Professional guide	
Industry	
Plant engineering	● ● ●
Chemistry	● ● ●
Pharmaceuticals	● ● ●
Supplier	● ●
Function	
Planner	● ● ●
Operator	● ● ●
Purchaser	●
Manager	●

Economical cleaning of complex industrial plants

Clean preparation, clean facilities

Process engineering production systems such as those in the chemical industry are sometimes extremely complex and correspondingly time-consuming to clean. However, with appropriate preparation and a cleaning process that is independent of the system geometry, this is possible with minimal downtime.

Authors

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Anstallation components such as pipelines, reactors, apparatus, sensors and control valves are generally made of high-quality materials and must be able to withstand aggressive chemicals. Nevertheless, deposits form over the course of the operating time, for example due to side reactions, which can harden over the course of the operating time and impair the heat transfer and throughput. As a result, product quality and production efficiency suffer. It is therefore necessary to remove these deposits from the systems. Complex systems such as HP systems and hydrogenation systems require special cleaning procedures because disassembly and assembly are difficult and time-consuming.

Less invasive processes are well suited to these tasks. The Comprex process, which works with pulsating compressed air and alternating blocks of air and water, has proven itself, for example, for systems for the production of basic chemicals, fragrances or polymers. The production of these substances requires high pressures and temperatures and therefore places high demands on the tightness of the systems, especially on the connections between the individual components. In addition to welded connections, pressure and temperature-compatible flange connections are also used. In contrast to welded connections, flange connections enable separable connection points for cleaning.

Typical distributor on a container. *Image: shutterstock.com*

How Comprex cleaning works: Alternating blocks of water and air remove impurities and deposits.

The Comprex technology, consisting of the Comprex unit at the infeed point and the separator unit at the outfeed point, can be easily connected to the flanges of the production systems using appropriate adapters. Since the founding of the subsidiary Hammann Engineering in 2018, the developer Hammann has also been able to supply customized stationary technology. This opens up new possibilities, especially when short cleaning cycles are required before the deposits harden and consequently become difficult to mobilize.

Careful planning makes cleaning easier

The cleaning of process plants normally takes place during planned downtimes. The operator must prepare the system for opening at the infeed and outfeed points, for example
with proper reprocessing or decontamination
The service provider carries out the cleaning of the media remaining in the systems and the conditioning of the system. Before the first Comprex cleaning, the service provider carrying out the work plans the feed and discharge points together with the operator using plans and on-site inspections. A plan for the disposal of the removed deposits is also part of the preparation. When this toxic or odor-intensive, certain measures are available to meet the requirements for exhaust air and waste water as well as occupational safety. It is advantageous to have to open as few flange connections as possible for the cleaning process. This makes it possible to clean just a few locations of the cleaning unit and saves set-up time. Reduced assembly measures also reduce the risk of possible leaks.

In contrast to other techniques, the compressed air-based cleaning process is largely independent of the depending on the geometry of the system. Devices and apparatus can remain installed, including measuring devices for pressure, temperature, mass flow, volume flow or conductivity. Control valves and other fittings must be adjusted so that they offer as little resistance as possible to the air and water blocks of the Comprex cleaning system. Apparatus such as reactors, heat exchangers or gas scrubbers can be cleaned in a targeted manner via the nearest inlet and outlet points.

In many cases, it is possible to determine the extent of the deposits formed during operation and removed by cleaning. Equipment such as inserted nonwovens for retaining coarse particles in the decompression box, turbidity measurement of the discharged waste water or separation measures at corresponding treatment plants are suitable for this purpose. In contrast to the decompression box, these allow the water to be reused for cleaning by recirculation, whereby the system is finally conditioned with appropriate media such as deionized water.

The cleaning process is largely independent of the geometry of the system.

Depending on the condition of the deposits, additional technology such as solids injection may also be required for basic cleaning. With recurring regular maintenance cleaning, special cleaning strategies can further increase cost-effectiveness, for example, by treating the wastewater for recirculation or installing fixed connections for feed and discharge points. The following examples illustrate possible applications of the purification process in production plants.

Batch operation

Chemicals are produced discontinuously in batch mode, especially when small product quantities are required. In the batch process, the production vessel, for example the reactor or the mixer, determines the amount of material. It is advantageous if by-products and unreacted reactants can be processed and reused, especially in closed systems. These often contain gas scrubbers or heat exchangers. Planned shutdowns are used to maintain these systems. The cleaning technology makes it possible to clean the pipelines and equipment economically with only a few feed-in and feed-out points. For temperature-controlled reactions, it is recommended that the temperature control circuits are also cleaned.

Redundant heat exchangers are sometimes installed in batch reactors. This arrangement makes it possible to ensure heat transfer within the reactor outside of downtimes.

Course of the input and output temperature at a heat exchanger during Comprex cleaning

Process water	before	after
Inlet temperature	*94 °C*	*94 °C*
Outlet temperature	*85 °C*	*81 °C*
Temperature difference ΔT	*9 K*	*13 K*
Heat transfer capacity	*100 %*	*144 %*

Source: Hammann

by cleaning one heat exchanger with Comprex while the other takes over temperature control. In some cases with non-redundant temperature control systems, Comprex cleaning can also be used for maintenance outside downtimes. As the temperature control performance of air is lower than that of water, Comprex cleaning takes place at intervals so as not to impair the reaction control.

