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THE ETSCHEL JET MASTER® – A HIGH PRESSURE IMPULSE PROCESS (HPI-PROCESS®) FOR WATER WELL REHABILITATION AND WATER WELL DEVELOPMENT

The technology to create high pressure impulses by means of high water pressure for loosening of deposits in water wells, which clog the filter screens, the gravel pack and the borehole wall is described in the DVGW (German Water Certification Authority) Handbook Section W 130 as a high pressure impulse process (HPI-Process®). This HPI-Process®, which has been developed by Etschel Brunnenservice GmbH for more than a decade, has proven itself in over 8.500 water wells as a very successful method to rehabilitate old or develop new water wells very efficiently. In the following, the HPI-Process® powered by the Etschel JET Master®, will be described based on actual research and practical experiences.



Figure – Mobile unit for water well rehabilitation and water well development

Process Description. Using the HPI-Process® the potential energy (pressure) created by a high pressure pump is transformed into kinetic energy (water exit speed). The result is High Pressure Impulses.

High Pressure Impulses. The kinetic energy created by the nozzles leads to the counter directional rotation of the two jet nozzle bodies (each body with two separate nozzles) at about 7.000 rpm generated by recoil effect. The extreme water exit speed of 180 meter/second together with the jet power of the individual nozzles of about 190 kN lead to a sudden acceleration of the water (impulse) around the nozzles. This initialises high pressure impulses, which expand from the

surrounding well water through the filter screen and the gravel pack into the aquifer. The high energy input creates micro movements, which lead to the breaking up of deposits between the individual gravel particles. Since they start rotating.

Consequently, the efficiency of the HPI-Process® is based on the creation of a high flow velocity within the well water and the gravel filter layer by using the shearing power of the water to loosen any kind of deposits. The generated high pressure impulses travel in a more or less horizontal direction deep inside the water well.

On top of that the two counter rotating nozzle pairs, which are adjusted to the individual well diameter, almost completely separate the water into two water horizons. Due to the constant up and down movement of the entire aggregate at a speed between 0.1 to 0.3 meter/second during the rehabilitation or development process, a swab effect is generated, which further contributes to the cleaning of the well.

Official investigations and research have proven that the described swab effect along with the generated suction lead to a transport of the loosened deposits into the water well, while simultaneous pumping extracts the solids from the well.

Extraction of loosened deposits. To further increase the efficiency of the well cleaning process and to get hold of measurable data of loosened deposits, a submersible pump is installed, which continuously extracts the loosened particles together with the well water simultaneously to the HPI-Process® taking place. It is absolutely necessary to adjust the pump performance to the well characteristic, since in case of a low flow less perched water horizons will not be activated.

In addition to the swab effect, the pump generates a flow pattern from the aquifer through the gravel pack and the filter screen into the well. This – in combination with the positive shock wave impulse and the effective tractive force towards the well – leads to the flushing of the channels between the individual gravel particles. The higher the flow velocity towards the well, the higher cleaning effect can be observed. However the flow velocity should be controlled as such to avoid a change from laminar flow to turbulent flow.

Measurements. To control the progress and success of the HPI-Process® with the Etschel JET Master® and to determine the break up criteria, continuous measurements are necessary. Those are typically made by measuring the loosened and pumped out deposits in regular intervals (usually every 5–15 minutes). The measurement readings are recorded from the deposit settlement in Imhoff cones. As soon as the readings show a stabilisation at a very low level of the pumped out deposits, the process can be stopped.

Planning / Variables. To obtain best results, planning of the HPI-Process® is vitally important and should amongst other factors include:

- water pressure (up to 550 bar);
- vertical speed of hose winch;
- distance of nozzles to screen;
- type of nozzles (size of water outlet, dispersion angle);
- simultaneous pumping rate;
- since 2017: angle of nozzles to axis of well (patent-registered, brand name “Maxinoz”).

