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New impetus for the system cleaning

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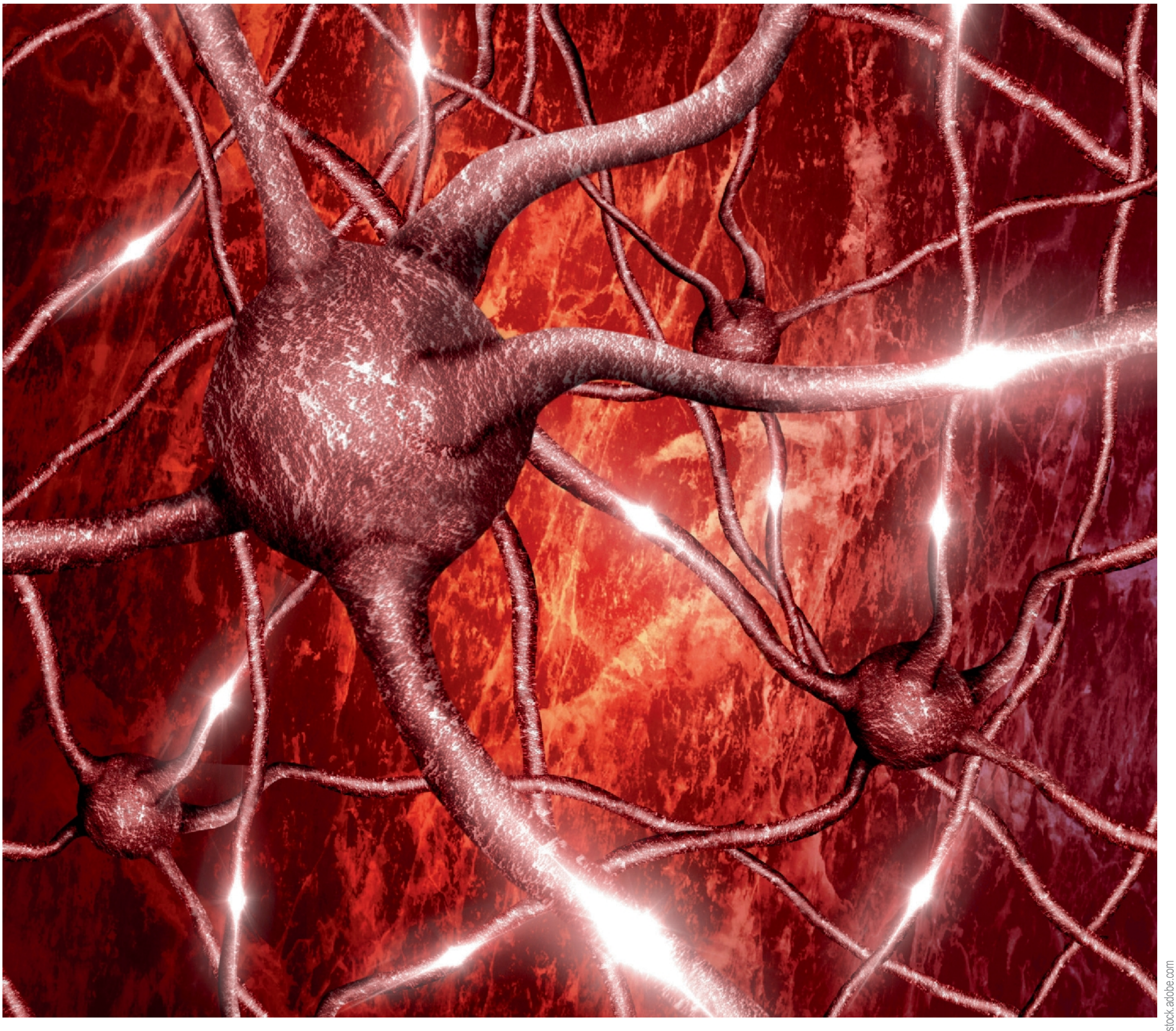

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CLEANING // THE PULSE RINSING PROCESS ENSURES HYGIENICALLY FLAWLESS PRODUCTION SYSTEMS, EVEN WITH PRESERVATIVE-FREE PRODUCTION OF WATER-BASED COATING MATERIALS. AS PROCESS-INTEGRATED STATIONARY DESIGN, THEY WORK AUTOMATICALLY AND SAVE RESOURCES.

