity, hydrochloric acid treatment is carried out. This process is based on the ability of hydrochloric acid to dissolve calcareous rocks [5].

In oily rocks, limestone, dolomite, or carbonate cementing substances are often present in varying amounts. Hydrochloric acid dissolves such rocks well, with the following main reactions occurring.

When exposed to limestone



When exposed to dolomite



Calcium chloride ( $\text{CaCl}_2$ ) and magnesium chloride ( $\text{MgCl}_2$ ) are salts that are readily soluble in water, the carrier of the acid produced by the reaction. Carbon dioxide ( $\text{CO}_2$ ) is also easily removed from the well, or dissolves in the same water at the appropriate pressure. The acid always contains impurities, which, when interacting with it, can form precipitates insoluble in a solution of neutralized acid. The deposition of these sediments in the pores of the formation reduces the permeability of the near-wellbore zone. These impurities include the following:

1. Ferric chloride ( $\text{FeCl}_3$ ), formed as a result of hydrolysis of iron oxide hydrate [ $\text{Fe}(\text{OH})_3$ ], which precipitates as a bulky precipitate.

2. Sulfuric acid  $\text{H}_2\text{SO}_4$  in solution when it interacts with calcium chloride  $\text{CaCl}_2$  forms gypsum ( $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$ ), which is retained in solution only in insignificant amounts. The bulk of the gypsum precipitates as a fibrous mass of needle crystals.

3. Some reagents introduced into the acid solution as anticorrosive additives (for example, PB-5 inhibitor).

4. Hydrogen fluoride and phosphoric acid, which are present in some technological schemes of hydrochloric acid production and, when reacting with carbonates, form insoluble precipitates of calcium fluoride ( $\text{CaF}_2$ ) and calcium phosphate [ $\text{Ca}_3(\text{PO}_4)_2$ ] in the formation.

The recipe for the preparation of the solution is worked out either in field laboratories or in research institutes. The following reagents are added to the HCL solution:

1. Inhibitors
2. Intensifiers
3. Stabilizers

If there is a sump sump in the well, the amount of calcium chloride required to prepare the solution in order to fill the sump and isolate it from the acidic solution should be calculated.

For given conditions, the acid concentration for primary treatments is taken as 8 - 10%. Let's take 10%.

The amount of acid consumed per 1m of the formation thickness for sandstones is 0.4 - 0.6m<sup>3</sup>, we take 0.5m<sup>3</sup>. In this case, the total volume of the working acid solution will be 0.5 · 20 = 10 m<sup>3</sup>.

For the preparation of 10 m<sup>3</sup> of 10% working hydrochloric acid solution, according to the table. 1 requires 3890 kg. 27.5% HCl and 6.6 m<sup>3</sup> of water.

Table 1

The amount of acid and water required to prepare a hydrochloric acid solution

Diluted acid volume, m <sup>3</sup>	Diluted acid concentration, %			
	8	10	12	14
6	$\frac{1840}{4,38}$	$\frac{2330}{3,96}$	$\frac{2830}{3,52}$	$\frac{3320}{3,40}$
8	$\frac{2460}{5,84}$	$\frac{3110}{5,28}$	$\frac{3770}{4,64}$	$\frac{4400}{4,16}$
10	$\frac{3080}{7,30}$	$\frac{3890}{6,60}$	$\frac{4720}{5,87}$	$\frac{5560}{5,14}$

Note. The numerator is the amount of concentrated acid, kg; the denominator is the amount of water, m<sup>3</sup> [6].

The amount of concentrated commercial hydrochloric acid for the preparation of a 10% working hydrochloric acid solution can be found by the formula

$$W_k = \frac{A \cdot B \cdot (x - z)}{x \cdot z} \quad (1)$$

where A and B are numerical coefficients, the values of which are given below; x and z are the concentrations of the working hydrochloric acid solution and the commercial hydrochloric acid,

respectively; W - is the volume of the working acid solution equal to 10 m<sup>3</sup>.

