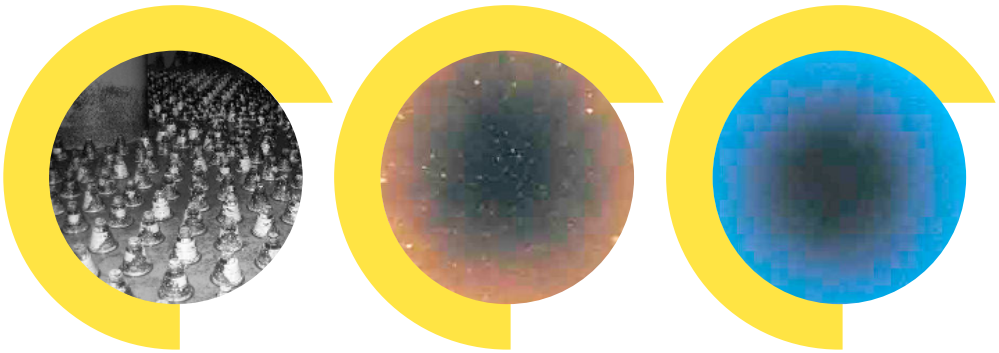
AIX 1.0

REHABILITATION AGENT

acid-free
chloride-free
non-corrosive



pH NEUTRAL

AIXTRACTOR® 1.0

REMOVAL OF IRON(III), MANGANESE(III, IV) – PROCESS WATER

- Crystalline concentrate ready-to-use
- 50 x more effective dissolution capacity of iron(III) compared to hydrochloric acid (pH 1) in identical molar concentration as per stoichiometry
- Continuous process control and result verification on site according to latest technical standards of DVGW, German Gas and Water Association e.V.
- Zero loss of dissolution capacity by elimination of carbonates in aquifer, gravel pack and adjacent geology
- No corrosive impact, applicable on all screen materials
- Short reaction time of 45 minutes per screen section
- More cost-efficient than any acid
- Safe and environmentally friendly handling on site
- No neutralisation or treatment of waste water required
- Easy disposal by sewage, seepage or irrigation outside water protection zones
- Immediate confirmation of restoring original water quality by simple measurements
- Calculation of dissolved incrustation quantities and agent effectiveness on site
- Water Hazard Category 1 (0 non-existent)
- Successful implementation 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

cleanwells®
REHABILITATION TECHNOLOGY

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1. DESCRIPTION

AIXTRACTOR® 1.0 is a fast, highly reactive and efficient chemical agent for the removal of iron and manganese oxides from water wells including the screen, the annular space and the adjacent geological formation. The working principle of the agent is based on the chemical reduction of poorly soluble iron(III) and manganese(III,IV) oxides in highly soluble iron(II) and manganese(II) ions. As AIXTRACTOR® 1.0 reacts in a neutral pH range and does not contain chlorides, it can be applied on all types of well construction and screen materials such as stainless steel, zinc-coated steel, copper, resin bonded preglued gravel, stonewear and laminated plywood. AIXTRACTOR® 1.0 is classified in Water Hazard Category 1 (0 does not exist).

A thorough mechanical cleaning and/or a hydraulic rehabilitation (gravel wash or high pressure jetting) of the well interior prior to any application of AIXTRACTOR® 1.0 is a prerequisite for the benefit of an effective outcome using the chemical agent. As the spatial distribution of incrustations along the screen is heterogeneous, a CCTV camera inspection is required to identify heavily incrusted areas which then may be treated more intensively.

A successful chemical rehabilitation is always based on a geochemical analysis of the well incrustation to identify its exact chemical composition. Subsequently a matching agent can be selected ensuring the highest level of dissolving capacity and the best result will be achieved. AIXTRACTOR® 1.0 is not suitable for the removal of carbonates, aluminium oxides or biomass due to its chemical characteristics. In any case, the specific electrical conductivity of the groundwater is to be measured and recorded prior to starting the rehabilitation work on site.

2. PREPARATION OF THE REHAB SOLUTION

AIXTRACTOR® 1.0 is delivered as a ready-to-use crystalline concentrate. It is diluted in clean groundwater prior to the injection in the well screen. The concentration varies depending on the type and quantity of incrustations from 15 g to 90 g per liter of the total cylinder volume of the borehole diameter multiplied by the screen length. When mixing AIXTRACTOR® 1.0 with water, protective clothing, goggles and safety gloves must be worn at all times. It is also imperative to comply with the requirements of the Material Safety Data Sheet.