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Product quality and user-friendliness have traditionally been of great importance in the paint and coatings industry. Until now, preservatives biocides for a sufficient shelf life and safe storage of water-based paints. The limit values for biocides, such as methylisothiazolinone (MIT) and chloromethylisothiazolinone (CIT), which have been in force since May 2020, restrict their use as preservatives. The goal of producing preservative-free products places enormous demands on raw material quality and industrial hygiene during production.

The pulse rinsing process is one way of ensuring hygienically flawless production. Mobile cleaning systems can be used across several buildings and plants for regularly recurring cleaning tasks, regardless of location. Automated, stationary cleaning systems, on the other hand, work in a process-integrated manner, require relatively little water and are used in particular before every batch or product change.

Cleaning as a challenge

Until now, cleaning tasks in paint and varnish production have focused on two factors: product compatibility during product changes and deposits during operation. Pigging technology was often used to maintain the pipelines. Areas that could not be pigged, such as pumps and branches, were flushed with water or other aqueous media. However, these methods are not suitable for completely removing product residues from the systems. In addition, rinsing generates considerable amounts of waste water with corresponding disposal costs, and high water withdrawals in hot summer months are increasingly difficult to justify.

Product residues in the systems harden over time and form stubborn deposits. This increases the cleaning effort enormously. System downtimes are the result.

The new limit values for biocides and preservatives pose further challenges for plant operators in terms of operational hygiene. New concepts for production are unavoidable, especially as existing rinsing and pigging processes are reaching their limits.

Pulse rinsing process as a problem solver

The impulse flushing process originally comes from drinking water distribution. It

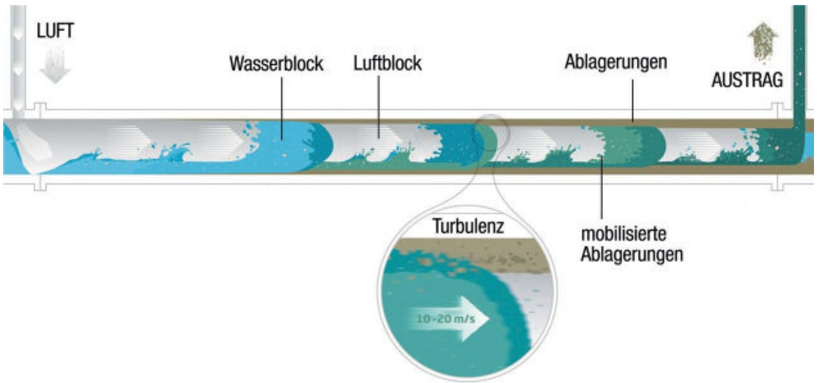

Fig. 1 // Diagram of the pulse flushing process.

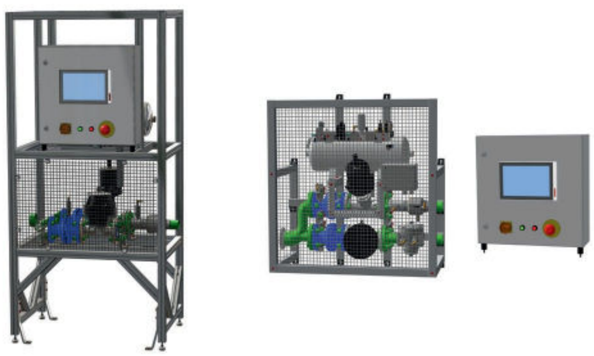

Fig. 2 // Different modular designs of the SCU, left with integrated control unit, right with spatially separated control unit.

Results at a glance

Compared to conventional rinsing and cleaning processes, the pulse rinsing process offers

- geometry-independent cleaning of pipes, distributors, pumps, filters and fittings,
- reduced water consumption and wastewater volumes as well as the possibility of water treatment and replacement of fresh water
- a mobile or stationary version with process integration and automation

ensures

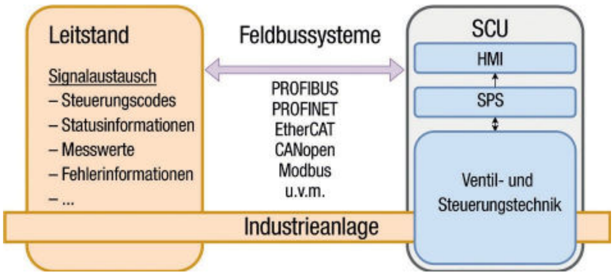

Fig. 3 // Basic communication structure of the SCU.

