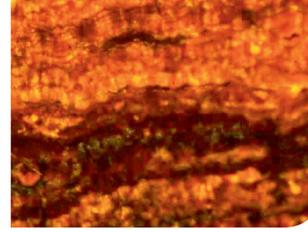


**pH dependent
Rehabilitation Agent**

- powdered concentrate
- chloride-free
- Efficiency > HCl

for Removal of goethite



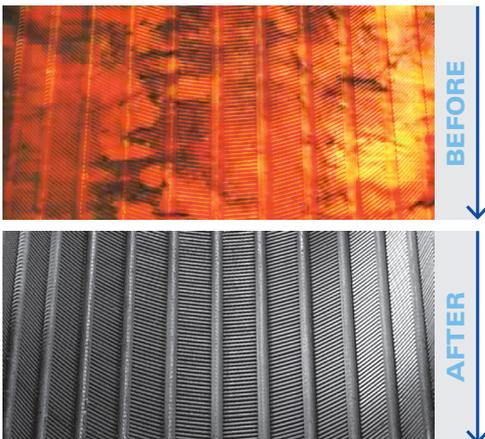
REHABILITATION AGENT AS PER GEOCHEMICAL ANALYSIS

AIXTRACTOR® 3.0

Goethite – pH dependent

- Removal of
 - Goethite (aged iron incrustations)
 - aged manganese incrustations
 - aluminium hydroxides
- Efficiency in identical molar concentration as per stoichiometry:
 - 10 x greater capacity of dissolving goethite compared to hydrochloric acid (pH 1,0)
 - 2 x greater capacity of dissolving ferrihydrite compared to hydrochloric acid (pH 1,0)
- Continuous process control and immediate result verification on site according to latest German technical standards of DVGW
- Short reaction time of 60 minutes per screen section
- Re-establishment and confirmation of original water quality by means of easy measurement on site
- Possibility of direct quantity calculation of dissolved incrustations and determination of agent effectiveness

**WE DISSOLVE YOUR
INCRUSTATION PROBLEMS!**



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1. DESCRIPTION

AIXTRACTOR® 3.0 is a fast reacting effective chemical agent for removing goethite and lepidocrocite (aged iron incrustations), manganese incrustations as well as aluminium hydroxides from wells. The working principle of the agent combines the effect of an acid with a reductive substance to transform the low soluble iron(III) and manganese(IV) oxide into their respective highly soluble iron(II) and manganese(II) ions. AIXTRACTOR® 3.0 has only little corrosive side effects and can therefore be used on most types of filter screen and well lining material. AIXTRACTOR® 3.0 may be used on site as a well rehabilitation agent without any environmental concerns. It is classified as environmentally harmless when compared to the relevant German Environmental Standard.

AIXTRACTOR® 3.0 has 10 times greater capacity of dissolving goethite and 2 times greater capacity of dissolving ferrihydrite when compared to hydrochloric acid at a pH value of 1,0 and in identical molar concentrations during the comparison test. Prior to the application of AIXTRACTOR® 3.0 concentration the well lining, the screen slots and the gravel pack should be cleaned using appropriate measures (e.g. gravel wash, gravel jetting etc). This will ensure the maximum effectiveness of the rehabilitation measure.

As the spatial distribution of incrustations within a well are often heterogeneous, inspecting the insides of the well using CCTV prior to the application of AIXTRACTOR® 3.0 is highly recommended. This will allow areas of thicker incrustation to be identified and these may then be selectively treated with longer application times during the rehabilitation procedure. In all cases, the specific electrical conductivity of the groundwater is to be measured and recorded prior to the commencement of the rehabilitation procedure. In order to ascertain suitability of AIXTRACTOR® 3.0 for removal of these substances, a sample of the incrustation should be geochemically analysed prior to any site activity.

2. PREPARATION OF THE WORKING SOLUTION

AIXTRACTOR® 3.0 is supplied as a ready-to-use powdered concentrate and should be mixed immediately prior to application. The agent should be completely dissolved in clean (ground) water with a concentration of 30 g AIXTRACTOR® 3.0 per litre volume of borehole to be treated. AIXTRACTOR® 3.0 is very soluble up to a concentration of about 100 g/l water at pH 0.5. A mixing ratio of 10 to 12 litres water to 1 kg AIXTRACTOR® 3.0 is recommended. Mixing chambers equipped with a lid and a circulation pump have proven useful for the preparation of the working solution.

