Pure efficiency in heat transfer

Clean heat exchangers in a disassembly-free, economical and environmentally friendly way

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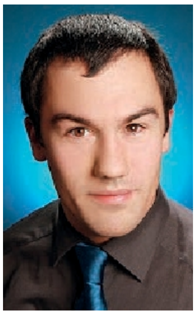

The Comprex mechanical cleaning process provides operators of heat exchangers and cooling circuits with a way to clean and operate them without dismantling and therefore more economically. If this process is combined with the use of suitable surfactant solutions, oily soiling (sludge, oil, biofilms, etc.) can be cleaned effectively and efficiently.

The Comprex cleaning process from Hammann in Annweiler am Trifels enables the gentle and disassembly-free cleaning of efficiency-determining components of process engineering systems such as heat exchangers, entire cooling circuits or cooling lubricant lines. Figure 1 schematically shows the procedure for Comprex cleaning.

Reasons for cleaning

In industrially used heat exchangers, deposits ("fouling") form during operation and impair the heat transfer. This impairment is often accompanied by a loss of pressure and flow. In developed industrialized countries, fouling causes an economic burden amounting to approx. 0.25 % of the gross domestic product. (According to Müller-Steinhagen, this amounts to around € 9 billion in Germany). In addition to inefficiencies in thermal and hydraulic performance, the necessary oversizing of system components causes additional costs. Downtimes for maintenance are necessary. A large part of the time required for the maintenance and cleaning of heat exchangers is often wasted.

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This is due to the necessary disassembly and subsequent reassembly before and after the actual cleaning. Chemical cleaning processes that do not require the disassembly of the heat exchanger are often associated with the use of corrosive cleaning agents.

Cleaning with the Comprex process

The Comprex process is a disassembly-free cleaning process. It is a further development of the impulse flushing process, which has been used successfully for cleaning drinking water distribution networks for around 20 years. In recent years, the use of the Comprex process for cleaning drinking water installations in buildings as well as heat exchangers and cooling circuits in the industrial sector has increased more and more. Hammann therefore offers solutions for three areas of application: Municipal, drinking water installations and industry.

For cleaning, water and compressed, pulsed air are alternately fed into the section of a system or system component to be cleaned at the feed point. The expanding air blocks have a strong accelerating effect on the water blocks. These are accelerated to up to 20 m/s and generate strong shear forces that act on the deposits. The blocks of air and water flow through the cleaning section. In doing so, they mobilize deposits and remove them completely. Dismantling is not necessary.

In the mechanical engineering and chemical industries, this cleaning process is particularly suitable for cleaning cooling circuits and heat exchangers. Another application is the cleaning of cooling lubricant lines.

The Comprex process is suitable for

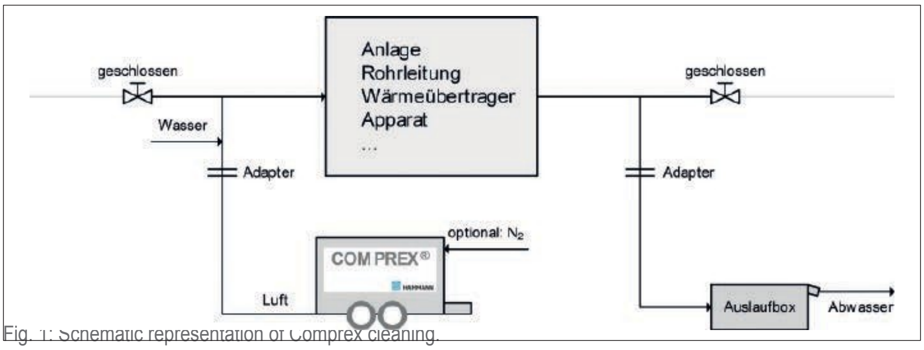

Fig. 1: Schematic representation of Comprex cleaning.