A, B .....14, 218, 221.5

z, x ..... 5.15 - 12.19 13.19 - 18.11 19.06 - 24.78

Continuation

A,B..... 226 227.5 229 232

z, x ..... 25.75 - 29.57 29.95 - 31.52 32.1 - 33.4 34.42 - 37.22

In our case, for 10% hydrochloric acid, the numerical coefficient A = 214, and for 27%, the coefficient B = 226; x - 10% concentration of hydrochloric acid solution; z - 27.5% concentration of commercial acid; W = 10 m<sup>3</sup> is the volume of the working acid solution.

Therefore, by formula (1) we have:

$$W_k = \frac{214 \cdot 10 \cdot 10(226 - 27,5)}{226 \cdot 27,5(214 - 10)} = 3,333 \text{ m}^3$$

After preparing the working solution of hydrochloric acid, the obtained concentration of the HCl solution is checked, and if it does not correspond to the selected one, water or concentrated acid is added to the solution.

Amount of added water at HCl concentration > 10%

$$q_B = \frac{(p_2 - p_1) \cdot W}{(p_1 - p)} \quad (2)$$

The amount of added hydrochloric acid if the HCl concentration is <10%

$$q_B = \frac{(p - p_1) \cdot W}{(p_3 - p)} \quad (3)$$

where q<sub>in</sub> and q<sub>to</sub> are the volumes of added water and concentrated acid, m<sup>3</sup>; p is the density of the solution of the selected concentration; P<sub>1</sub> and P<sub>2</sub> - the density of the prepared solution, respectively, lowered and increased concentration; p<sub>3</sub> is the density of concentrated hydrochloric acid; W is the volume of a hydrochloric acid solution of 10% concentration [7].

As a corrosion inhibitor, we take a cationic reagent - cation A c

the amount of 0.01% of the volume of the working acid solution

$$Q_i = 10 \cdot 0.01 \cdot 0.01 = 0.001 \text{ m}^3.$$

Against the precipitation of the iron salts contained in the hydrochloric acid solution, acetic acid is added to the working solution in an amount

$$Q_{aa} = 1000 b_y \frac{Q_i}{C_y} \quad (4)$$

where  $b_y$  is the amount of acetic acid, % of the working solution of hydrochloric acid ( $b_y = f + 0.8$ , where  $f$  is the content of iron in hydrochloric acid, equal to  $f = 0.5\%$ , then  $b_y = 0.5 + 0.8 = 1.3\%$ ;  $W$  is the volume of the working hydrochloric acid solution equal to  $10 \text{ m}^3$ ;  $C_y$  is the concentration of acetic acid (we take  $C_y = 80\%$ ).

Substituting the numerical values of the quantities into the formula (4) we have:

$$Q_{uk} = 1000 \cdot 1.3 (10/80) = 162.5 \text{ dm}^3.$$

To dissolve silicate and clay materials cementing the rock, as well as to clean the bottomhole surface from a clay or cement crust, hydrofluoric acid is added to the working solution of hydrochloric acid in an amount

$$Q_{nk} = 1000 b_n (W / C) \quad (5)$$

where  $b_n$  is the amount of added hydrofluoric acid, % of the volume of the working hydrochloric acid solution (usually equal to 1 - 2%, we take 2%);  $C_n$  is the concentration of hydrofluoric acid (usually 40%).

Substituting the numerical values of the quantities in formula (5), we will have:

$$Q_{pc} = 1000 \cdot 2 (10/40) = 500 \text{ dm}^3.$$

As an intensifier for lowering the surface tension, the drug DS (detergent "Soviet") is used, which is simultaneously an inhibitor and the most active reducing the rate of reaction of hydrochloric acid with the rock. A large decrease (several times) in the reaction rate contributes to a deeper penetration of the acid into the formation.

The required amount of DS for  $10 \text{ m}^3$  of solution is taken at the rate of 1 - 1.5% of the working hydrochloric acid solution, we take 1%, i.e.  $10 \cdot 0.01 = 0.1 \text{ m}^3$  or  $100 \text{ dm}^3$ .

