EUROPEAN COATINGS journal

www.european-coatings.com

02 – 2022

PROCESS-INTEGRATED PLANT CLEANING – NEW IMPULSES

By Sebastian Immel and Norbert Klein, Hammann & Hammann Engineering, Jan Walther, sycotech.

Source: Mulderphoto - stock.adobe.com

VINCENTZ

Source: Alex Stemmers - stock.adobe.com

PROCESS-INTEGRATED PLANT CLEANING – NEW IMPULSES

Automated cleaning, reduced water consumption, no issues with geometries. By Sebastian Immel and Norbert Klein, Hammann & Hammann Engineering, Jan Walther, sycotech.

Product residues in systems can harden, forming persistent deposits and significantly increasing cleaning efforts. Plant shutdowns can result. The new limits for biocides and preservatives create further challenges for plant operators in terms of industrial hygiene. New production concepts are necessary, as existing rinsing and pigging processes have reached their limits.

Product quality and usability are very important in the paints and coatings industry. Until now, preservatives or biocides ensured sufficient shelf life and safe storage of water-based paints. But new limits for biocides, such as methylisothiazolinone (MIT) and chloromethylisothiazolinone (CIT), in force since May 2020, restrict their use as preservatives. Manufacturing preservative-free products places enormous demands on raw material quality and factory hygiene.

THE CLEANING PROBLEM

Cleaning in paint and coatings production focuses on two factors: product compatibility during product changes and deposits during operation. Pigging technology is often used to clean the pipelines. Non-piggable areas, such as pumps and branches, are flushed with water or other aqueous fluids. However, these methods are not suitable for completely removing product residues. Flushing also generates significant amounts of waste water with corresponding disposal costs, while high water withdrawals during hot weather are increasingly difficult to justify.

The impulse cleaning process can ensure hygienically proper production. Mobile cleaning systems are usable across several buildings and plants, independent of location, for regularly scheduled cleaning tasks. Automated, stationary cleaning systems operate in a process-integrated manner, require relatively small amounts of water, and are usually used before each batch or product change.

PROBLEM SOLVED: IMPULSE CLEANING

The impulse cleaning process originated in drinking water distribution, ensuring that the pipelines remained in a hygienically flawless condition. This process is therefore established in the relevant guidelines and regulations. It is based on the controlled pulsed injection of compressed air into a throttled water flow (*Figure 1*).

Efficiency is 10 to 1,000 times higher compared to water flushing at 3 m/s [1], due to increased wall shear stresses. Water consumption and waste water volume are reduced by over 80 %, and up to 95 % when the process is integrated [2].

Mobile and stationary impulse cleaning units

RESULTS AT A GLANCE

Compared to conventional rinsing and cleaning processes, the impulse cleaning process offers:

→ geometry-independent cleaning of pipelines, distributors, pumps, filters and valves,

→ reduced water consumption and wastewater volume,

→ water treatment and substitution of fresh water possible,

→ mobile or stationary design with process integration and automation.

Figure 1: Scheme of the impulse cleaning process.

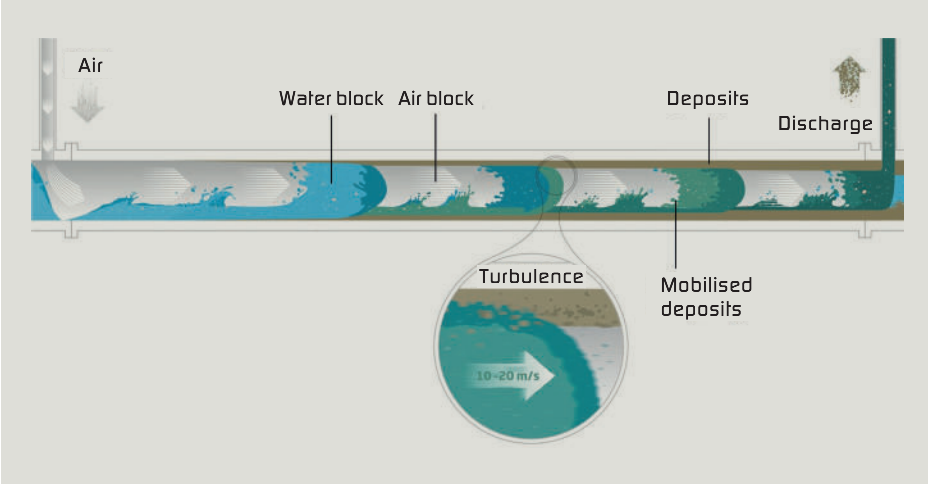


Figure 2: Basic communication structure of the SCU.

