Cleaning wastewater pressure pipes during operation

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Clean pipes are a prerequisite for safe and energy-efficient wastewater disposal. The Comprex impulse flushing process makes it possible to economically clean entire wastewater pressure pipes as well as particularly critical sections during operation.

Description of wastewater pressure pipes

Wastewater pressure pipes are part of a wastewater pressure system. They can transport wastewater over long distances and adapt well to the terrain. Wastewater pressure systems consist of the pumping unit (pumping station, usually with centrifugal pumps), the wastewater pressure pipe and the outlet structure (treatment plant, shaft of a gravity sewer or pumping station of another wastewater pressure pipe). Depending on the course of the terrain, there are aeration and deaeration valves (BEV) at high points and drains (E) at low points. ***Figure 1*** schematically shows the typical route of a wastewater pressure pipe between a pumping station and a sewage treatment plant.

Culverts for crossing under rivers, for example, are a special feature. Here there is a BEV before and after the culvert, but no discharge at the low point (***Fig. 2***).

Waste water pressure systems are characterized by intermittent operation. This mode of operation entails the risk of deposits and blockages, odor and corrosion problems due to anaerobic decomposition of the wastewater and gas development. Culverts are particularly critical for deposits.

Operation of the wastewater pressure pipes

In recent years, safety and energy aspects have played an increasingly important role. Pipes with constricted cross-sections require more energy and time to transport the water in normal operation and can no longer transport the water fast enough at peak times. The performance of the pipe decreases and the energy requirement of the pump increases. ***Figure 3*** shows the pipe characteristic curve when planning or commissioning the new pipe (green) and with deposits (red). The points of intersection with the pump characteristic curve are the operating points N for the new pipe and B for the cross-sectionally narrowed pipe. Compared to N, there is a higher pressure at B with less volume flow. The pump efficiency is reduced. In the event of performance problems, the operator first considers measures at the pumping station: Pump repair

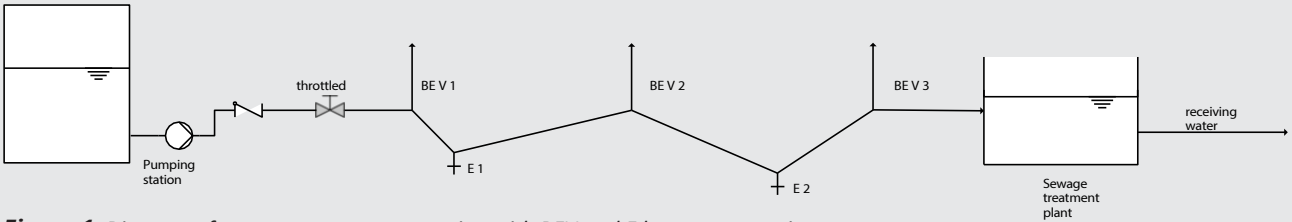

Figure 1*: Diagram of a wastewater pressure pipe with BEV and E between pumping station and sewage treatment plant*

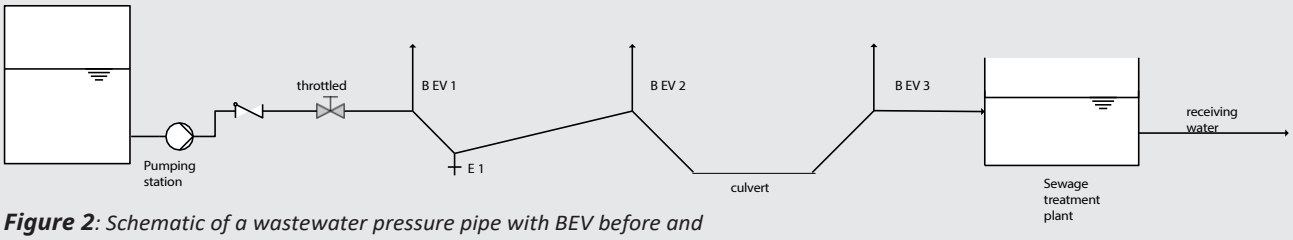

Figure 2*: Schematic of a wastewater pressure pipe with BEV before and after culvert*

or even pump replacement, perhaps even stationary compressed air flushing. However, measures at the pumping station alone are not enough to restore the sewage pressure systems. Cleaning the wastewater pressure line is just as important.

