

# Magnetic Apparatuses in Oil and Gas Recovery

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## 1. THE GENERAL STATE OF THE PROBLEM.

The influence on the properties of water systems is well-known. It changes their structure, density, viscosity, freezing temperature, surface strain characteristics, corrosion activity, electroconductivity, salt solubility and pH factor. This influence serves as the main idea of the magnetic treatment used in energy supply and production industries, in building industry, medical service, mining and oil production industries. The theoretical basis of this process has been worked out due to the researches done by Mirzadzhanzade, Tebenikhin, Klassen and others [1-5]. The following interesting facts have been discovered in the course of this researchers:

- a) the influence of relatively weak magnetic fields (like those with the tensivity of 10-30 kA/m<sup>2</sup> on water system is very strong;
- b) the properties gained by the system after the treatment retain for a long time;
- c) the best effect of a magnetic field treatment is observed when the treating magnetic field has a polyextrimal character.

Magnetic field treatment technology can be used for coping with oil and gas production complication of the following types:

1. Corrosion activity;
2. Asphalt, tar and paraffin sedimentation (APTS);
3. Salt sediments formation in the process of oil and gas recover;
4. Water-oil emulsion formation in the process of oil recovery.

## 2. CORROSION.

The decrease of the corrosion activity of produced liquids is caused by the influence on one of their component - overmineralized water. The ions of minerals get polarized and deformed under a magnetic field treatment changes in water molecule aggregation occur. Usually the molecule orientation order get higher and water acquires the so-called ice-resembling state. The greatest corrosion activity decreasing effect of the technology of a magnetic field treatment is observed in carbonate, sulphate and sulphide types of environment.

But the laboratory research and oil and gas recovery data show that the best way to use this type of treatment is to combine it with inhibitor protection system, which allows to reduce the usual dosage of an inhibitor and makes the latter's performance more effective. It should be mention that the best results of the treatment were observed when a permanent magnetic field was used.

Table 1. The corrosion Activity Reduction Efficiency of a Magnetic Field Treatment for Steel 20

The places of samples taking	The composition of water	Corrosion process speed without magnetic treatment (mm per year)	Corrosion process speed with magnetic treatment (mm per year)
Martemya-Teterev field (the town of Uray)	Chloride-hydrocarbonate	0.201	0.086
Sergeyev field (Bashkortistan)	Chloride-sulphide	1.125	0.430
Checkmagush field (Bashkortistan)	Chloride-sulphide	0.830	0.217
Ufa water supply	Oxygen-hydrocarbonate	0.189	0.105

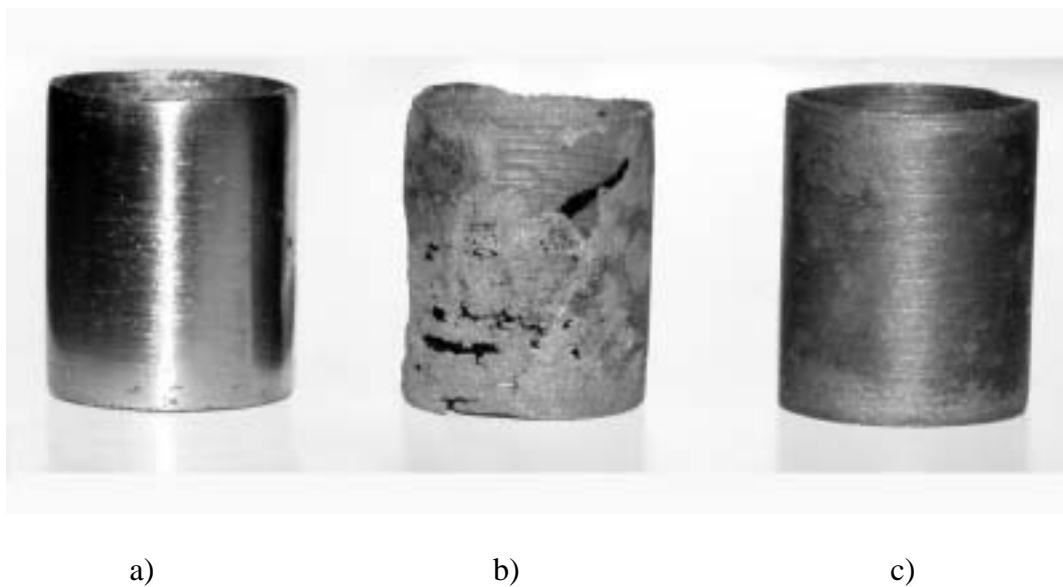


Fig. 1. The appearance of the sample (a) – a new one, (b) – got from an untreated environment, (c) – got from environment treated with a magnetic field (Sergeev field, Bashkortostan)