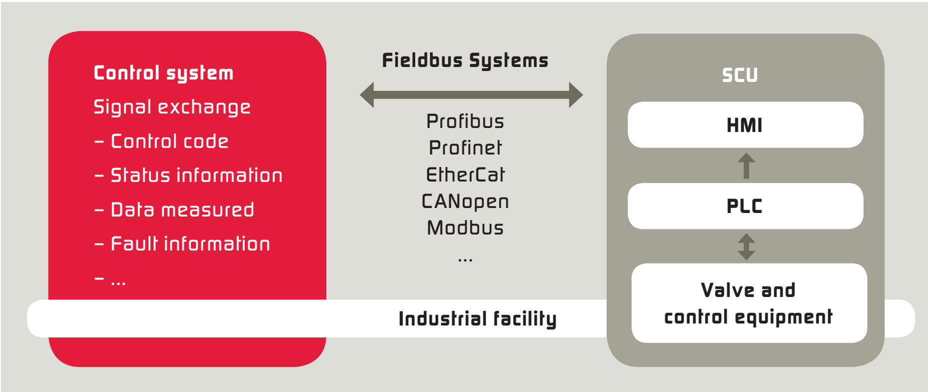
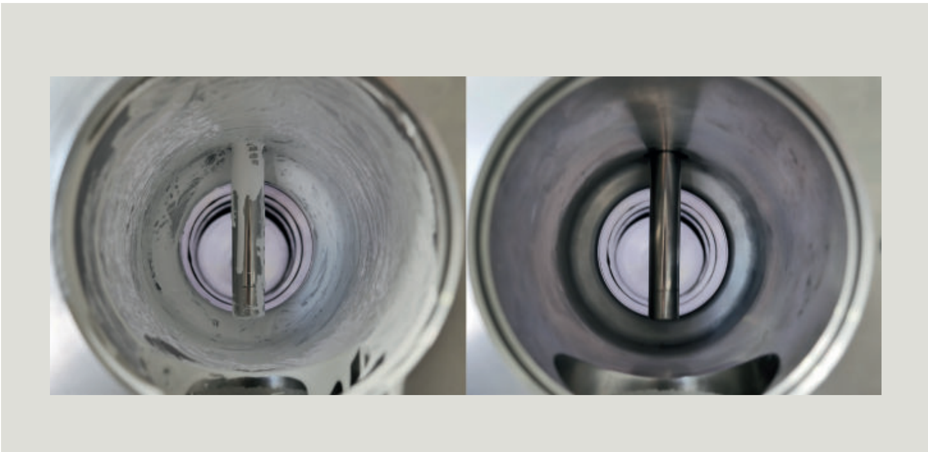


Figure 3: Pig gate before and after cleaning with the impulse cleaning process.



are increasingly being used in a wide variety of industrial areas and offer the following advantages:

- suitable for entire systems, not just pipelines,
- independent of geometry, nominal diameters and branches,
- also suitable for pumps, fittings and apparatus in installed condition.

A distinction is made between basic cleaning (curative) and routine cleaning (preventive). Persistent deposits must be removed during basic cleaning, which can be performed as a service during scheduled plant shutdowns. Routine cleaning is a part of maintenance, where product residues can be reliably removed as long as they can be mobilised and are not yet solidified.

MOBILE UNITS

Mobile cleaning units (Mobile Comprex Unit, MCU) are suitable for regular cleaning tasks with longer intervals. The “MCU-300” [2] is already being used successfully by manufacturers of paints and coatings. The mobile design allows selective, manual cleaning of production plants over several levels or in multiple buildings. Compact dimensions and low weight allow easy transport. The intuitive touchscreen interface requires minimal training.

STATIONARY UNITS

Stationary cleaning units (Stationary Comprex Unit, SCU) offer new opportunities with shorter cleaning intervals. They are integrated into new or existing production environments and automated cleaning takes place without manual user input. The SCU is integrated into the existing plant control system, enabling process-integrated cleaning operation.