One problem in recent years has been overdimensioned wastewater pressure pipes due to incorrect planning data or as a result of demographic change, resulting in long dwell times for the wastewater. As a result, degradation processes already take place in the wastewater pressure pipe before the wastewater treatment plant. Suspended solids can be deposited and, together with other solids, reduce the cross-section of the pipe. Microbial reactions also cause gases to form, which can lead to odors and corrosion attacks on the components at the BEV or at the outlet. Regular cleaning is particularly necessary here.

On the other hand, although wastewater pressure pipes are constructed correctly according to requirements, sanitary wipes or moist toilet tissues, which are difficult or impossible to biodegrade, accumulate in the seal skin, especially in pipes up to DN 65. These impairments are difficult or impossible to remove using conventional cleaning methods. Only intensive cleaning with modern methods can help here.

Efficient cleaning of wastewater pressure pipes

Newly constructed wastewater pressure pipes must be equipped with cleaning facilities. This is pointed out in the new worksheet DWA-A 113 [1]. Equipment for cleaning wastewater pressure pipes varies depending on the cleaning method. In the impulse flushing process, the BEVs at the high points of the wastewater pressure pipe can be used to feed in compressed air. The BEVs thus divide the wastewater pressure line into clearly defined cleaning sections (Fig. 1).

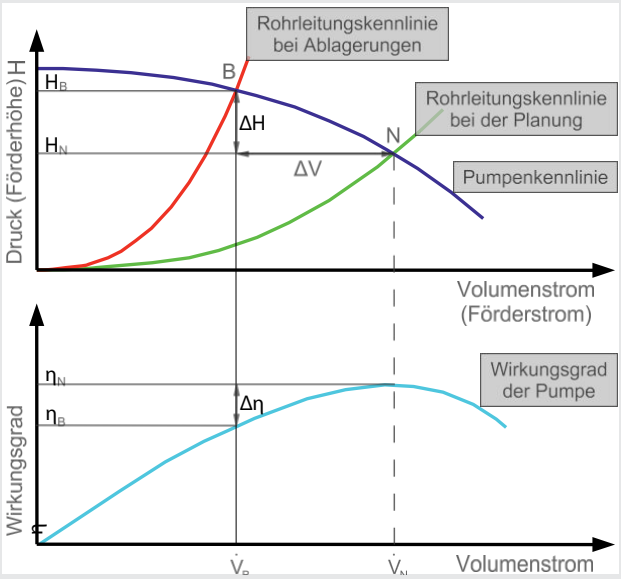

***Figure 3**: Characteristic curves of pump and pipe without and with deposits*

The patented, innovative Comprex technology is increasingly being used to clean wastewater pressure pipes. Here, wastewater accumulated upstream of the pumping station is used together with compressed air as a cleaning medium. The wastewater flows slowly through throttled valves into the pipe section to be cleaned. The compressed air comes from Comprex units, which also contain innovative software for controlling the compressed air dosage. Adapters connect the compressed air lines to the waste water pressure line section. ***Fig. 4*** and ***Fig. 5*** illustrate the compressed air feed in a pumping station into a wastewater pressure line.