We clarify the amount of water required to prepare the accepted volume of the working hydrochloric acid solution, taking into account all the additives:

$$V = W - W_k - \Sigma Q \quad (6)$$

where  $W$  is the volume of the working hydrochloric acid solution equal to  $10 \text{ m}^3$ ;  $W_k$  - the volume of concentrated commercial acid equal to  $3.333 \text{ m}^3$ ;  $\Sigma Q$  is the total volume of all additives to the hydrochloric acid solution (acetic and hydrofluoric acids, DS).

$$\Sigma Q = 163 + 500 + 100 = 763 \text{ dm}^3 = 0.763 \text{ m}^3.$$

Therefore, according to the formula (6):

$$V = 10 - 3.333 - 0.763 = 5.904 \text{ m}^3.$$

To isolate the sump - a sump, a solution of calcium chloride with a relative density of 1.2 is used.

The volume of 1 m of the wellbore with an inner diameter of  $DB = 0.15 \text{ m}$  is  $0.785 \cdot 0.15^2 \approx 0.018 \text{ m}^3$ , and the volume of 15 m of the sump will be  $0.018 \cdot 15 \approx 0.27 \text{ m}^3$ .

To obtain  $1 \text{ m}^3$  of calcium chloride with a relative density of 1.2,  $540 \text{ kg}$  of  $\text{CaCl}_2$  and  $0.66 \text{ m}^3$  of water are required. To isolate the entire sump, the amount of  $\text{CaCl}_2$  will be  $540 \cdot 0.27 = 146 \text{ kg}$  and water  $0.66 \cdot 0.27 = 0.18 \text{ m}^3$ .

Before processing the well, the sump is filled with a solution of calcium chloride. To do this, the pipes are lowered 1 - 2 m above the bottomhole, the circulation is restored in the well, and with an open annulus, a solution of calcium chloride is pumped into the sump by pumping oil into the pipes in the volume of the flow line (the volume of pipes with a diameter of  $0.062 \text{ m}$ ,  $100 \text{ m}$  long from the pumping station). unit to the wellhead will be  $0.00302 \cdot 100 = 0.3 \text{ m}^3$  plus the volume of flushing pipes ( $\frac{\pi d^2 B}{4} H = 0.00302 \cdot 1630 = 4.96 \text{ m}^3$ ). Then the pipes are raised and the shoe of the flushing

pipes is installed at the lower holes of the filter, after which acid is pumped into the well.

When injected, acid fills a flow line with a diameter of 0.062 m, a length of 100 m from the pumping unit (its volume will be  $0.00302 \cdot 100 = 0.3 \text{ m}^3$ ), flushing pipes with a diameter of 0.062 m, a length of 1630 m (their volume is  $0.00302 \cdot 1630 = 4.96 \text{ m}^3$ ) and the lower part of the well from the bottom to the top of the formation (its volume will be  $0.018 \cdot 20 = 0.36 \text{ m}^3$ ), a total of 5.58 m<sup>3</sup>. After that, the wellhead is sealed (the annulus is closed) and the remainder of the working hydrochloric acid solution is pushed into the bottomhole zone of the well. To displace hydrochloric acid from the pipes, 5.58 m<sup>3</sup> of oil is required[1].

## **CONCLUSION**

Acid treatment of wells is one of the types of well production stimulation, in which acid is injected into the formation under pressure below the fracture pressure, in order to increase the permeability of the rock, or to treat and clean up the bottomhole zone of the well from contamination

## **Literature:**

1. A.M. Yurchuk, A.Z. Istomin. Calculations in oil production. M. ; "Nedra", 2009, 271s.
2. "Oilfield equipment". Handbook edited by E.N. Bukhalenko. M. ; "Nedra", 2000, 560s.
3. Murin V.I., Kislenko N.N., Surkov Yu.V. Handbook - Technology of natural gas and condensate processing. Moscow. "Nedra-Business Center", 2002
4. Basarygin Yu.M., Makarenko PP, Mavromati VD Gas well repair Moscow. "Nedra" 2007
5. Nifontov.Yu.A., Keleschenko.I., Telkov.A.P. Repair of oil and gas wells NPO Professional, 2007
6. Blazhevich V.A., Umetbaev V.G. - Handbook of the foreman for workover of wells

(2005) Rules for conducting repair work in wells (2000)

7. K.A. Ibatulov. Practical calculations for drilling and production machines and mechanisms. Baku, "Azneftizdat", 1956, 291s.
8. Project for pilot production of the Karatepa gas condensate field. UzNIONNGP, Tashkent, 2013