The rehab solution is to be prepared and mixed shortly before its actual injection in the chosen screen section. As the agent is very soluble up to a concentration of 400 g/l water, the mixing ratio of 2 to 3 litres water to 1 kg AIXTRACTOR® 1.0 is recommended.

For safety reasons the preparation using a mixing unit including a small pump, must take place outdoor, preferably with tailwind. It is most important to make sure no chemicals get in contact with skin and eyes. The agent is added slowly into the circulating water in order to prevent clumping. As soon as the solution is pumpable (make sure no layer settles on the bottom of the mixing unit), it is ready to be injected in the screen section. Please note that a slight turbidity and potential odour can occur.

WARNING:
Never dissolve AIXTRACTOR® 1.0 in any kind of acidic substance (e.g. hydrochloric or sulphuric acid) or oxidizing agents (e.g. hypochlorite, hydrogen peroxide). This does not lead to more effectiveness but instead would cause the decomposition of the agent and as consequence develop toxic gas.

3. INJECTION OF THE REHAB SOLUTION AND PROCESS MONITORING

The most effective chemical rehabilitation is conducted using a multi-chamber gravel washer with a circulation capacity of 30 m³ to 150 m³ per hour between the chambers depending on the size of the borehole diameter. The treatment of the screen starts at the top and proceeds, section by section, towards the sump. After its injection in the screen section to be treated, the rehab solution circulates between the chambers of the gravel washer with a reaction time of 45 minutes in order to induce the agent as far as possible into the pore channels of the formation. At the same time the continuing circulation prevents its drifting off in the aquifer.

Within 45 minutes the chemical reaction is completed and the injected rehab solution depleted. A longer duration in the screen section does not increase the effectiveness of the agent. Instead, it might only drift off and lengthen the clear pumping at the end. The process of dissolution in the individual screen sections is controlled and monitored by continuous measurements of the specific electrical conductivity and the concentrations of the reaction products in the return flow of the depleted rehab solution. Simple measuring equipment and analytical test strips have proven sufficient.

The chemical treatment is to be repeated in any screen section showing high remaining concentrations of reaction products until the specific electrical conductivity and the analytical test strips have reached their initial values. Any significant migration of the rehab solution in the aquifer can also be observed by monitoring the electrical conductivity of the solution in each screen section. The power consumption of the gravel washer changes due to the increase of the circulated water volume (s. pump curves), which can be used as an additional monitoring tool. Both the quantity of the dissolved incrustations and the effectiveness of AIXTRACTOR® 1.0 can be determined by means of mass balancing. The quantities of incrustations are calculated based on their concentrations at the sampling time multiplied by the quantity of the depleted rehab solution during the measuring period. Providing that the quantity of the rehabilitation agent is known, its efficiency can be calculated precisely as explained.

4. DISCHARGE OF THE DEPLETED REHAB SOLUTION

The discharge of the depleted rehab solution takes place immediately after the reaction time of 45 minutes. The pump should be placed as low as possible in each treated screen section and operated at a rate corresponding approximately to the maximum capacity of the well. Both the duration and the rate of the pumping are to be recorded. The specific electrical conductivity and the concentration of the reaction products are to be measured and documented during the discharge in regular intervals of 15 minutes. Analytical test strips (colour tests) for the latter are delivered with AIXTRACTOR® 1.0. The clear pumping is completed by cleaning the well sump as some rehab solution may have settled due to its higher density.

The duration of the clear pumping varies from well to well and therefore can only be estimated. However, the pumping is finished when the specific electrical conductivity has reached its initial value and the test strips for the reaction products show zero for at least 30 minutes. It is recommended to pump the well overnight at the highest possible rate. As AIXTRACTOR® 1.0 contains eutrophic substances which can theoretically cause a microbiological contamination it is recommended to disinfect the well after treatment.

5. DISPOSAL OF THE DEPLETED REHAB SOLUTION

There is no formation of chemically or microbiologically critical secondary substances or reaction products during the dissolution process.