***Figure 4**: Comprex unit at pumping station*

***Figure 5**: Feed point via pump*

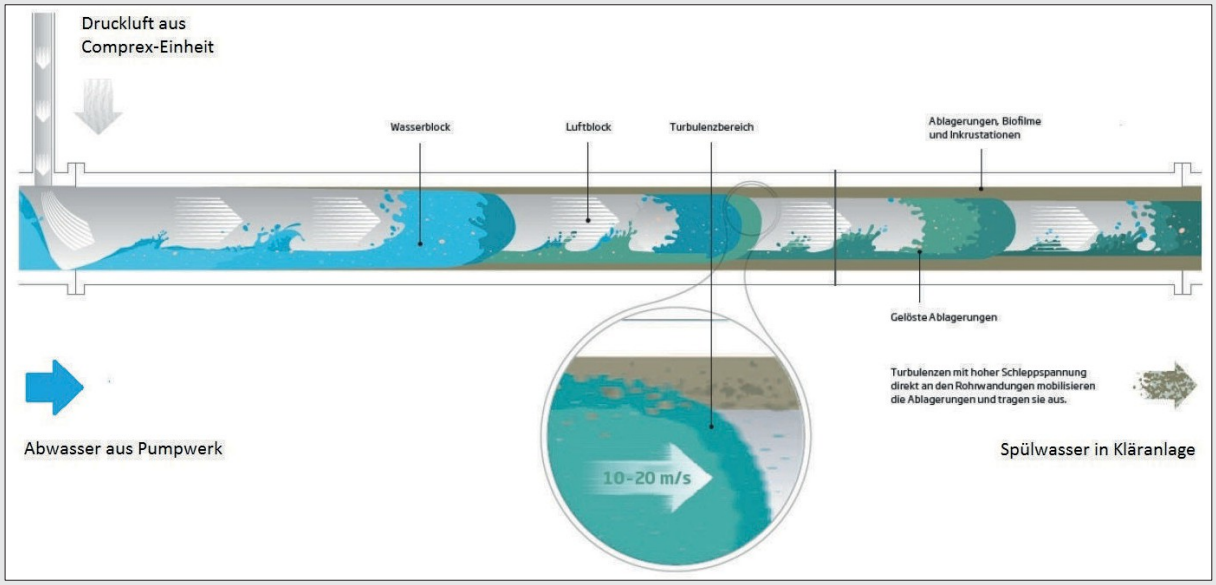

***Figure 6**: Diagram of Comprex cleaning of wastewater pressure pipes*

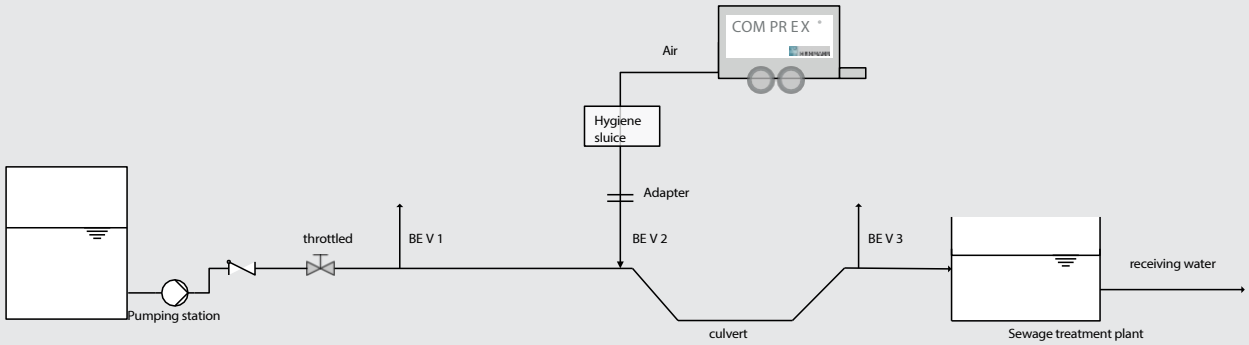

***Figure 7**: Comprex cleaning of a culvert in a wastewater pressure pipe*

Figure 6 schematically explains the processes involved in Com- prex cleaning. During cleaning, plugs of water and air blocks form in the cleaning section. They move through the pipe at high speed. The innovative control system modulates these plugs in such a way that, on the one hand, they achieve high drag voltages to mobilize the deposits and, on the other hand, they completely and reliably discharge the mobilized particles.

Comprex cleaning of pipelines

In the new patented Comprex process, compressed air is metered into a partially filled pipe section. There, the air can expand abruptly and thus form impulse-like cleaning-effective plugs of water and air blocks. The effectiveness of the cleaning initially depends on the speed at which these Comprex plugs move through the pipe. The speed can be determined from the transit time between two measuring points. There are sensitive sensors at the measuring points, for example

Pressure sensors that can measure and record the pressure curve with a high temporal resolution. With the Comprex method, the velocities determined in this way are over 15 m/s, often even well over 20 m/s. It is not entirely accurate to speak of velocity or even flow velocity because acceleration effects have a decisive influence. To form the plugs, the surface of the water at rest in the bottom of the pipe is brought up to speed in fractions of a second. Acceleration and velocity together cause the drag stress. This is orders of magnitude higher with the Comprex process than with simple water flushing.