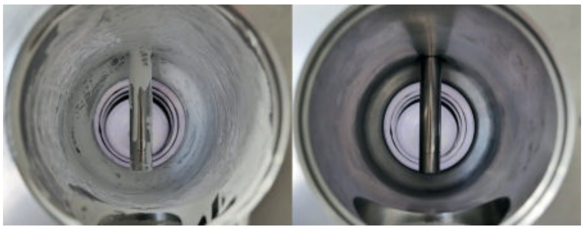

Fig. 4 // Pigging station before and after cleaning with the impulse rinsing process.

one foodstuff are in perfect hygienic condition and remain so. The pulse flushing process is therefore anchored in the relevant regulations. It is based on the controlled pulse-like addition of compressed air to a throttled water flow (*Fig. 1*). Compared to water flushing, the effectiveness is significantly improved due to increased wall shear stresses. On average, it is 10 to 1000 times higher than with water flushing at 3 m/s [1]. At the same time, the water requirement and thus the volume of wastewater is reduced by more than 80 %, and by up to 95 % when integrated into the process [2].
In industry, the impulse rinsing process is increasingly being used in a wide variety of areas. It offers the following basic advantages:

- Suitable for entire systems, not just pipelines
- Independent of geometry, nominal widths and branches
- Also suitable for pumps, fittings and appliances when installed

A basic distinction must be made between basic cleaning (curative) and routine cleaning (preventive). Basic cleaning involves removing stubborn deposits, among other things. During planned system downtimes, basic cleaning can be carried out as a service. In contrast, routine cleaning is part of maintenance. Product residues can be reliably removed as long as they can be mobilized and are not yet solid. This is best achieved with adapted cleaning technology. Depending on the requirements, mobile or stationary systems are suitable.

Mobile systems for targeted and manual cleaning

For regular cleaning tasks that are due at longer intervals, mobile cleaning systems (mobile cleaning units) are suitable.
"Comprex" Unit, MCU). One example of this is the "MCU-300" [2], which is already being used successfully by manufacturers of paints and varnishes. The mobile design makes it possible to clean production facilities on several levels and in separate buildings. Its compact dimensions and low weight make it easy to transport. The intuitive touchscreen interface requires little training for personnel.

Stationary systems for fully integrated and automated cleaning

In contrast to the mobile version, stationary cleaning systems (Stationary "Comprex" Unit, SCU) offer new possibilities with short cleaning intervals. The systems are integrated into new or existing production environments so that automated cleaning can take place without manual user input. The SCU, which is integrated into the existing system control, thus enables process-integrated cleaning based on the higher-level system control.
Typically, the production plant is divided into suitable cleaning sections for cleaning with the pulse rinsing process, each of which is assigned optimized cleaning programs. Communication between the SCU and the control room is bidirectional: cleaning commands are sent from the control room to the SCU and measured values from sensors or status messages from the SCU to the control room. This procedure enables condition-based maintenance.
Depending on the installation location, stationary cleaning systems are available in various designs (*Fig. 2*), which differ in the arrangement of their assemblies. For example, the module with the valve and measuring technology can be separated from the control module.

Automated control of the SCU

In contrast to mobile technology, the SCU is fully integrated and automated. The process is adapted to the respective application and requires no manual user input on the SCU to carry out the cleaning. Cleaning programs optimized for the respective production system are stored in a software database and ensure reproducible cleaning results. The SCU provides relevant measured values and status information. The SCU display shows a selection of important parameters.
Standardized industrial interfaces are used for communication with the control room or control station, such as Profinet, EtherCat, Profibus or CAN bus (*Fig. 3*). All parameters and error codes are transmitted to the control room in real time. This ensures monitoring of the system status. Defined error codes are used to quickly identify irregularities and faults, for example in the event of an insufficient compressed air supply. To rectify faults, the manufacturer has set up a remote maintenance option for quick access to the SCU. Updates to the software or cleaning database can also be carried out in this way. The database is designed in such a way that it can be adapted and expanded by the manufacturer at any time. For example, additional cleaning programs can be added for new or modified system parts.

Application: Production of emulsion paints

In production plants for emulsion paints, it is common practice to use pigs to separate the batches in the pipelines when changing products.