The depleted rehab solution contains dissolved well incrustations including sodium (Na^+), hydrogen carbonate (HCO_3^-), sulphite (SO_3^{2-}), sulphate (SO_4^{2-}), citrate, iron (Fe^{2+}) and/or manganese (Mn^{2+}) only. AIXTRACTOR 1.0 is a combination of substances which support the dissolution of iron and manganese oxides alike. The reductant in AIXTRACTOR® 1.0 transforms the insoluble Fe^{3+} and Mn^{3+}, Mn^{4+} in soluble Fe^{2+} and Mn^{2+} ions. The complexing agent in AIXTRACTOR® 1.0 contributes to the dissolving process binding Fe^{2+} and Mn^{2+} and prevents a precipitation in the well. The pH buffer keeps the value in neutral range (pH 7.0).

Sodium, hydrogen carbonate and sulphate are natural and harmless particles in any normal groundwater. The original reductant is completely depleted within the reaction time due to its chemical characteristics. Therefore the discharged waste is free of any remnants. The sulphite, which forms during the dissolution process is unstable and changes quickly into sulphate when in contact with air. The remaining sulphite concentration in the return flow of the depleted rehab solution is verifiyed by analytical test strips delivered by cleanwells®. All ingredients consist of sodium salts. As with any other type of rehabilitation agent the depleted rehab solution shows increased salt content. It originates from the ions of sodium, hydrogen carbonate and sulphate which occur in higher concentrations than in the aquifer. The salt content is not only influenced by the quantity of the rehabilitation agent applied but also by the volume of discharged water (dilution). It is determined by measurements of the specific electrical conductivity.

The depleted rehab solution from potable water wells has to be disposed outside the Source Protection Zones I and II. The first gush from each treated screen section (1 m³) is pumped into a container in order to allow for possible iron and manganese ions to settle on the bottom. The depleted rehab solution from process water wells can be disposed at a distance of at least 50 m from the well beneath the flow direction of the groundwater by seepage, irrigation, sprinkling or sewage and in accordance with the local water authority.

All discharged clear water is disposed untreated either by seepage, irrigation, sprinkling or sewage outside the Source Protection Zones I and II as per Statement of the Berlin Senate Administration in coordination with the Federal Environmental Agency (02/2006). It is recommended to comply with the FAO limit value of 3000 µS/cm or with the German Drinking Water Ordinance limit of 2790 µS/cm which is considered unproblematic.

As the discharged water is neutral with a pH value of around 7, it does not require any neutralisation. It may have a certain turbidity due to loosened particles of sand and dissolved incrustations. The process parameters of specific electrical conductivity, turbidity and remaining concentrations of reaction products are monitored in regular intervals of 15 minutes. Unreacted rehab solution in large quantities can disturb oxidization processes in sewage plants due to its reducing characteristics. This can be avoided by adding oxygen, i.e. contact with air causes an immediate precipitation of dissolved iron and manganese.

Any impairment described above may effectively be counteracted by dilution, sedimentation or simple exposure to the atmosphere before disposal of the depleted rehab solution in a sensitive aquatic environment or passing it on to a local sewage plant. Prior to undertake any rehabilitation measure and irrespective of the technique and agent, it is imperative to clarify with the local water authority whether the depleted rehab solution can be disposed via seepage, irrigation, sprinkling or sewage.

6. CONTROL OF RESULTS

Well yield: When evaluating step-discharge tests the original yield of the new well at commissioning should be taken as the 100% value for an objective comparison. Intermediate step-discharge tests allow the verification of effectiveness of individual working steps.

Condition of well interior: As the structural condition of a well is often revealed after the removal of incrustations only, it is recommended to carry out a second CCTV camera inspection following the mechanical cleaning or hydraulic rehabilitation. A clean well interior is not necessarily proof of successful treatment – decisive and the main factor is the cleanliness of the pore channels in the gravel pack and in the annular space.

Condition of well outside screen: Comparative examinations by means of borehole geophysics extend the success control including the otherwise hidden gravel pack, annular space and adjacent geological formation. As oxide incrustations reduce the pore volume and increase the density of the gravel pack, geophysical methods have proven to be particularly accurate as they provide valuable data on the porosity and the degree of density.

Quantity of dissolved incrustations: Concentrations of dissolved and/or suspended iron and manganese can be determined by mass balancing on site. The quantity of dissolved incrustations is calculated by multiplying their concentrations (e.g. mg/l) at the time of the sampling with the pumped volume of depleted rehab solution (e.g. litres) during the measurement period.

Effectiveness of rehabilitation agent: As the total amount of rehabilitation agent is known, its effectiveness can be determined by mass balancing also, i.e. which percentage reacted with incrustations and which did not.