Above-average increase in well performance through chemical-free rehabilitation

Treatment with the newly designed MAXINOZ® rotary nozzle system when using the JET Master® High Pressure Impulse-Process with high water pressure brings trend-setting findings

In 2016 the new guideline "Saving costs and energy in drinking water supply" was published by the Bavarian State Office for the Environment in cooperation with the University of the Federal Armed Forces in Munich. The appendix includes "case studies and best practice". The "Best Practice" example of "Introduction of a well management system to increase the energy efficiency of submersible pumps and extend the service life of existing wells through rehabilitation" also covers the topic of well rehabilitation. An average performance increase of about 69 % was determined for the examined well rehabilitations using **High Pressure Impulse-Process®** with high water pressure [1]. The investigations were based on the **UNINOZ®** rotation system previously used for rehabilitations using the **High Pressure Impulse-Process®** with high water pressure.

The “Zweckverband Wasserversorgung Bayerischer Wald”, based in “Deggendorf”, supplies drinking water to approx. 100 towns and communities in Lower Bavaria and the “Oberpfalz” in an association area of >8,000 km². Approximately 225,000 people are thus reached via a more than 850 km long pipeline network. Furthermore “waldwasser” offers the first certified technical safety management (TSM) in Bavaria at a regional water supplier. The water supplier “Wasserversorgung Bayerischer Wald” has two extraction areas. Approx. 79 % of the drinking water of > 10 million m³/a is drawn from the “Frauenau” dam, which was built by the Free State of Bavaria between 1976 and 1983. Approx. 21 % come from the well field “Moos bei Plattling” (Fig. 1).

Figure 1: well filed "Moos" maps

In the well field “Moos”, an approx. 11 m (33 ft.) deep well was sunk in 2000. The well has a 4 m (12 ft.) long filter section made of DN750 stainless steel winding wire and is operated with an average flow rate of 35 l/s. The pumped water contains iron and manganese and is treated before discharge. Already in the well (filter slots, filter gravel, pump, riser pipe) iron and manganese dissolved in the water precipitates partially as iron/manganese (hydric) oxide (-> ochre formation) (Fig. 2). The reason for this is the sudden change in the physical-chemical equilibrium of the groundwater entering the well during pump operation. The flow velocity increases drastically, the temperature rises (release of heat by the pump motor, elimination of the insulating effect of the cover layers) and enrichment processes lead to increased contact with atmospheric oxygen. In addition, almost all wells contain

bacteria that are completely harmless to health, which gain their energy from the conversion of dissolved iron/manganese into the respective (hydr)oxides and thus usually contribute significantly to faster ochre formation.

Previous rehabilitations of the described well with a nozzle system rotating in one plane (high-pressure internal flushing according to W130) in combination with a High Pressure Impulse-Process by means of gas compression in 2005 and again in 2011 had not achieved the desired success.

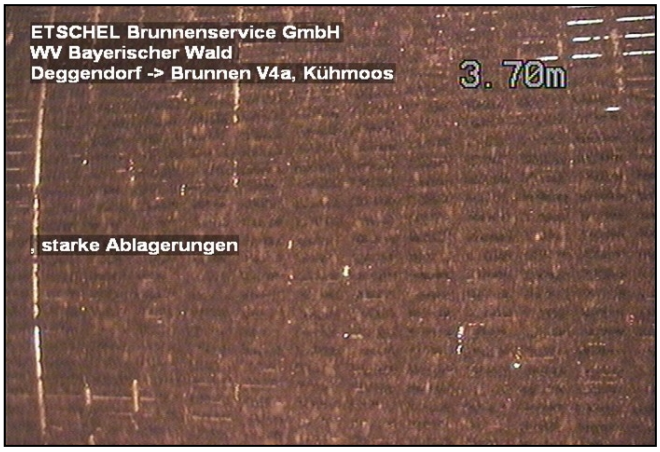

Figure 2: heavy deposits in the filter slots

High Pressure Impulse-Process® with high water pressure

The well was to be rehabilitated for the first time using the **High Pressure Impulse-Process®** with high water pressure (**JET Master®** system from Etschel Brunnenservice GmbH). Within the scope of a series of practical tests throughout Germany, the newly designed and patented double rotation unit System **MAXINOZ®** with two pairs of nozzles rotating in opposite directions in two planes was also used for this project. In contrast to the double rotation unit **UNINOZ®** which has been in use since 1991, the nozzle configuration is additionally adapted to the geometry of the lining material by adjusting the outlet angle. A water jet generated by a high-pressure pump exits through the nozzles at a pressure of up to 550 bar. The eccentric arrangement of the nozzles leads to a rotation by the recoil principle with approx. 7,000 rpm. The high rotational speed ensures that no directed high-pressure jet impinges on the various well lining materials. Instead, the energy of the rotating water jets is converted into pressure wave impulses upon contact with the well water, which spread through the extension piping and filter gravel into the existing soil formation (see DVGW W130, W55/99). Vibrations generated by this in the entire lining, including filter gravel, and right into the existing soil formation loosen the deposits that cause blockages in the waterways.

The friction of the individual gravel/sand grains against each other can also loosen already hardened deposits. In the well itself a negative pressure is created and a pump installed above the unit constantly removes the loosened deposits. A flow rate oriented to the well capacity is particularly important here. The rehabilitation process can be applied to all lining materials, however, the corresponding experience of the executing company is a prerequisite (Etschel Brunnenservice: over 11.000 HPI-rehabilitations). The company has to adapt the variables pressure, driving speed, nozzle distance, nozzle type and now also the angle of radiation to the lining material and structural condition in order to achieve the highest possible effective depth without causing structural damage.