### 3. ASPHALT, TAR AND PARAFFIN SEDIMENTATIONS.

The method of a magnetic field treatment may be referred to the group of the most perspective physical methods used for asphalt, tar and paraffin sedimentation prevention. Influencing a flowing liquid a magnetic field destroys the existing in it aggregates, which consist of submicron ferromagnetic microparticles of iron. Usually such aggregates can be found in oil and in according water. Each aggregate consist of hundreds or thousands of microparticles, that's why their destruction leads to a 100-1000 time increase of the concentration of paraffin and salt crystallization and formation of gas bubbles on the surface, of the ferromagnetic particles. As a result of the aggregates' destruction paraffin, crystals

precipitate as a fine equally distributed stable suspension. The speed of sediments formation on the surfaces of compressor pumping tubes, pumping equipment is reduced in this case. The sediment formation reduction is proportional to the reduction of the average size of those paraffin crystals, which precipitate into the hard phase together with tars and asphaltens. Some data show that microbubble formation taking place at crystallization centers after the treatment in certain cases may lead to the gaslift effect.

#### 4. SALT SEDIMENTATION.

Inorganic salt sediments formation in the process of water saturated oil production at the majority of Russian oil fields. Salt sediments are formed if any of the known well exploitation methods is used, but the most harmful effect is observed when oil is recovered with the help of a rod-type pump (RTP) or an electric submerge working surfaces of deep pumps may cause their early wear, unstable work and breaks of the shaft of the submerge centrifugal pump (ECP), RTP plunger jams, etc.

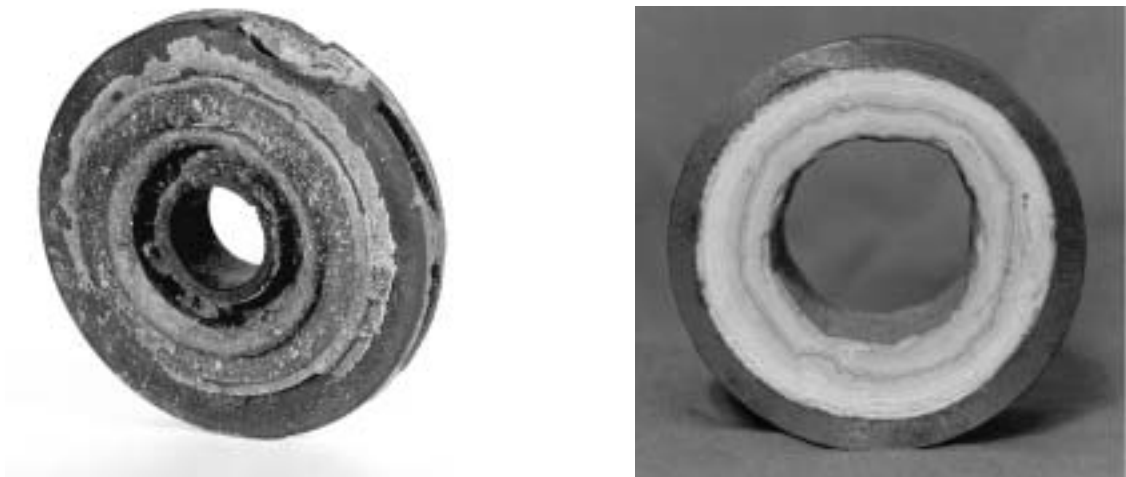
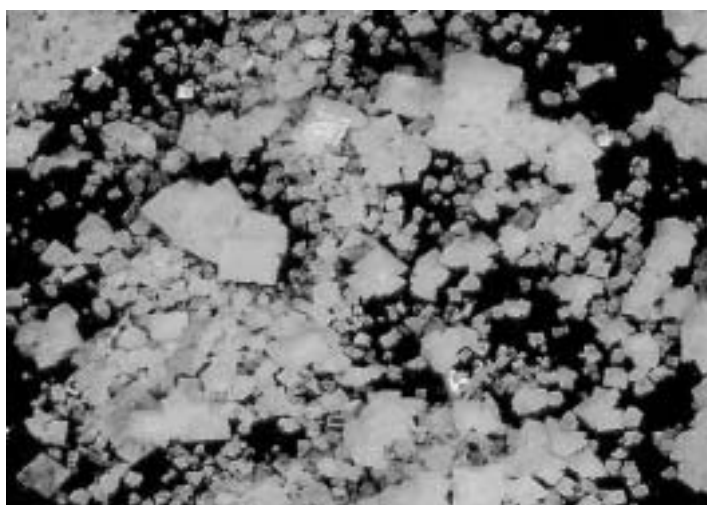


Fig.2 Salt sediment on the working wheel of an ECP and in pumping and compressor pipes.