Typically, a production plant is divided into suitable sections for the impulse cleaning process, with optimised cleaning programs assigned to each section. Communication between the SCU and the control system is bidirectional: cleaning commands are sent from the control system to the SCU, and measured values from sensors or status messages are sent from the SCU to the control system. This approach enables main-

Table 1: Comparison of basic cleaning and maintenance cleaning.

Parameter	Basic cleaning	Maintenance cleaning
Impulse cleaning process	Mobile	Stationary
Cleaning method	By specialised personnel, combination with solid injection and chemical pretreatment possible	Automated and process-integrated
Plant shutdown	Required	Not required
Time and staff requirements	Plant-specific, depending on plant geometry and extent of deposits	Low, due to short cleaning interval and low deposit formation
Condition of the deposits	Accumulated during the operating period, partly hardened	New deposits, not hardened
Type of waste water	With solid fraction due to hardened deposits	Without solid fraction
Waste water management	Waste water disposal via treatment plant	Water recycling possible

Figure 4: Schematic structure of the process-integrated technology by SCU, based on filter back cleaning, switching of the cleaning sections and activation of the cleaning programs by the control station.

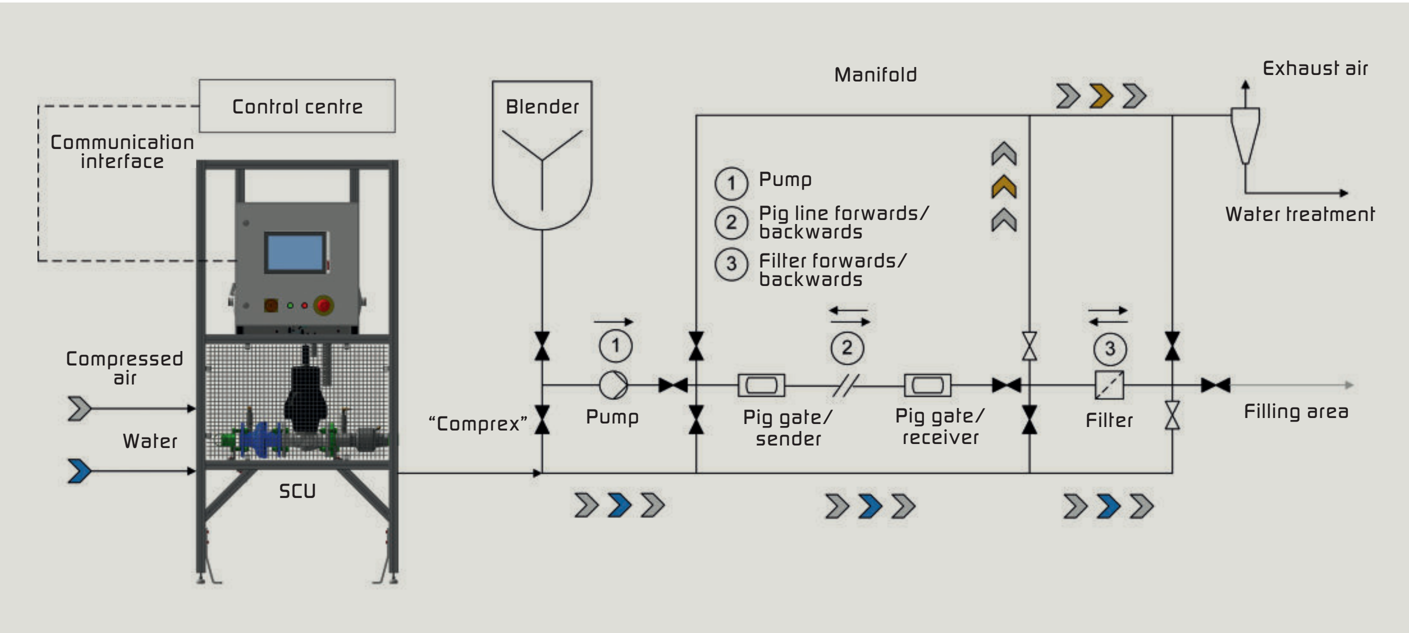
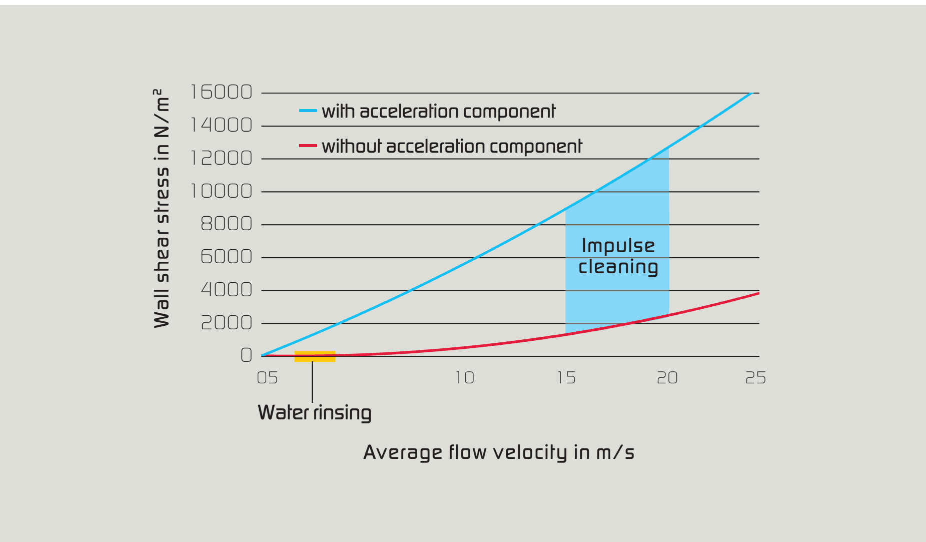