In order to completely dissolve the agent and prevent coagulation of the agent, the powder should be added slowly to continuously stirred or circulated water. The solid material will dissolve in less than 30 minutes. A slight turbidity is normal, but no residue should be visible at the bottom of the mixing chamber prior to application. While mixing the working solution a good ventilation is necessary (mixing outside is the best). The development of a slight odour during the mixing process is normal.

Under no circumstances is AIXTRACTOR® 3.0 to come in contact with or be dissolved in any form of acidic substance (e.g. hydrochloric or sulphuric acid) or oxidising agent (e.g. hypochlorite, hydrogen peroxide). This would not lead to an increase in effectiveness but may lead to the decomposition of the agent and in some cases even lead to the development of toxic gases. When mixing AIXTRACTOR® 3.0 with water, it is highly recommended to wear protective clothing such as safety gloves, goggles and a filtering half mask. In all cases, the guidelines set out on the ECU Safety Data Sheet are to be considered.

3. ON SITE USE AND MONITORING

The rehabilitation of the well screen is conducted in sections at various depth intervals using an injection technique such as a gravel washer. The process of removing the incrustations begins at the top of the well and continues downwards towards the sump.

The prepared working solution of AIXTRACTOR® 3.0 is applied in 2 to 3 equal portions into the screen section to be treated. The rehabilitation process may be observed and regulated through continual measurement of the process parameters during the course of the reaction.

The parameters which need to be monitored to determine the effectiveness of the rehabilitation process are the pH value, the specific electrical conductivity and the concentration of the reaction products Fe(II) and / or Mn(II). These need to be recorded throughout and after the reaction process. Simple measuring equipment and / or cheap analytical test strips have proven sufficient. Measuring the process parameters will help determine if further treatment of obstinate incrustations may be necessary. By monitoring these parameters it may also be possible to reduce the total amount of working solution during treatment time based on their development during the process.

When forcing the working solution through the screen slots into the surrounding sand and / or gravel pack it is not recommended to apply compressed air. In order to prevent discharge of the working solution into the aquifer and to optimise the effectiveness of the process, the working solution should be kept in motion by means of a circulation pump. After its application onto any one section of the well, the process of removing the incrustations is completed within 60 minutes.

Leaving the working solution on the screen for longer than 60 minutes will not increase its effectiveness and may be counter-productive. An increased amount of reaction products may migrate into the aquifer and a longer pumping time will be necessary to remove them.

Any significant migration of the working solution into the aquifer can be observed by monitoring the electrical conductivity of the solution during the reaction time of 60 minutes in each screen section. The quantity of dissolved incrustation as well as the effectiveness of AIXTRACTOR® 3.0 may furthermore be determined by means of mass balancing using the results of the continual measurements during the abstraction of the water and working solution mixture from the well.

4. REMOVAL OF THE WORKING SOLUTION

Following the treatment process the dissolved incrustations should be removed from the well by abstracting water at a high rate. This also allows the dissolved incrustations in the surrounding sand and / or gravel pack to be removed.

The abstraction pump should be placed as low as possible within the treated screen section and be operated at a rate, which roughly corresponds with the maximum capacity of the whole well. The rate of abstraction and the duration of pumping to fully remove all dissolved incrustations per treated screen section should be noted. During the abstraction stage the electrical conductivity, the pH value and the concentration of reaction products should be measured and recorded in the abstracted water every 10 minutes.

Analytical test strips (colour test) for the latter are supplied with AIXTRACTOR® 3.0. The concentration of the process parameters in the abstracted water determines when abstraction can end for any one section of screen. When the electrical conductivity has reached its pre-rehabilitation level and the pH value has normalised (pH > 6) the abstraction procedure for that section of the well may be considered complete. An exact period of time for the duration of the abstraction process cannot be given in these instructions, as it varies considerably from well to well.

After completion of the whole rehabilitation procedure for any given well a thorough cleansing of the well sump is recommended. The working solution has a higher density than water and may have accumulated during the rehabilitation process.

To ensure the complete removal of reactants from the well, it is recommended to pump the well overnight after treatment.

