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

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.

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Installation 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 that occur in the

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 processes.

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 of the individual components. In addition to welded connections, pressure and temperature-compliant flange connections are also used. In contrast to welded connections, flange connections enable separable connection points for cleaning.

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 inlet and outlet points, for example by properly preparing or removing the media remaining in the systems and by conditioning the system. Before the first Comprex cleaning, the service provider carrying out the work plans the entry and exit 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. If these are 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 only a few locations of the cleaning unit

Input and output temperature curve on 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

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

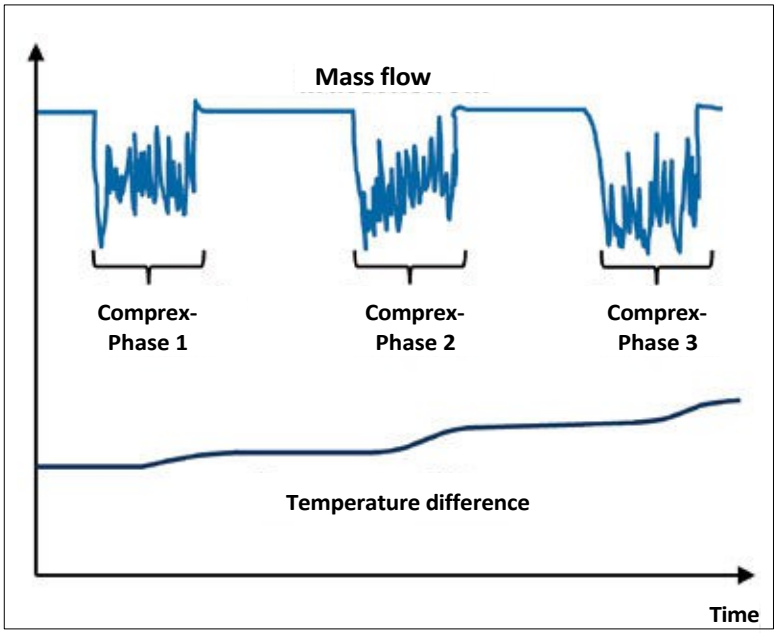
and saves set-up time. Reduced assembly measures also reduce the risk of possible leaks.

In contrast to other techniques, the compressed air-based cleaning process is largely independent of the 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 armatures must be adjusted in such a way that they and water blocks offer as little resistance as possible to Comprex cleaning. Apparatus such as reactors, heat exchangers or gas scrubbers can be cleaned in a targeted manner via the nearest feed and discharge points.

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

In many cases, it is possible to determine the extent of the deposits formed during operation and removed by cleaning. Suitable for this

In addition to the decompression box, there are devices such as inserted nonwovens to retain coarse particles in the decompression box, turbidity measurement of the discharged wastewater or separation measures at corresponding treatment plants. In contrast to the decompression box, these make it possible to reuse the water for cleaning by recirculating it, whereby the wastewater is treated in the same way.



Course of the input and output temperature at a heat exchanger d u r i n g Comprex cleaning.

The system must then be conditioned with appropriate media such as demineralized water.

Depending on the condition of the deposits, additional technology such as solids injection may also be required for basic cleaning. In the case of recurring regular maintenance cleaning, special cleaning strategies can further increase economic efficiency, for example by treating the wastewater for recirculation or by using permanently installed systems. connections for infeed and outfeed points. The following examples illustrate possible applications of the cleaning process in production plants.

Batch operation

Chemicals are produced discontinuously in batch operation, especially when small product quantities are required. In the batch process, the product

The reactor or mixer, for example, determines the amount of material in the reactor vessel. 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 plants. The cleaning technology makes it possible to clean the pipelines and apparatus 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.

Sometimes redundant heat exchangers are installed in batch reactors. This arrangement makes it possible to maintain the heat transfer outside downtimes by cleaning one heat exchanger with Comprex while the other takes over the 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

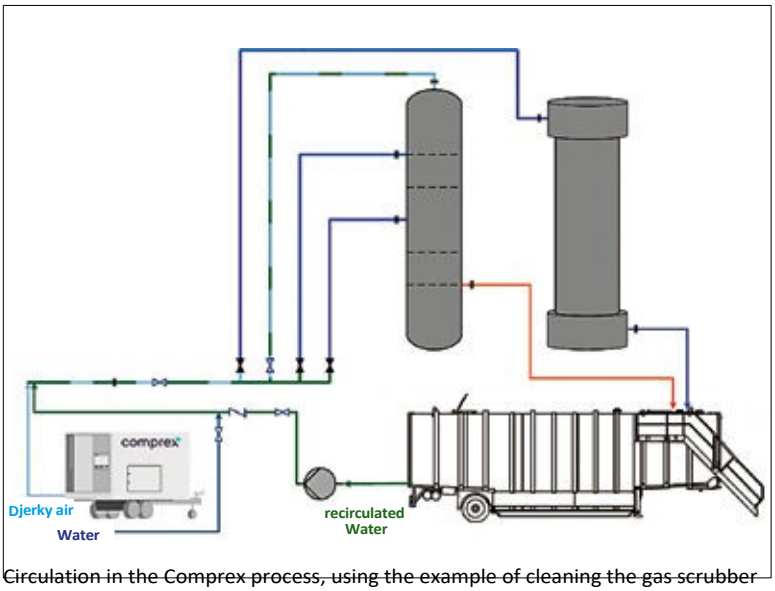
Basic chemicals mainly come from large-scale plants that operate continuously. Continuous processes are characterized by higher productivity compared to batch operation. They do not require downtimes for filling and emptying the production vessels, possibly with cleaning before the next batch process. 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 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*

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 divider with fittings makes it possible to clean specific sections of the system by setting the fittings accordingly, without having to change the unit and the separation and recirculation systems.

reinstallation of the cleaning system. After intensive Comprex cleaning, the system sections can be conditioned, for example with demineralized water or pulsed compressed air. •

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.*