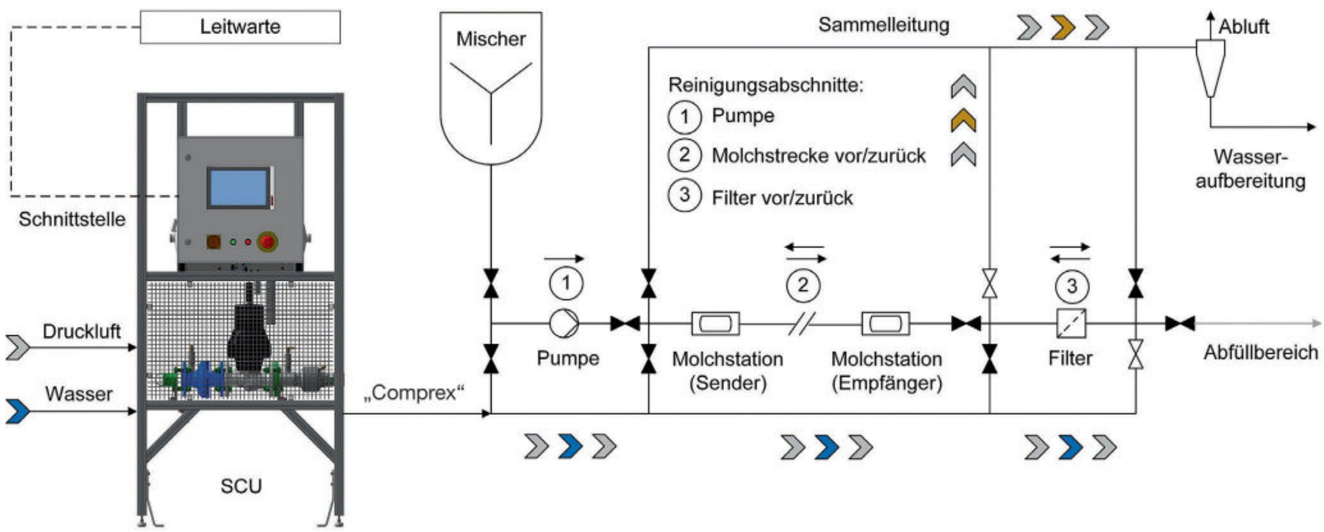

Fig. 5 // Schematic structure of the process-integrated technology by SCU using the example of filter backwashing, switching of the cleaning sections and release of the cleaning programs by the control room.

separate. This tried and tested procedure has the disadvantages already mentioned.

Modern products with low biocide content, which are increasingly in demand from customers, require extreme cleanliness on all surfaces that come into contact with the product. The impulse rinsing process, which originates from the hygienically demanding drinking water sector, has been used more and more frequently in highly sensitive areas of the chemical and pharmaceutical industries in recent years. Hygiene therefore has a high priority. This also applies to the use in production plants for modern water-based emulsion paints. They place high demands on the product quality of the raw materials and the water quality as well as the hygiene of the production facilities.

Highly effective pulse cleaning works with clean compressed air and requires significantly less water than a water rinse. This is particularly important if the water contaminated by the cleaning process is to be reused for new products, for example. The process cleans systems regardless of their geometry, as the air and water blocks adapt to it. This allows them to reach branches, constrictions and crevices as well as areas where pigs cannot work, such as pumps or pig sluices (*Fig. 4*).

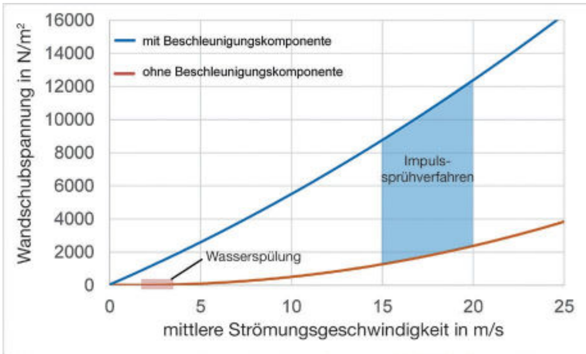

Fig. 6 // Wall shear stress at steady flow with and without acceleration component compared to water flushing for a hydraulically smooth DN 100 pipe, calculated according to [3].

Basic cleaning of existing systems

Existing systems often contain old, hardened deposits. In order to completely remove these stubborn deposits, the pulse flushing process alone is usually not sufficient. For this application, upstream chemical cleaning with special products is recommended in order to mobilize the deposits. The temperature and exposure time must be adapted to the individual case. After this step, the compressed air pulses remove the pre-treated residues. Basic cleaning is only possible during production plant downtimes. The effort required to return the system to the target condition is comparatively high. The basic cleaning of existing systems is a prerequisite for process-integrated maintenance cleaning.

Process-integrated maintenance cleaning

In contrast to time-consuming basic cleaning, process-integrated maintenance cleaning does not require any chemical treatment if it is carried out at short intervals, for example several times a day for

Fig. 7 // Test section at the test facility. The video behind the QR code gives an impression of the cleaning effect of the pulse rinsing process.