The Comprex pulse flushing process always works "online" in wastewater pressure pipes, i.e. during operation. The discharged particles enter the wastewater treatment plant and are disposed of there without any further effort. A distinction must be made between one-off basic cleaning of the entire wastewater pressure line and regular maintenance cleaning. In contrast to stationary compressed air flushing in accordance with

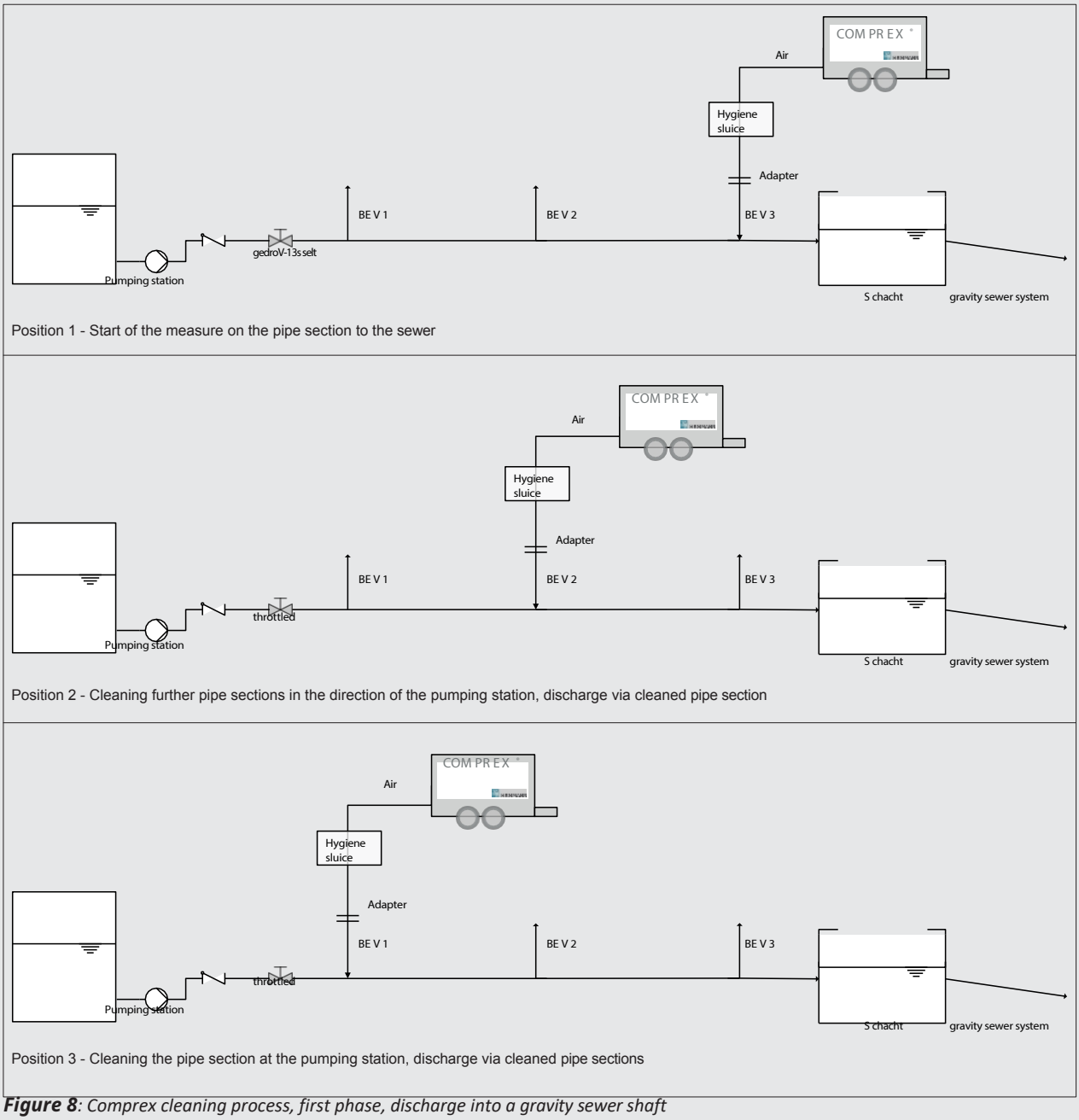

***Figure 8**: Comprex cleaning process, first phase, discharge into a gravity sewer shaft*

DWA-A 116-3 [2], which has only a limited cleaning effect, especially in long pipes, the Comprex technology is mobile and can be used specifically on individual pipe sections. This makes it possible to intensively clean critical areas such as culverts in order to reliably remove even large particles such as stones (***Fig. 7***). Such stones can cause damage to the pipeline invert [3].

