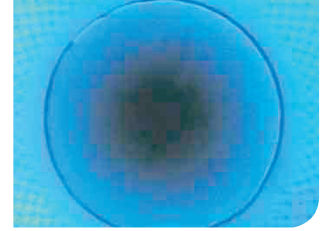
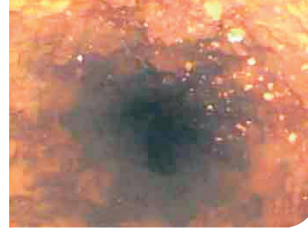


**pH neutral
Rehabilitation Agent**

- acid-free
- chloride-free
- non corrosive

**for Removal of iron(III),
manganese(III,IV)**



REHABILITATION AGENT AS PER GEOCHEMICAL ANALYSIS

AIXTRACTOR® 1.0

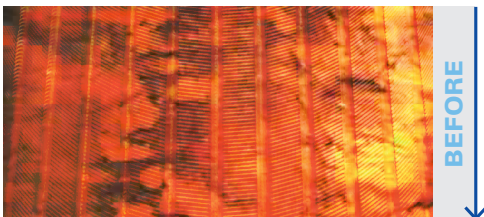
iron(III), manganese(III,IV) – pH neutral – process water

- pH neutral dissolution of iron(III) and manganese(III,IV)
- 50 x greater capacity of dissolving iron compared to hydrochloric acid (pH 1) in identical molar concentration as per stoichiometry
- Continuous process control and immediate result verification on site according to latest German technical standards of DVGW
- Non-corrosive impact, applicable on all filter screen materials
- More cost-efficient than any acidic rehabilitation agent
- Short reaction time of 45 minutes per screen section
- Easy and environmentally friendly handling on site
- No neutralisation or treatment of exhausted agent necessary
- Simple disposal outside Source Protection Zones (SPZ) I and II
- No loss of dissolving capacity through elimination of carbonates in aquifer, gravel pack and adjacent geology
- Re-establishment and confirmation of original water quality by means of easy measurements on site
- Direct quantity calculation of dissolved incrustations and determination of agent effectiveness
- Successful implementation on well sites worldwide since 1999

Effectiveness and material compatibility tested by the Technology Centre for Water, Karlsruhe (TZW), a Member of German DVGW Board of Institutes

Potable water related hygienic assessment by IWW Rheinisch-Westphalian Institute for Water Advisory and Development GmbH, Gerhard-Mercator-University, Duisburg

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1. DESCRIPTION

AIXTRACTOR® 1.0 is a fast reacting effective chemical agent for removing incrustations of iron and / or manganese oxides from wells. The working principle of the agent is based on the chemical reduction of relatively low soluble iron(III) and manganese(IV) oxide into their respective relatively highly soluble iron(II) and manganese(II) ions. AIXTRACTOR® 1.0 has a neutral pH so it has no corrosive side effects and can therefore be used on all types of filter screen and well lining material. It does not contain chlorides and as such may be applied on even the most sensitive well lining materials, e.g. stainless steel, zinc-coated steel, copper, glued gravel wall screens, wooden screens etc. AIXTRACTOR® 1.0 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® 1.0 is not suitable for the removal of carbonates, aluminium oxides and microbiological slime. In order to ascertain suitability of AIXTRACTOR® 1.0 for removal of these substances, a sample of the incrustation should be geochemically analysed prior to any site activity.

Prior to the application of AIXTRACTOR® 1.0 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® 1.0 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.

2. PREPARATION OF THE WORKING SOLUTION

AIXTRACTOR® 1.0 is supplied as a ready-to-use powdered concentrate and should be mixed immediately prior to application, as prolonged contact with atmospheric oxygen reduces its effectiveness. The agent should be completely dissolved in clean (ground) water with a concentration of 15 g AIXTRACTOR® 1.0 per litre volume of borehole to be treated. AIXTRACTOR® 1.0 is very soluble up to a concentration of about 400 g/l water. A mixing ratio of 2 to 3 litres water to 1 kg AIXTRACTOR® 1.0 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, whereas an excessive turbulence with air is to be avoided. 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. When mixing AIXTRACTOR® 1.0 with water, it is highly recommended to wear protective clothing. In all cases, the guidelines set out on the ECU Safety Data Sheet are to be considered.

Under no circumstances is AIXTRACTOR® 1.0 to come in contact with or be dissolved in any form of acidic substance (e.g. hydrochloric or sulphuric acid) or oxidizing 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.