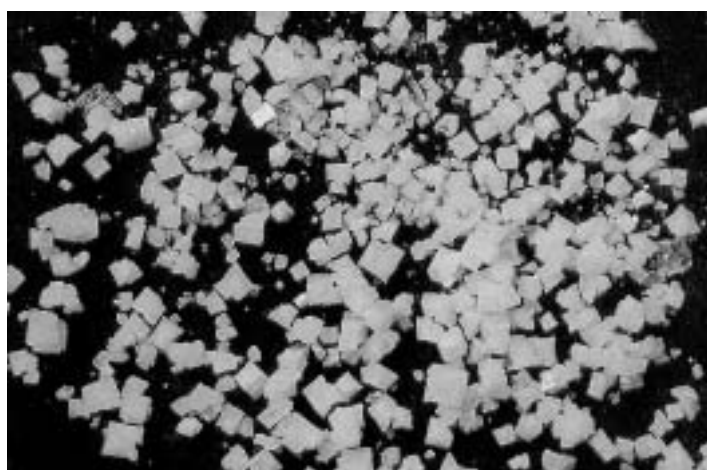
In this case the period of work without repairs at “salt producing” well, is shortened. Besides as results of water saturation of the wells production salt sediments are formed on the surface equipment, group and measuring installations, oil gathering collectors and oil preparatory systems.

During the process of the magnetic treatment water system changes its relatively stable, state and inside its volume, but not on the surface, a lot of small crystals formed precipitated from an oversaturated solution, given on picture 3.

The crystals, which precipitated from the treated solution are almost of the same shape and don't differ from each other very much.



a



b

Fig.3. Sodium chloride crystals precipitated from an untreated solution (a) and from a magnetic field treated solution (b).

### 5. EMULSION FORMATION.

In the process of oil recovery oil gets mixed with water and makes a hard-to-destruct fine emulsion. Emulsion formation is one of the main causes of the high prices for oil transportation and preparation. If the amount of water in oil increases by 1% only, transportation expenses increase by 3-5%. If an alternative magnetic field influences water-oil emulsions, the process of their exfoliation can be accelerated. The best result is observed when the magnetic field has an impulse character (see Fig. 4)

Paraffin microcrystals and minimal particles with the surface modified by surface active substances of oil as well as by tars and asphaltens are concentrated at the interphase surface and the finishing stage of this process is oil emulsions' exploitation in an precipitation tank, which is the cause of so-called intermediate layers.

The presence of an intermediate layer containing a great amount of paraffin combinations, asphaltens, tars and mechanical impurities make the work of precipitation tanks less effective, reducing actual space, and preventing the separated water from being removed.

Practise has shown, that only thermochemical methods when used, don't provide deep treatment of intermediate layers. The best results were got only when they were combined with the work of magnetic treatment apparatuses.

The method was used in the following way:

- 1) determination of the moment when the intermediate layer was formed in a precipitation tank'
- 2) the in-time removal of the layer and its' treatment with an alternative magnetic field of a low frequency;
- 3) the feeding of the treated product into the receiver of the apparatuses.

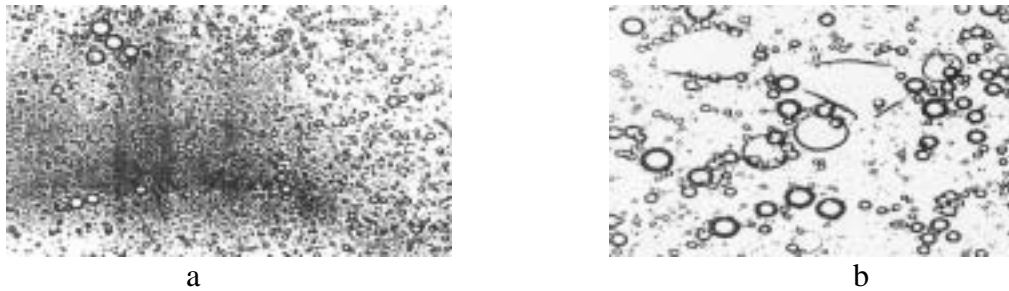


Fig. 4. Dispersion characteristics of the emulsion before (a) and after (b) a magnetic treatment.

## 6. THE INTRODUCTION OF MAGNETIC TREATMENT APPARATUSES INTO PRACTICE.

Recently "BashNIPIneft" and USPTU have worked a set of apparatuses for coping different complications in oil and gas now used at different enterprises. The well equipment UMZh-73, using permanent magnets eliminate paraffin sediments, salt sediments at "Bashneft", "Lukoil", "Belkamneft" and "Orenburggasprom" wells. The work without repair period was 1,5-2 times increased. Permanent magnets apparatuses of the UMZh type with the diameter of 100-325 mm are used to reduce the corrosion activity in the reservoir pressure maintenance system in Western Syberia and Udmurtia. The amount of the inhibitors used was decreased by 30-50%.

Low frequency and impulse electromagnet apparatuses of the UMP type with diameter of 100-520 mm were introduced to combat with emulsions formation at TPE "Kogalymneftegas", OSC "Bashneft", SE "Belkamneft".

The Engineering company "Incomp-neft" produces such magnet apparatusesx[6].

## CONCLUSION.

Magnetic treatment devices working with permanent or electromagnets should be used in the sphere of oil recovery for coping with complications caused by emulsion formation, salt precipitation and asphalt and paraffin precipitation.

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