5. DISPOSAL OF THE WORKING SOLUTION

The reaction products of AIXTRACTOR® 3.0 consist of iron (Fe²⁺), manganese (Mn²⁺), calcium (Ca²⁺), magnesium (Mg²⁺), aluminium (Al³⁺) and biologically degradable organic remnants depending on the type of well incrustations.

Attention: Intense development of foam combined with discharge of acid is possible. Sufficient ventilation is necessary since carbon dioxide (CO₂) has a suffocating effect.

AIXTRACTOR® 3.0 brings a combination of different chemical processes to bear in which a simultaneous dissolving of iron and manganese incrustations as well as that of carbonates and aluminium hydroxides is possible. The reactants in AIXTRACTOR® 3.0 transform the insoluble Fe(III) and / or Mn(IV) into soluble Fe(II) and Mn(II) ions whereas the acid attacks carbonates and aluminium hydroxides.

If the pH value of the abstracted water is lower than 6.5, it has to be raised to a level between 6.5 and 8.5 (the neutral level is pH 7) prior to disposal. It has proven useful to collect the waste water in a basin and to neutralise it in batches. The compliance with the target pH value is to be documented by continuous measurements.

In order to neutralise the abstracted water a certain amount of base (lye) has to be added corresponding to the pH value. Easily soluble hydroxides like caustic soda (NaOH) and milk of lime (Ca(OH)₂) are particularly suitable because of their availability as powdered concentrate and manageability on site. Lime (CaCO₃) can also be used in form of a solid granulate instead of the easily employable but caustic hydroxides. Compared to the hydroxides the reaction time is significantly longer and the basin has to be placed outside due to the formation of carbon dioxide (CO₂).

The exhausted working solution to be disposed of contains an increased amount of biologically degradable substances. The concentration depends on the respective input quantity and the amount of abstracted water (dilution) and can be determined by measuring the specific electrical conductivity. The abstracted water can be turbid and coloured due to the precipitation of carbonates. The settled solid material should be collected from the basin and disposed of separately before passing the water on to a local sewage plant.

Due to the acidic and reducing characteristics of the unused working solution there may be issues with its disposal as in high dosages it can disturb oxidation processes in sewage plants. However, the reducing property of the working solution will quickly cease once the solution is brought into contact with the atmosphere. All impairments described above may effectively be counteracted by neutralisation, dilution, sedimentation or injection of air (oxygen) before disposal of the exhausted working solution in e.g. a local sewage plant. The process parameters of the solution (the electrical conductivity, turbidity and pH value) may be measured with simple instruments on the well site (measuring equipment, analytical test strips).

Since AIXTRACTOR® 3.0 contains organic substances microbiological contamination is always theoretically possible. Contrary to the organic acids which have been used for well rehabilitation in the past, the biological degradation processes taking place here are slow enough to make microbiological contamination of the well unlikely. This risk is further minimised by the low biological exploitability of the organic components in combination with immediate abstraction of all water from the treated screen sections.

Irrespective of the process technology used it is advisable prior to any rehabilitation measure to clarify with the local water authority, if the exhausted working solution may be discharged, soaked away or disposed of via a sewage plant after a treatment on site.

6. MONITORING SUCCESS

Well capacity: When evaluating pumping tests the original capacity of the newly built well should be taken as 100% to make the results comparable. Intermediate pumping tests enable the determination of the effectiveness of each working step.

Condition of well in well interior: It is highly recommended to inspect the insides of the well prior to and after rehabilitation using CCTV as an examination of the structural condition of a water well can only commence once oxide incrustations have been removed.

Condition of well outside screen: Comparative examinations by means of borehole geophysics extend the success control down to the otherwise invisible sand and / or gravel pack surrounding the well casing. Oxide incrustations reduce the pore volume and increase the density of the sand and / or gravel pack so geophysical methods providing data on the porosity and the degree of density have proven successful in the past in monitoring success.

Quantity of dissolved incrustations:

Concentrations of dissolved and / or suspended iron and / or manganese can be determined by mass balancing on the well site. The quantity of dissolved incrustations can be calculated by multiplying their concentration (e.g. mg/l) at the time of sampling with the pumped volume of used working solution (e.g. litres) during the period of measurement. The duration of treatment for each screen section can be determined by analytical testing on site finishing at that point where no further development of oxide concentrations in the working solution is evident.

Effectiveness of rehabilitation agent: As the total utilised amount of rehabilitation agent is known, the effectiveness of the agent can be determined by mass balancing in each screen section.