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® 1.0 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) and sulphite. 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 as contact with oxygen reduces its effectiveness. 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 45 minutes. Leaving the working solution on the screen for longer than 45 minutes will not increase its effectiveness and may be counterproductive. 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 45 minutes in each screen section. The quantity of dissolved incrustation as well as the effectiveness of AIXTRACTOR® 1.0 may furthermore be determined by means of mass balancing using the results of the continuous 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 of the well 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.

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

No chemically or microbiologically critical secondary substances or reaction products are created during the rehabilitation process. Reaction products comprise only of dissolved well incrustations consisting of sodium (Na⁺), hydrogen carbonate (HCO₃⁻), sulphite (SO₃²⁻), sulphate (SO₄²⁻), citrate, iron (Fe²⁺) and / or manganese (Mn²⁺).

The reductants in AIXTRACTOR® 1.0 transform the insoluble Fe(III) and / or Mn(IV) into soluble Fe(II) and Mn(II) ions. The complexing agent in AIXTRACTOR® 1.0 supports the dissolving process binding Fe(III) and / or Mn(III) into a complex and so prevents precipitation in the well.

The pH buffer keeps the pH value in a neutral range (pH 7). All active ingredients in AIXTRACTOR® 1.0 exist in the form of sodium salts. Sodium, hydrogen carbonate and sulphate are common and harmless constituents of normal groundwater. The organic complexing agent is biologically degradable. Due to its chemical characteristics the original reductant is able to react completely within the reaction time, so that no residue will be found in the water being extracted during the final abstraction procedure.

The sulphite, which is formed during the dissolution process is unstable and transforms quickly into sulphate in contact with the atmosphere. Remnants of sulphite will be detected during the final abstraction procedure by means of analytical test strips available from cleanwells®.

The exhausted working solution has, as with any other type of rehabilitation agent, an increased salt content, which has to be disposed of after application in an appropriate manner. The salt content is influenced not only by the quantity of the rehabilitation agent applied but also by the volume of the pumped water (dilution). It can be determined by measuring the electrical conductivity of the working solution. The salt content originates from ions of sodium, hydrogen carbonate and sulphate. These ions are normal constituents of groundwater where they occur at a lower concentration.

When the rehabilitation process is being undertaken on a potable water well the applied and later exhausted working solution should not be disposed of within the SPZ of the well. After application on any one treated screen section of the well, the initial cubic metre of extracted water is to be collected separately in a container. The dissolved iron and manganese in the water will oxidise on contact with the atmosphere and form an oxide sludge at the base of the container. This is to be disposed of in an appropriate manner.

A statement issued in February 2006 by the Senate Administration for the City Development of Berlin in cooperation with the Federal Environmental Agency set guidance for the disposal of the abstracted water. This water waste can be sprinkled outside the SPZ of a potable water source. Frequent monitoring of the electrical conductivity and its sulphate concentration is to be undertaken. It is recommended that the electrical conductivity be maintained at a concentration of less than 3000 µS/cm, a level not considered to be harmful by FAO.

After a rehabilitation measure on a non-potable water well it is also not recommended to allow the untreated working solution to be sprinkled directly into the surrounding soil. As already stated, the first (initial) relatively high salt concentrated cubic metre of the extracted water (reactant) is to be collected separately and disposed of accordingly. The clear waste water portion may be disposed of by a soakaway system provided the soakaway is located more than 50 m away from the non-potable well and permission has been obtained from local authorities.

Due to the 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, this property of the working solution will quickly cease once the solution is brought into contact with the atmosphere as any dissolved iron and manganese will immediately precipitate out.

All impairments described above may effectively be counteracted by dilution, sedimentation or simple exposure to the atmosphere before disposal of the exhausted working solution in a sensitive aquatic environment or passing it on to a local sewage plant. Any sort of mixing chamber will prove sufficient for this purpose.

After the rehabilitation measure the exhausted working solution is chemically pH neutral, thus neutralization with lye solutions is not necessary. Mechanically loosened particles, e.g. sand and ochre, can cause some turbidity. The process parameters of the solution (the electrical conductivity, turbidity and remnants of the reaction products) may be measured with simple instruments on the well site (measuring equipment, analytical test strips).

Since AIXTRACTOR® 1.0 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 minimized by the low biological exploitability of the organic components in combination with immediate abstraction of all water from the treated screen sections.

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 proved 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.