Changes in nominal diameter are also no problem for Comprex plugs. Unlike pigs, Comprex plugs adapt to the geometry of the pipeline and cannot get stuck. Even heat exchangers, which are used to recover heat from waste water, can be used.

The Comprex cleaning system can be used to reliably clean wastewater pressure pipes. The daily output of Comprex cleaning depends primarily on the nominal diameter and degree of contamination of the wastewater pressure pipe. It can be 1 km/d for basic cleaning of very narrow pipes and up to 3 km/d for maintenance cleaning.

For basic cleaning in particular, it has proven to be advantageous to start with the last section of the wastewater pressure pipe to the sewage treatment plant or gravity sewer and then work in sections up to the pumping station (***Fig. 8***). The water column between the compressed air injection point and the pumping station is not compressible, so that the Comprex plugs work optimally in the cleaning section

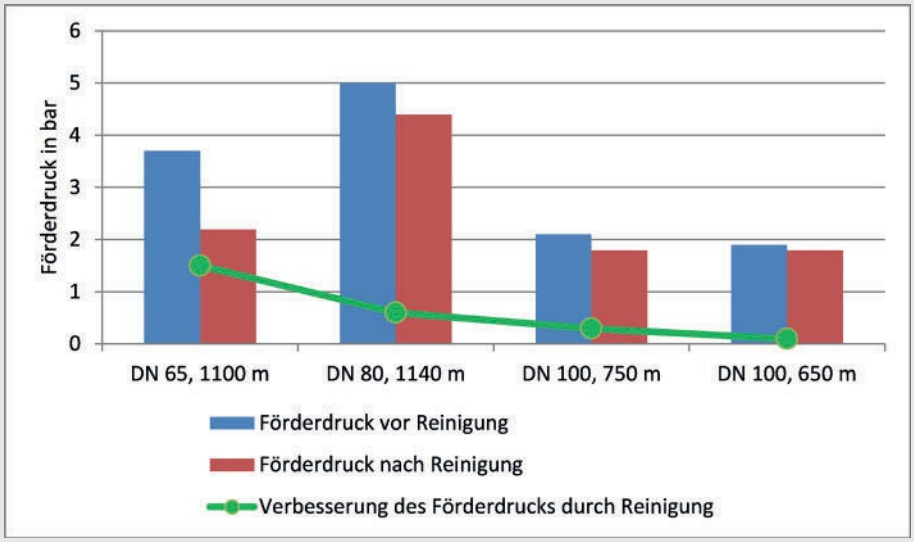

***Figure 9**: Improvement in the required delivery pressure as a result of Comprex cleaning*

becomes. This means that the intensity of the discharge of solids or turbidity may increase again after an initial phase. This is an indication that more firmly adhering deposits are mobilized and then reliably discharged. Comprex cleaning is not only interesting from a technical point of view. It can also be more economical than other methods. The prerequisite is good planning. Particularly in the case of maintenance cleaning, the measures can be planned in daily operations and thus implemented cost-effectively.

can. It is also efficient to remove detached deposits via a cleaned pipe with an optimum cross-section. Figure 7 illustrates this procedure using the example of a wastewater pressure pipe between the pumping station and gravity sewer.

After the first cleaning phase, it is advantageous to flush the pipe sections again in reverse order in order to reliably remove all mobilized deposits. This second cleaning phase is particularly necessary for culverts (Fig. 7).

If a basic cleaning of a wastewater pressure pipe with expected large quantities of deposits is due and this pipe flows into a gravity sewer, it is advisable to provide a vacuum truck. Experience has shown that the effectiveness of Comprex cleaning and the discharge are so great that the gravity sewer must be cleaned afterwards.