The art in operating the system is to adjust all variables to the material, diameter, depth and condition of the well. The aim is to maximize penetration without damaging the structural integrity. Etschel Brunnenservice can build upon the experience of rehabilitating more than 8.500 wells using the HPI-Process®.

TV inspections before and after the cleaning process are highly recommendable.

Third party and own scientific research. For a better understanding of the HPI-Process® and to obtain solid data for the technical improvement of the Etschel JET Master® itself, the following R&D projects have been executed since putting the JET Master® into operation back in 1993.

Own research. Tests in conjunction with a thesis at the Bergakademie Freiberg (SAAED, 1996), which as a result has led to further improvement of the HPI-Process® and an increase of the penetration depth beyond the filter screen.

In some cases we have extracted Bentonite and other drilling fluids from old wells which under normal circumstances should have been extracted when the well was developed. This serves as a proof that the created impulses reach even beyond the borehole wall. In such cases it often happened that the performance of the well exceeded the one after the final pump test of the newly drilled well.

Patent registered nozzle Maxinoz® (Patent Nr. 2 770 161)(2017). In 2017 a new version of the nozzle branded Maxinoz® was patented and released. It features two pairs of nozzles with adjustable angles relative to the well material. This results in a deeper penetration depth and the creation of hydraulic rollers for a heightened backwashing effect of the loosened deposits. The quantity of the extracted materials rises significantly compared to the previous system Uninoz with a fixed angle of 90°.

First results were published in German professional publications:

- Rehabilitation at “Waldwasser”: increase in efficiency by 229 % (gwf 04/2017).
- Rehabilitation Public Services Karlsruhe: average increase in efficiency by 152.5 % in 10 rehabilitated wells (ewp 05/2017).
- Well development “Landeswasserversorgung Baden-Württemberg”: in average 9.7 times heightened amount of extracted sand compared to the previous system “Uninoz” (bbr 09/2017).

Third party research. In conjunction with an updated edition of the DVGW (German Water Certifying Authority) handbook section W 130 (Water Well Rehabilitation Techniques), which should take into consideration the state of the art rehabilitation techniques, an official research program was initiated by the DVGW in the year 2000. The goal was to compare the various mechanical rehabilitation techniques and verify their efficiency by determining their penetration capabilities beyond the filter screens into the gravel pack. The investigations were carried out at the Dresdner Grundwasserforschungszentrum e.V. (Dresdner Groundwater Research Centre) on real well models.

The results have been finalised in 2003 and were published in the DVGW Research edition W 55/99, in which the HPI-Process® has achieved best results compared to other rehab methods. The HPI-Process® was the only system to simultaneously perform loosening (breaking up of deposits), transport of loosened deposits and also its measurement / monitoring.

A further test of the actual efficiency of the HPI-Process with the Etschel JETMaster® was carried out by the Dutch Water Certifying Authority (KIWA WATER RESEARCH). This test shows the efficiency of the JET Master® during well development in sandy aquifer without gravel pack using Johnson screens.

Etschel JET Master® System Technology. For the majority of applications (wells up to 1000 mm diameter and until 400 m depth), the entire equipment is installed on a three axle four wheel truck configured by our own factory.

The high water pressure is generated by a plunger pump. The flow can be regulated between 100 and 200 l/min (6 to 10.2 m³/hour). The pump pressure can be regulated in range between 100 and 560 bar according to the requirement. The Truck is completely equipped with its own power supply, a compressor, various nozzle configurations, distance holders, control instruments, high pressure hoses, riser pipes, various pumps, hydraulic accessories and data recorders. To operate the Etschel JET Master®, external water must be made available on site.

Applications. The applications of the Etschel JET Master® are variable. The HPI-Process® is mainly used for water well rehabilitation of vertical water wells, pump shafts, horizontal water wells, infiltration wells, observation wells and similar applications, but also for the development of new water wells and de-sanding. In a relatively short period of time – compared to other rehabilitation technologies – most particles (e.g. sand, loosened deposits, sludge, sintered materials) are removed from the well and the sump.