Figure 3: rehabilitation with the High Pressure Impulse-Process® with high water pressure, system JET Master®

Implementation of the measure

The obligatory camera inspection clearly showed precipitates of iron and manganese oxides in wide areas of the filter (fig. 2). A fine sandy sedimentation had formed in the well sump. In addition to a decline in well performance, the operator had also observed a temporary sand flow.

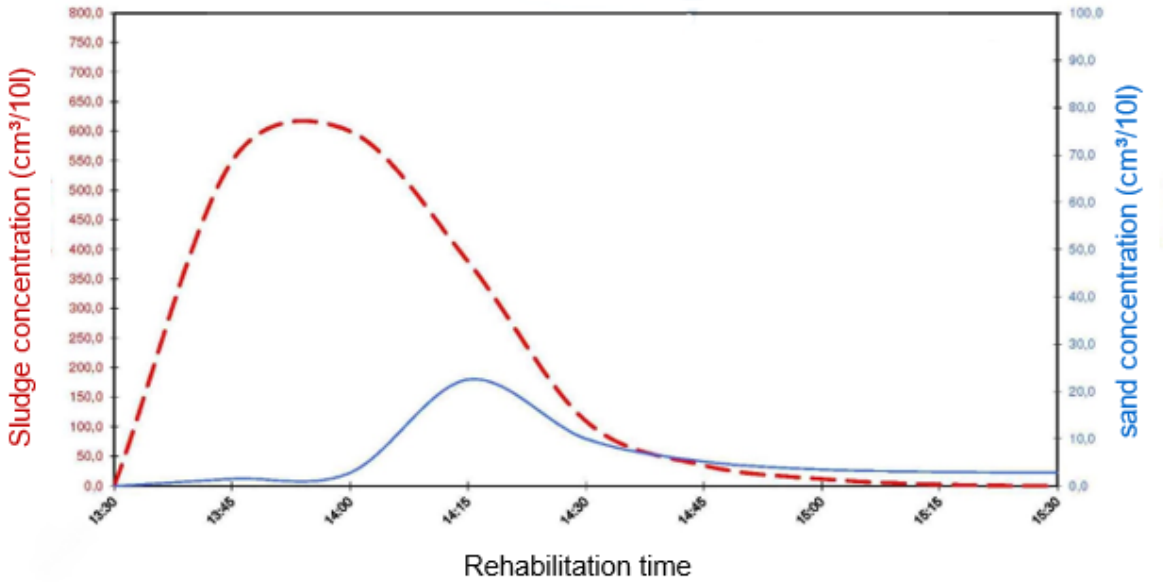

Figure 4:discharge diagram

During the subsequent rehabilitation, the JET Master® (Fig. 3) discharged a total of 389 liters of (fine) sand and 11.602 liters of finer components ("sludge") at a water flow rate of 545 m³ (Fig. 4) until the termination criterion was reached after two hours. The dirt loads were determined by means of extraction from the pump flow and subsequent measurement in the Imhoff hopper (Fig. 5). The simultane simultaneous pumping rate had initially been adjusted to the well at 50 l/s and when finer components were discharged after 30 minutes to 80 l/s, the increase in the pumping rate was accompanied by a significant increase in the (fine) sand content. Before the final camera inspection, which now showed free filter slots again (Fig. 6), the sediments were removed from the well sump using a mammoth pump. Pump tests before and after the measure clearly proved the success of the rehabilitation.

Figure 4: measurement with Imhoff hoppers

Result

The following table shows the specific yield (water quantity that can be withdrawn per one meter of water level drop in l/s) of the well at different flow rates - both before and after rehabilitation - proven by pumping tests.

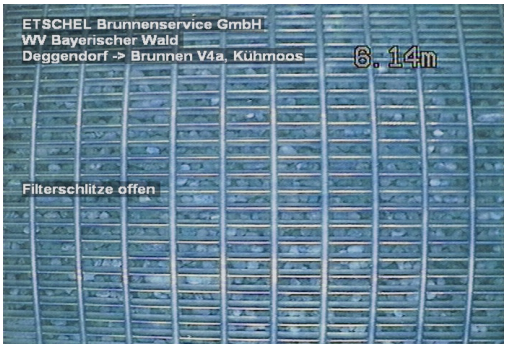

Figure 5: cleaned filter slots

Extraction volume [l/s]	Lowering before rehab. [m]	Lowering after rehab. [m]	Specific yield before rehab. [l/s / m]	Specific yield after rehab. [l/s / m]	**Percentual change through use of JET Master with Maxinoz®**
30	1,48	0,45	20,3	66,7	**+ 229 %**
40	2,32	0,77	17,2	51,9	**+ 201 %**
80	---	1,78	---	44,9	---

Table 1: Results of MAXINOZ rehabilitation

system **MAXINOZ®** in the **High Pressure Impulse-Process®** with high water pressure compared to other rehabilitation processes used in the past (see above). Furthermore, it can be assumed that the development method used for the new well could not develop the well completely due to insufficient depth effectiveness.

In this case, the "remarkable fine grain discharge (...) (desanding effect)" certified by the DVGW in research project W55/99 as the only rehabilitation system for the JET Master® was of particular importance [2]. This led - as a by-product of the rehabilitation process, so to speak - to a subsequent development of the well to full capacity and thus simultaneously demonstrates the advantages of the **HPI-Process®** over conventional methods of well development such as pistons, brushes, shocks and intensive sands.

Conclusion

The further development of the JET Master® nozzle rotation system MAXINOZ® clearly shows in this example the improvements that innovations can lead to. Through the further development of modern rehabilitation methods, it is possible to give a well its actual performance only many years after it has been newly constructed. Often such a rehabilitation also leads to a subsequent development of the well. Completely developed wells save costs, as improved yields can significantly reduce the total number of wells required per supplier.