

Comparative consideration of different nozzle rotation units for the rehabilitation of wells using the High Pressure Impulse-Process® with high pressure water.

History: From "UNINOZ®" to "MAXINOZ®"

In 1991/92 the company E+M Bohr (today: ETSCHSEL Brunnenservice GmbH) introduced the **High Pressure Impulse-Process®** (HPI-Process®) by using high pressure water for the rehabilitation and development of wells under the name "**JET Master®**" / Rotation nozzle system "UNINOZ®".

Two eccentrically arranged pairs of nozzles rotate in two plains in opposite directions using the recoil principle at a speed of approx. 7,000 rpm and eject water at a pressure of 100 to 550 bar. The high rotational speed ensures that no high-pressure beam hits the filter screen material directly, but instead the energy of the compressed water is converted into pressure wave impulses.

Additional impulses result from the pulsation of the water due to the piston impacts of the high-pressure pump and from the rotational movement of the nozzle arms. The resulting cavitation between the two nozzle pairs leads to a disinfection of the well at the same time. Above and below the unit, a vacuum is formed which causes a flow directed towards the well. This is reinforced by simultaneous pumping out with a quantity adapted to the yield of the well during the continuous up and down movement of the double rotational unit.

The generation of high pressure impulses makes it possible to loosen and remove even already hardened deposits from the filter gravel and the adjacent borehole wall by purely mechanical means (= without the use of chemical agents), or in the area of the well development to completely remove the filter cake after a new well and to desand the well at the same time. The DVGW research project W55/99 describes the effective depth as "up to several decimeters into the existing aquifer".

The new process replaced the usual method of mechanical-chemical rehabilitation using brushing, swabbing, surge plugging and large quantities of hydrochloric acid or other chemical substances. The well shut down times due to rehabilitation decreased significantly, while the efficiency of the individual measures increased, which led to an extension of rehabilitation intervals.

The HPI-Process is now regularly used by several companies throughout Germany with a total of over 20 units. With appropriate experience, it can be adapted to all well construction materials and ageing conditions by means of the variables pressure, travel speed, nozzle distance from the construction material and nozzle type. It can also be used for gravel filters (see also the following example) and double gravel packs.

	2007 UNINOZ mechanical	2007 gravel washer chemical	2017 MAXINOZ® purely mechanical	Percentage Change
Duration (h)	9	ca. 35%	7,75	--
Sand discharge [L]	251	--	1.200	+478%
Sludge discharge [L]	5.284	--	14.083	+ 267%
Residual sand [cm³/10L]	1,3	--	1,0	- 23%
Specific yield [L /m/s]	1,41	1,49	2,27	+ 61% / + 52%

Table 1: Comparison of mechanical-chemical rehabilitation with UNINOZ / gravel washer in 2007 and purely mechanical rehabilitation with MAXINOZ® in 2017.

In 2015, the **HPI-Process®** was included in the LfU's Drinking Water Guidelines as a "best practice" solution. The underlying study of 18 wells throughout Bavaria showed an average performance increase of 69 % with the "UNINOZ®" rotational nozzle system. In 2017 a further development of the double rotational unit was patented by ETSCHEL Brunnenservice GmbH under the name "**MAXINOZ®**". The capability to adjust the nozzle arm angles to the geometry of the filter screen material is protected by patent. Up to now, these have been installed at an unchangeable angle of 90° to the filter screen material of all brands used. By means of inclined and slanted nozzles, depending on the material to be treated, higher effective depths and a significantly improved discharge of the dissolved material are achieved by the additional formation of hydraulic waves. The development of new wells also shows a higher effective depth and a much higher sediment discharge compared to the previous nozzle configurations.



Figure 1: Construction sight Mering. **HPI-Process®** in progress.

In the following the effect of both systems on the same well is documented: The 155 m deep well No.1 Meringzell of the Markt Mering, DN 400, steel Hagulit coated, bridge slotted filter screen with gravel coating, of coating, which taps tensioned tertiary water containing iron and manganese and is affected by ochre formation, was rehabilitated in 2007 with the "UNINOZ®" system and additionally chemically. In 2017, it was rehabilitated exclusively mechanically with the "**MAXINOZ®**" system (see Fig. 1 and Fig. 2). A comparison of the rehabilitation results reveal significant differences in the discharged deposit quantities and the resulting rehabilitation success (Table 1). In 2007, a total of 251 L of sand / 5,284 L of sludge were removed purely mechanically up to the completion criteria after nine hours. Further loads were removed by using approx. 2 t of a hydrochloric acid-based liquid chemical in conjunction with a so called gravel washer. In 2017, the new "**MAXINOZ®**" system succeeded in removing 1,200 L of sand / 14,083 L of sludge in only 7.75 hours, which is 4.8 times more sand and 2.7 times more sludge than the mechanical rehabilitation of 2007. The residual sand content was 1.3 cm³/10 L in 2007 and only 1.0 cm³/10 L in 2017. The significantly increased solid extraction was also noticeable in the specific yield. This was - verified by pumping tests - 61 % higher after rehabilitation in 2017 with the "**MAXINOZ®**" system than after mechanical rehabilitation in 2007 with the "UNINOZ®" system. Compared with the value after the additional chemical rehabilitation, there was still a remarkable increase of 52 % in 2017 (Table 1)

The evaluation of the rehabilitation results at well No.1 in Mering clearly proves the higher effectiveness of the new **MAXINOZ®** system compared to the previous UNINOZ®. Likewise, the effect of the additional chemical rehabilitation is far surpassed and thus considered obsolete. Rehabilitations with the new **MAXINOZ®** rotary nozzle system therefore mean an enormous savings potential for the operator and at the same time a better rehabilitation result in the form of significantly higher specific capacities. The necessary approval by water law procedure required for chemical rehabilitations can be avoided when using the new rotary nozzle system.