Because of the flexible adjustment of the aforementioned parameters, the Etschel JET Master® can work in all known filter screen materials. Even in very old wells the HPI-Process® has proven to do a successful job.

It is vitally important for many water well operators to have a minimal break down time of the well production for a rehabilitation. In many areas, it is almost impossible to take the well off

the supply network for a longer time. In most cases the Etschel JET Master® does not need more than one or two days to rehabilitate a well successfully. Including the pulling and installation of a pump and a TV inspection of the well before and after applying the HPI-Process®, the total time consumption in conjunction with wells up to 200 m depth does not exceed four to five days. Deeper wells may take longer.

It is only natural that in some cases the rehabilitation makes visible eventual damages (e.g. corrosion, mechanical damages) of the water well construction or the filter screen itself. In such cases the water well rehabilitation can serve as an indicator of preventive maintenance, giving the operator a clear proof that a sanitation of the well may be highly recommendable. This can save a lot of costs versus the costly and time consuming possibility to have a new well drilled.

Monitoring. At the beginning of the HPI-Process®, a great amount of sludge extraction can be observed, which is caused by cleaning the casing and the filter screens including the slot openings.

After a while, the extracted sand concentration increases since due to its higher mass and the fact of often being incrustated in ironoxides inside the gravel pack, sand requires a longer time to be “mobilized” by the HPI-Process®.

After continuously applying the process, the sand and sludge transport falls pretty steady. By increasing the pump capacity in the next step, one can observe another increase of sludge and sand extraction from the well.

Finally, when the extracted particles reach a stabilized level of no more than 0 to 0.5 ml per ten liters, this serves as an indicator that the HPI-Process® can be stopped.

Thereafter, another specially designed pump is installed and lowered into the bottom of the well to finally clean the sump of deposits which have sunk during the process and before. The extracted amount of deposits is also measured and will be shown in the extraction graph.

Water well maintenance. In a best case scenario, the Etschel JET Master® using the HPI-Process® should not be a one off single approach towards proper well maintenance. A water well is a costly building, which under normal circumstances should be monitored in regular intervals by the owner. Relatively little effort can save lot of costs in the long run. Elements of a proper water well maintenance scheme should include:

Regular Eye Observation of (every month):

- the pump house and well shaft;
- the hydraulic and electrical installations in the well shaft.

Judgement of the water well itself by (interval to be determined):

- TV inspections;
- control of the pump and its riser pipe;
- Geophysical measurements;
- Assessment of the hydraulic and chemical parameters by pump tests / by water analysis.

Assessment of the well performance (weekly or monthly) by:

- measurement of the still water level (pump is off);
- measurement of the draw down water level (pump is on);
- measurement of the running times of the pump;
- measurement of the sand content and other materials (gas, sand etc.) in the pumped water.

The records of this data should be filed and serve as an indicator that a rehabilitation as part of preventive maintenance may be adequate once a significant deviation from the new condition is observed.

The DVGW handbook W 130 recommends that a rehabilitation is an urgent need and can achieve best results if the well has not lost more than 10 % to 20 % of its original productivity.

Conclusion. The HPI-Process® powered by the Etschel Jet Master® is a proven and chemical free technology to mechanically rehabilitate old wells or develop new wells after the borehole has been drilled. So far, over 8.500 wells were rehabilitated and several hundred developed by Etschel Brunnenservice GmbH.

In most cases this process makes a chemical treatment unnecessary. Its state of the art technology stands for a time and cost saving solution with highest cleaning and solid extraction

performance. It guarantees the necessary penetration depth beyond filter screen and gravel pack and is adjustable to all well materials. In addition, the creation of positive cavitation leads to disinfection of the well already during the rehabilitation and contributes to a slow-down of bacteria growth.

To gain impressions of the technology various videos are available: <https://www.youtube.com/user/Etschel1>

Etschel Brunnenservice GmbH also manufactures individually customisable JET Master units either truck or container mounted.

Literature sources

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