Figure 5: Wall shear stress at steady flow with and without acceleration component compared to water flushing for a hydraulically smooth DN 100 pipeline, calculated according to [4].



tenance to be carried out on a condition-oriented basis.

Depending on the installation site, SCUs are available in various designs which differ in the arrangement of their assemblies, e.g., with integrated control unit or with control unit separated physically [3]. For example, an assembly group containing the valve and measuring technology can be separated from the control assembly group.

AUTOMATED SCU CONTROL

In contrast to mobile units, an SCU operates in a fully integrated, automated manner. The process is adapted to the application and requires no manual user input. Cleaning programs optimised for the specific production plant are stored in the software database, ensuring reproducible cleaning results. The SCU provides relevant process values, status information and selected important param-

Figure 6: a) Pig gate, opened to remove the pig, b) Pig after application of dispersion paint, c) pig after cleaning.

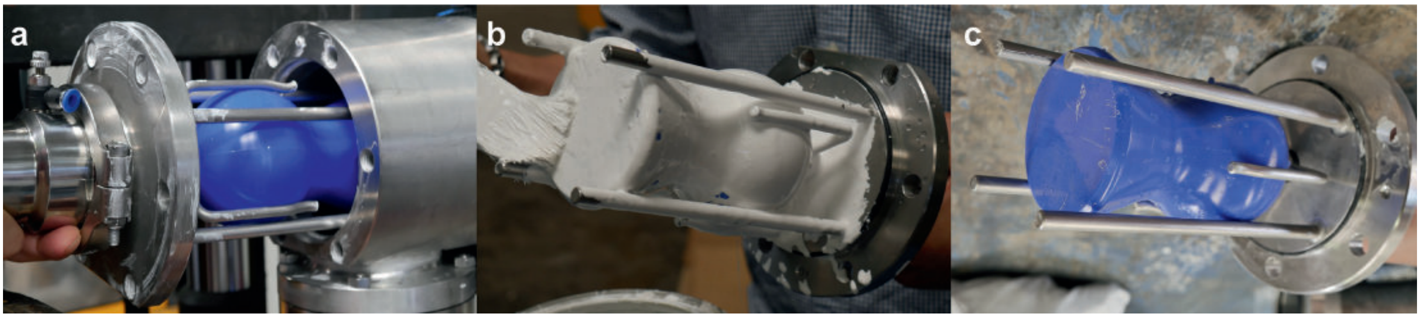
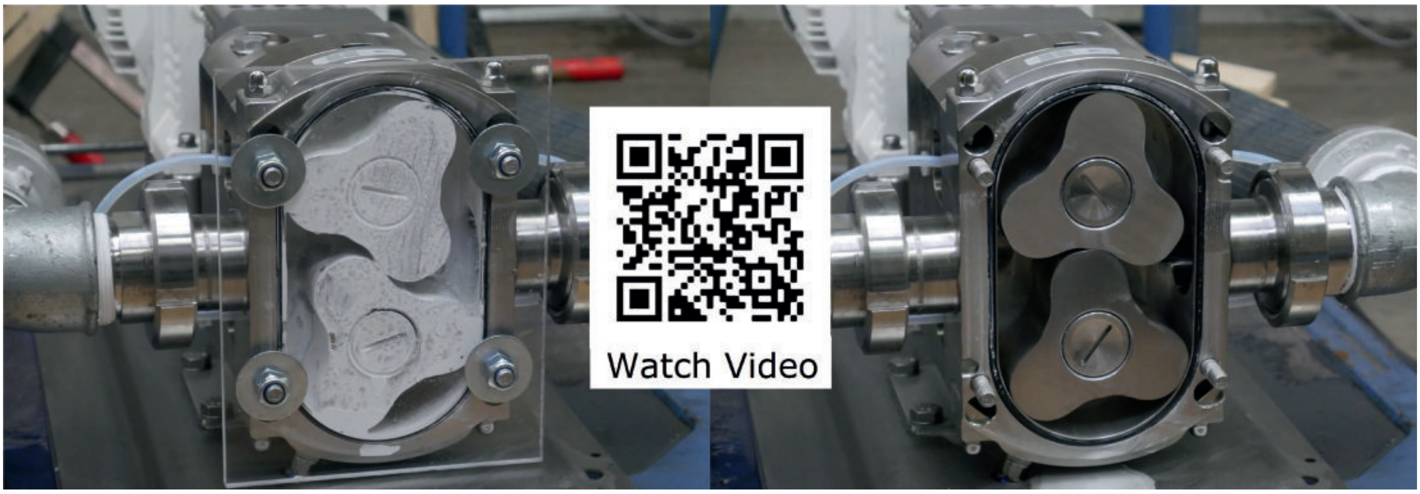