In some wastewater pressure systems, the storage tanks are quite small, so that the volume of accumulated wastewater is not sufficient to clean the entire wastewater pressure line despite the low demand of the Comprex cleaning system. If it is also not possible to supply process water from pipes, vehicles with a 30 m^3 tank from the machinery ring can be used in such cases. Such vehicles are used in biogas plants, for example, and are available throughout the country. Agricultural contractors take on the task of providing service water for Comprex cleaning.

The advanced control system in the Comprex units makes it possible to select specially adapted flushing programs. Adapted to the nominal diameter, length of the cleaning section and geographical conditions, the flushing parameters can be changed so that the optimum cleaning effect is achieved over the entire pipe section.

Practical examples

The following examples show practical experience with Comprex cleaning of wastewater pressure pipes.

Peine Water Board

The Peine water board had a 3 km long PVC wastewater pressure pipe DN 150 cleaned using the Comprex process. The cleaning took just under a day.

The effectiveness of the cleaning process was quantified on the basis of pump running times and electricity consumption. There are two pumps in the wastewater pumping station. The pump running times of one pump averaged over two months were as follows:

" Pump running time before Comprex cleaning:
13.3 hours per week
" Pump runtime after Comprex cleaning: 8.3
hours per week

With approximately the same volume of wastewater, this resulted in a running time saving of 37 %. This reduced the electricity consumption at each pump by 93 kWh per week. At an electricity price of € 0.20/kWh, this results in an annual cost saving of around € 1,900 for electricity consumption.

Urban drainage Pforzheim

The Pforzheim municipal drainage system had an approximately 450 m long DN 200 cast iron wastewater pressure pipe in the Eutingen district cleaned. The advantage was that, in addition to the current consumption of the pump in the wastewater pumping station, the flow rate could also be measured. The cleaning took less than a day.

The effectiveness of the cleaning could be quantified on the basis of flow rate and power consumption. The prerequisites were the same conditions before and after cleaning at the pump and filling level upstream of the pump, i.e. delivery by the same pump, the same switch-on point

and automatic operation:

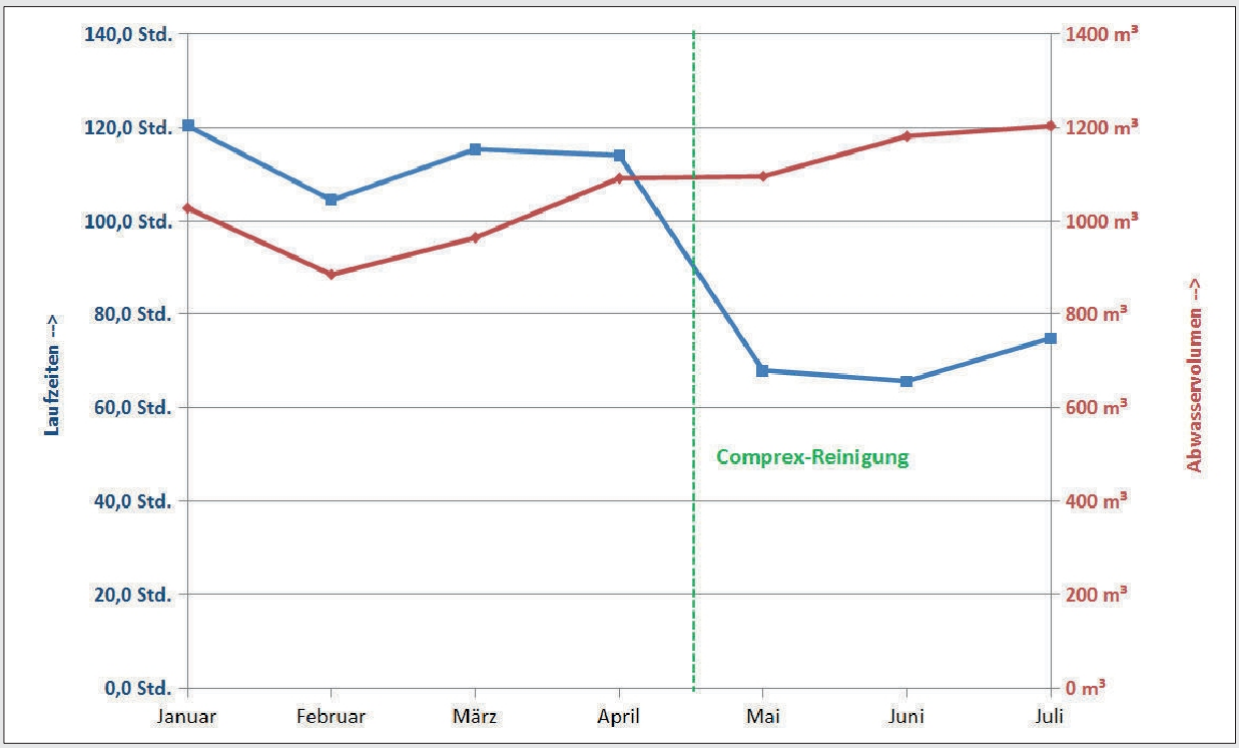

***Figure 10**: Wastewater volume and pump runtimes on a 2.81 km long DN 125 PVC wastewater pressure pipe before and after Comprex cleaning*

" Capacity before cleaning: Q = 43 l/s
" Capacity after cleaning: Q = 50 l/s
" Current consumption before cleaning: I = 61.5 A
" Power consumption after cleaning: = 68.0 AWith an annual wastewater volume of around 588,000 m³, the savings in electricity costs are so great that the costs for Comprex cleaning are amortized after just over a year.

Technical Works Burscheid

Technische Werke Burscheid had wastewater pressure pipes cleaned for the first time in 2010. At that time, the focus was on the actual Comprex cleaning and not on quantifying the cleaning success. A new cleaning was to take place after a few years. In addition to the actual cleaning, the optimum time between two maintenance cleanings was also of interest. As the wastewater pressure pipes were not yet equipped with flow meters, the pressures downstream of the pumps were measured before and after cleaning (***Fig. 9***). This showed that the improvement was most significant with small nominal diameters (green line in Fig. 9).

District Association for Water Management Nienburg

The district association for water management in Nienburg has already had several wastewater pressure pipes cleaned using the Com- prex process. The reason for this was deposits that had led to considerable cross-sectional constrictions and

This led to longer pump running times and rising electricity costs. In the 1980/1990s, the pipelines were dimensioned for significantly larger wastewater volumes than those produced today. Long dwell times and the reduction in fresh water requirements increasingly led to deposits and odor problems. After various methods of odor control had been tested, iron salts were added to the wastewater to bind the hydrogen sulphide and precipitate it as iron sulphide. During operation, incrustations appeared on the walls of the pressure pipes as undesirable side effects.

Operational safety was the first priority for the purification process. Therefore, the first objective was to ensure that wastewater could be transported to the treatment plant even when there was an increased volume of wastewater. This was achieved in all cases. Another positive effect was the energy saving. After cleaning, the wastewater pressure pipe system regained its original performance. ***Fig. 10*** and ***Fig. 11*** show the monthly values determined for wastewater volume and pump runtime on two wastewater pressure pipes before and after Comprex cleaning. In contrast to the first, the second wastewater pressure pipe conveys considerably less wastewater and is much too large. Each of the two pipes could be cleaned in one day using the Comprex process.

Figures 10 and 11 illustrate that the pump running times were practically halved by cleaning.