Continuous flow reactors

Basic chemicals mainly come from large-scale plants that operate continuously. Continuous processes are characterized by higher productivity compared to batch operation. They do not require downtimes for filling and emptying the production vessels, possibly with cleaning before the next batch process. Some production systems work with aqueous solutions at high temperatures and pressures. The requirements for tightness are correspondingly high.

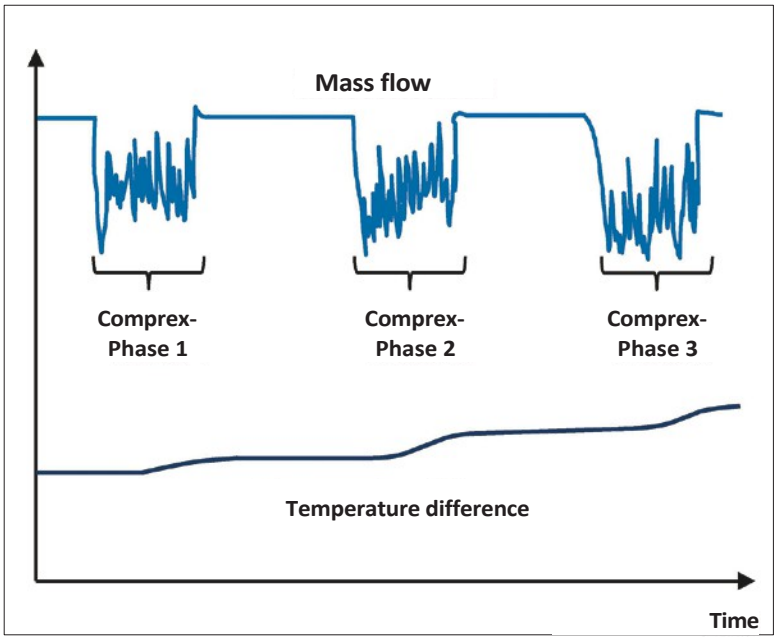
Hammann has been cleaning product-carrying pipes and reactors as well as the temperature control circuits in such systems with Comprex technology for more than 15 years. In the case of stubborn deposits in the reactors, solid injection with rock salt helps to restore the original heat transfer and flow.

Hydrogenation systems

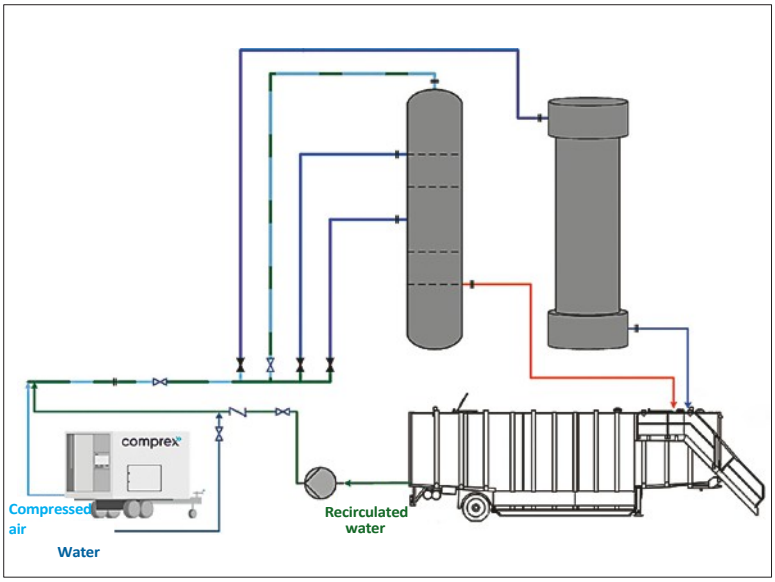
One type of continuous flow reactor is found in hydrogenation plants. The hydrogenation reactions take place in the presence of metal catalysts, elevated temperatures and corresponding pressures. A current example where Comprex technology is used is in hydrogenation plants for the synthesis of fragrances. Fragrances must be volatile in order to disperse well in the air. Systems for the production of these substances must meet high requirements in terms of tightness. The cleaning of these systems also has special requirements. This example shows how the recirculation of the rinsing water in combination with Comprex technology fulfills this task economically.

Circulation

In contrast to the direct disposal of wastewater in the company's own wastewater treatment plants, the reprocessing of wastewater offers the possibility of recycling. The treatment plant first separates compressed air or inert gas from the wastewater and removes aerosols from the exhaust air. The solids are then separated by filtration and sedimentation. Figure 4 schematically shows the wastewater treatment plant for reusing the water as a rinsing medium in the recirculating Comprex process. A manifold with fittings makes it possible to clean specific sections of the system without having to reinstall the unit and the separation and recirculation device. After intensive Comprex cleaning, the system sections can be conditioned, for example with demineralized water or pulsed compressed air. •



Course of the inlet and outlet temperature at a heat exchanger during Comprex cleaning.



Circulation in the Comprex process, using the example of cleaning the gas scrubber and reactor with Comprex unit and distributor as well as separation and recirculation device. *Pictures: Hammann*

Decision-maker facts

- *The Comprex process enables complex industrial production facilities to be cleaned economically. Economical cleaning requires careful planning.*
- *The cleaning process can be used with both mobile and stationary units.*
- *Apparatus such as reactors, heat exchangers or gas scrubbers can be cleaned in their installed state using the geometry-independent process.*