Figure 7: Pump with transparent plastic lid for tests after application of dispersion paint (left) and after cleaning (right). The QR code links to the corresponding video of the pump cleaning in real time.



eters. Standardised industrial interfaces are used to communicate with the control system or control station, e.g., Profinet, EtherCat, Profibus or CAN bus (*Figure 2*). All parameters and error codes are transmitted to the control system in real time, ensuring plant status monitoring. Defined error codes are used for quick identification of irregularities and malfunctions, for example, insufficient compressed air supply. A remote maintenance option is available for quick access to the SCU for troubleshooting. This access also allows software and cleaning database updates. The database is designed to be adaptable and expandable at any time. Additional cleaning programs can be added for new or modified plant components.

APPLICATION: PRODUCTION OF DISPERSION PAINTS

In dispersion paint production plants, it is common practice to separate batches in the pipelines with pigs when changing products. This proven procedure has the disadvantages mentioned above.

Modern products with low biocide contents, which are increasingly in demand, require extreme cleanliness of all surfaces in contact with the product. The impulse cleaning process has increasingly been used in highly sensitive areas of the chemical and pharmaceutical industries, where hygiene has a high priority. This also applies to modern water-based emulsion paint production plants, where high demands are placed on the product quality of raw materials and water, and production facility hygiene. The highly effective impulse cleaning system uses clean compressed air, requiring significantly less water than a water rinsing system. This is particularly important if the water contaminated by the cleaning process is re-used. The process cleans systems regardless of their geometry, because the air and water blocks adapt, reaching branches, constrictions, gaps and even areas where pigs cannot act, such as pumps or pig gates (*Figure 3*).

BASIC CLEANING IN EXISTING PLANTS

Existing plants often contain old, hardened deposits, where impulse flushing alone is usually not sufficient to remove such deposits. Upstream chemical cleaning with special products is recommended to mobilise the deposits. Temperature and duration of application must be adapted to the individual case. After this step, compressed air pulses remove the pre-treated residues.

Basic cleaning is only possible during production plant shutdown periods. The effort required to restore the plant to its target condition is comparatively high, but basic cleaning of existing plants is a prerequisite for process-integrated maintenance cleaning.

PROCESS-INTEGRATED MAINTENANCE CLEANING

In contrast to basic cleaning, process-integrated maintenance cleaning does not require chemical treatment if it takes place at short intervals, for example several times a day during product changes. It requires little time and requires less wastewater disposal. *Table 1* compares the main features of basic and maintenance cleaning.