Fig. 8 // a) Pigging station, opened to remove the pig, b) Pig after application of the emulsion paint, c) Pig after cleaning.

Fig. 9 // Pump with transparent plastic cover for the tests after application of the emulsion paint (left) and after cleaning (right). The QR code leads to the corresponding video of the pump cleaning in real time.

product change takes place. It requires little time and entails low wastewater disposal costs. *Table 1* compares the main features of basic and maintenance cleaning.

Practical examples of stationary technology

A manufacturer of emulsion paints operates several plants with different production lines from the delivery of the raw materials to the filling of the end products. A typical production plant consists of pipes, fittings, filters, pumps, sieves, distributors in different production areas such as raw material stores, dissolvers, binder stores, mixing stations or finished goods areas.
The piping systems typically have nominal diameters in the DN 50 to DN 150 range. Distributors and fittings ensure that the required raw materials reach the intended mixing systems. Cooperation with the plant operator resulted in the optimal positioning of the SCU and the sensible design of the cleaning sections. The position of the valves is controlled by the control room and determines the respective cleaning sections (*Fig. 5*). Various cleaning programs are available for cleaning depending on the requirements or condition. Standard cleaning of an entire production area takes between 30 and 45 minutes, depending on the area. Eco cleaning, on the other hand, only requires 15 to 20 minutes at short intervals and represents a compromise between time and water requirements and the required cleaning result. Therefore, the more intensive standard cleaning follows after a fixed number of eco-cleaning cycles. Standard cleaning is also provided for when changing products in order to prevent product mixing.

Effectiveness and operating costs

Fig. 6 shows the wall shear stress calculated according to [3] for the impulse flushing method in comparison to water flushing. This method accelerates water blocks (*Fig. 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 compared to the purely stationary method. The resulting acceleration component increases the wall shear stress enormously compared to purely stationary flow.
The operating costs for water flushing and the process-integrated pulse flushing method can be compared using the example of a 200 m long DN 100 product pipe [3]. Three to five times the pipe volume is required for water flushing. This means between 23,565 m³/a and 39,275 m³/a. At a water price of 1.75 EUR/m³ and a wastewater price of 2.60 EUR/m³, the total costs therefore amount to 102,508 EUR/a to 170,846 EUR/a. With process-integrated cleaning using an SCU, the water requirement is reduced to just 1,224 m³/a and the total costs accordingly to EUR 9,074/a. This corresponds to a saving of up to 95%. The lower water requirement and the shorter cleaning time significantly reduce the resource requirement and therefore the total costs. The acquisition costs for the SCU are amortized after a short time.

Preliminary tests in the technical center

Hammann operates a test facility in the company's own technical center to test new applications and adapt the pulse flushing process, for example in combination with pigging technology. Corresponding assemblies can be integrated or connected to the test line for this purpose (*Fig. 7*).
Fig. 8 demonstrates a pig launching station installed in the test facility in situations that are common on product pipelines for dispersion paints. *Fig. 8a* shows the pigging station during the

Tab. 1 // Comparison of basic cleaning and maintenance cleaning.

Parameters	Basic cleaning	Maintenance cleaning
Impulse rinsing process	Mobile Stationary	
	By specialized personnel, combination with solid injection and	
Type of cleaning	Chemical pre-treatment possible Automated and process-integrated	
System downtime	Absolutely necessary	Not required
Time and personnel	System-specific, depending on system geometry and extent of deposits	Low, due to short cleaning intervals and low deposit formation
requirements Nature of the deposits	Accumulated during operating time, partly hardened With solids content through	Fresh deposits, not hardened
Type of wastewater	Hardened deposits particles	Without hardened
Wastewater management	Wastewater disposal via sewage treatment plant	Water recycling possible

opening can be seen. The pig lies on a guide rail. During the test runs, emulsion paint was applied to both the pig and the inner surfaces of the pig chamber. *Fig. 8b shows* the corresponding surfaces after application of the emulsion paint and *Fig. 8c* after cleaning. These tests were carried out with different emulsion paints supplied by the customer. For tests on a rotary lobe pump a transparent housing cover was attached. This made it possible to monitor and assess the cleaning progress and ultimately the effectiveness of the cleaning. *Fig. 9 shows the* condition of the inside of the pump before and after cleaning. The main aim of the tests in the pilot plant was to test the suitability of the impulse technology for cleaning complex geometries on components of production plants.

tion systems for different dispersion paints. In addition, the tests provided setting parameters for test runs on site and finally for the process-integrated SCU. These differ depending on the cleaning section or system.

component.

Literature

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