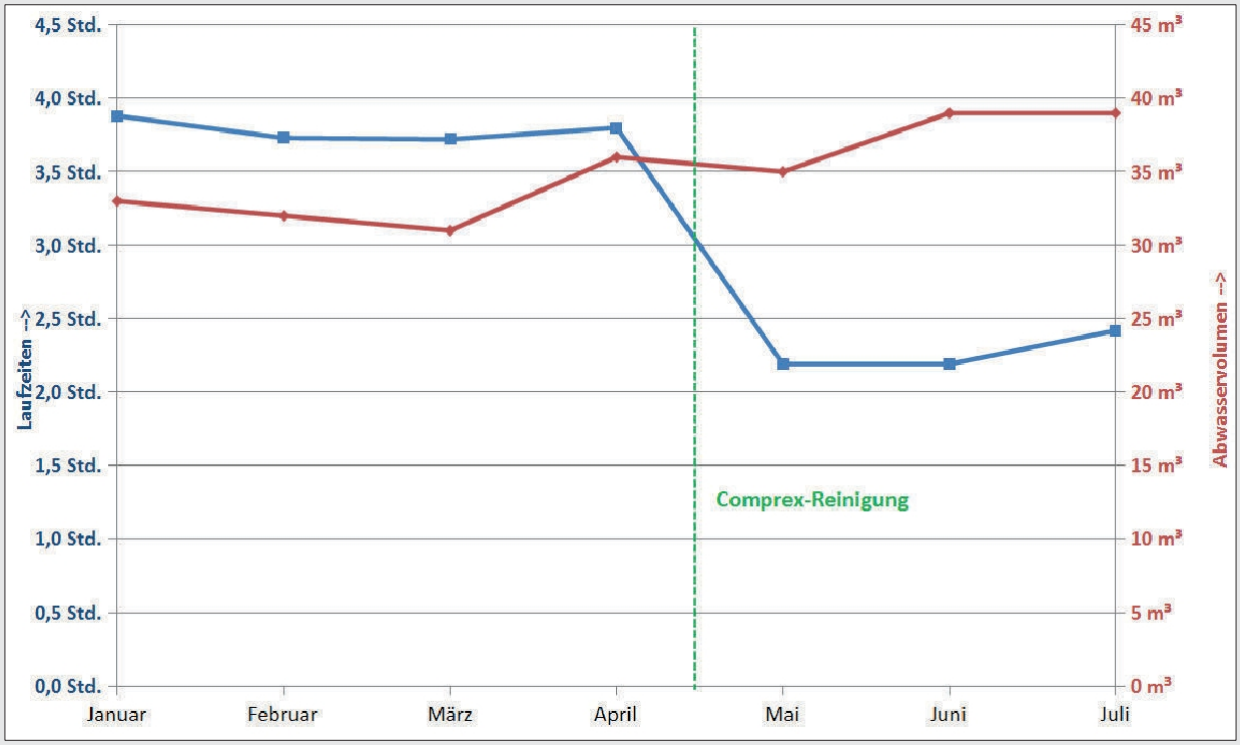

***Figure 11**: Wastewater volume and pump runtimes on a 2.89 km long DN 125 PVC wastewater pressure pipe before and after Comprex cleaning*

Calculated on the basis of pump running times and electricity costs, the annual cost savings amounted to €888 and €1,757 respectively. Due to the energy savings, the costs for cleaning are amortized after just two and four years respectively.
Further information on cleaning wastewater pressure pipes with the Comprex process, including practical examples and descriptions of reference projects, can be found on the website: http://comprex.de/kommunal/comprex-reinigung-von-abwasserdruckleitungen/

Conclusion

Comprex cleaning helps to ensure trouble-free operation of the wastewater pressure system and to keep energy and operating costs low. In contrast to pigging, it requires no airlocks and no system downtime. As only compressed air and waste water are used for cleaning, no pig can get stuck and cause additional problems. In the case of very thick deposits, the intensity of the cleaning can be controlled so that the sewer or sewage treatment plant is not overloaded after the discharge point.
Comprex cleaning is an economical way of maintaining wastewater pressure pipes. Due to the energy savings, the costs for cleaning are amortized after a short time, often in less than two years.

We thank you for your support and for providing the data:

" the Peine water board, Mr. Hanko,
" of the Pforzheim municipal drainage system, Mr. Augustin,
" Technische Werke Burscheid, Mr. Grauvogel and
" the District Association for Water Management Nienburg, Ms. Nitsch.

Literature

[1] Worksheet DWA-A 113 "Hydraulic dimensioning and performance verification of wastewater pressure systems", draft 08-2016
[2] Worksheet DWA-A 116-3 "Special drainage methods, Part 3: Air-flushed wastewater transport pipes"
[3] Prosser M.: Damage to a wastewater pressure pipe; KA Betriebs-Info (46) October 2016, pp. 2540-2541

KEYWORDS: Wastewater pressure pipes, Comprex process, Online cleaning, Energy efficiency

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