EXAMPLES OF STATIONARY TECHNOLOGY IN PRACTICE

An emulsion paint manufacturer operates several plants with different production lines from the delivery of raw materials to the filling of the end products. A typical production plant consists, among other things, of piping systems (DN 50 to DN 150), valves, filters, pumps, strainers, manifolds in the different production areas such as raw material stor-

age, dissolver, binder storage, mixing stations or finished goods area. Distributors and fittings ensure that the required raw materials reach the designated mixing systems.
The optimum positioning of the SCU and the appropriate design of the cleaning sections were determined together with the plant operator. Fitting positions are controlled by the control station, outlining the individual cleaning sections (*Figure 4*). Various cleaning programs are available, depending on requirements or conditions. Standard cleaning of an entire production area takes between 30 and 45 min, depending on the area. Eco-cleaning requires only 15 to 20 min at shorter intervals, representing a compromise between time and water requirements, and the required cleaning result. More intensive standard cleaning is performed after a fixed number of eco-cleaning cycles. Standard cleaning is implemented after product changes to prevent product contamination.

EFFECTIVENESS AND OPERATING COSTS

Figure 5 shows the wall shear stress, calculated according to [4], for the impulse cleaning process compared to water rinsing. This process accelerates water blocks *(Figure 1)* to a maximum flow velocity of up to 20 m/s in less than 0.1 s. The resulting acceleration component increases the wall shear stress enormously compared to purely steady flow. The operating costs for water rinsing and process-integrated impulse cleaning can be compared using the example of a 200 m long DN 100 product line [5]. Three to five times the pipeline volume is required for water rinsing, between 23,565 m^3/a and 39,275 m^3/a. Based on a water rate of 1.75 EUR/m^3 and wastewater rate of 2.60 EUR/m^3, total costs are between 102,508 EUR/a and 170,846 EUR/a. With SCU-based process-integrated cleaning, water requirements are reduced to just 1,224 m^3/a and total costs to 9,074 EUR/a. This is a saving of up to 95 %. The lower water requirement and shorter cleaning time significantly reduce resource requirements and total costs. The SCU purchase costs are rapidly amortised.

PRELIMINARY TESTS IN THE PILOT PLANT

Hammann operates a test facility in its own technical department to test new applications and adapt the impulse cleaning process, for example the combination with pigging technology. Relevant components can be integrated or connected to the test plant [6].
Figure 6 demonstrates a pig gate installed in the test line, reflecting situations common in product pipelines for dispersion paints. *Figure 6a* shows the pig station while open. The pig is positioned on a guide rail. During the test runs, dispersion paint was applied both to the pig and to the inner surfaces of the pig chamber. *Figure 6b* shows the surfaces after application of the dispersion paint and *Figure 6c* after cleaning. These tests were carried out with different dispersion paints.
Figure 7 shows the condition of the pump interior before and after cleaning. A transparent housing cover was attached for tests on a rotary lobe pump, allowing the cleaning progress and effectiveness to be monitored and evaluated.
The tests in the pilot plant demonstrate the capability of the impulse process for cleaning complex geometries in production plants components for different dispersion paints. The trials also provided setting parameters for test runs on site and for the process-integrated SCU. These differ depending on the cleaning section or plant component.

Sebastian Immel
Hammann
s.immel@hammann-engineering.de

REFERENCES

[1] CFD simulations: University Duisburg-Essen (Chair for Mechanics and Robotics) – Prof. Dr.-Ing. Wojciech Kowalczyk), https://comprex.de/wp-content/uploads/2014/02/Forschung-Comprex-Verfahren-CFD-Simulationen.pdf
[2] Website about mobile Comprex-Units, example: MCU-300 https://hammann-engineering.de/mcu-300/
[3] Immel, S., Klein, N. und Walther, J.: Neue Impulse für Anlagenreiinigung; FARBE UND LACK 12/2021, P. 48 - 56
[4] Development of methods for selecting efficient flushing programs for the prevention of rust water in under-used sectors of existing water supply networks, Final report DVGW – Water Technology Centre Karlsruhe, Dresden branch, Project No. 02 WT 0077, 29. March 2004
[5] Operating costs calculation for water flushing and stationary, process-integrated Comprex cleaning – Product line case example, http://hammann-engineering.de/wp-content/uploads/2021/07/2021-07-26_Kostenrechnung_Fallbeispiel_Produktleitung_DN100_200m.pdf
[6] Website with video of test plant at Hammann GmbH, https://comprex.de/video-wasser-vs-comprex-reloaded/