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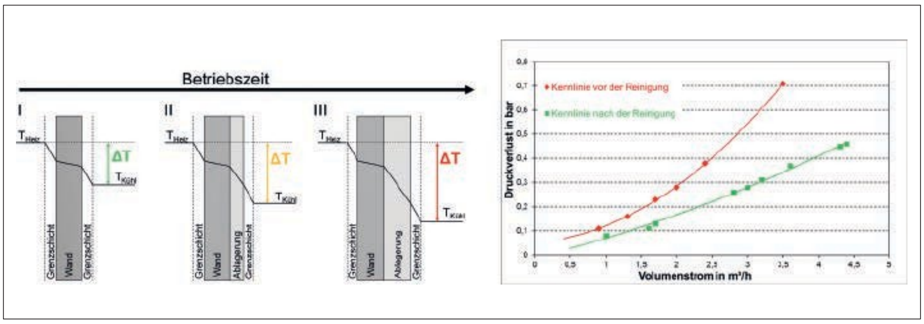

Fig. 2: Deposits influence heat transfer and hydraulic characteristic curve.

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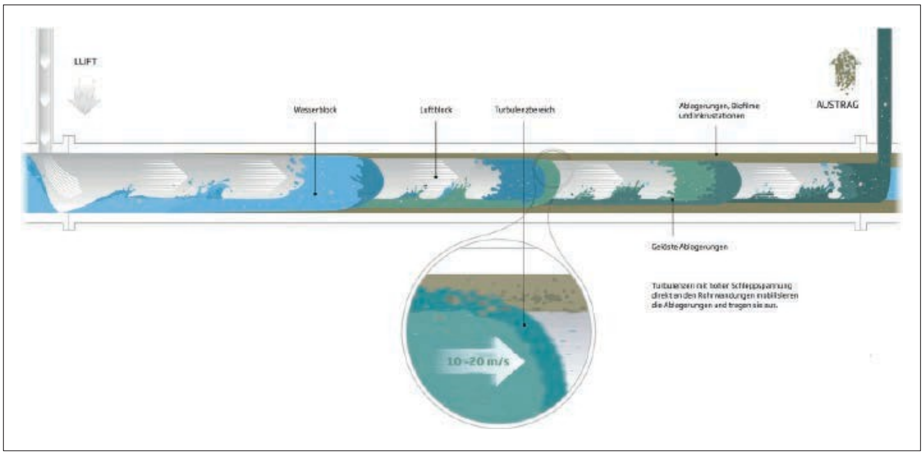

Fig. 3: Schematic representation of how the Comprex process works.

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The cleaning of sediments, flaky or crumbly limescale layers, biofilms and river sludge. Numerous practical cleaning projects in industry have shown that cleaning without dismantling was often successful after a short time. The comparatively low logistical threshold allows optimum cleaning cycles. Deposits should be removed before sediment layers age and encrust.

The Comprex process reaches its limits when highly adhesive coatings are present in heat exchangers. A more or less thin layer can then remain on the surface to be cleaned. These thin but often closed layers can result in a considerable impairment of the heat transfer.

Aged deposits on heat-transferring surfaces are also difficult to remove.

Extension of the performance limits of the Comprex process

A look at the "Sinner's Circle" is useful for exploring the possible applications of the Com- prex process (see Fig. 5). The "Sinner's circle" represents the four factors that determine the success of any cleaning process. In addition to "mechanics", on which the Comprex process is based, there are also the factors of "time", "temperature" and "temperature".
"chemistry" that could potentially increase the effect of this procedure.

The expansion of the "time" factor makes no sense. Experience has shown that increasing the time required only increases the cleaning effect.

and the process becomes less economical as a result.

Changing the "temperature" factor is also economically disadvantageous. Comprex cleaning takes place at the respective room temperature. Any influence on the cleaning temperature requires technical equipment as well as measuring and control systems. The larger the system in question, the less economical it is.

A closer look at the "chemistry" factor reveals a range of input materials. However, these are often corrosive and require special handling and disposal, at least in the case of acids, bases and oxidizing agents.

In cooperation with the company Kolb, a manufacturer of non-ionic surfactants, a gentle alternative based on

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Fig. 4: Discharge of impurities from an industrial cooling system.

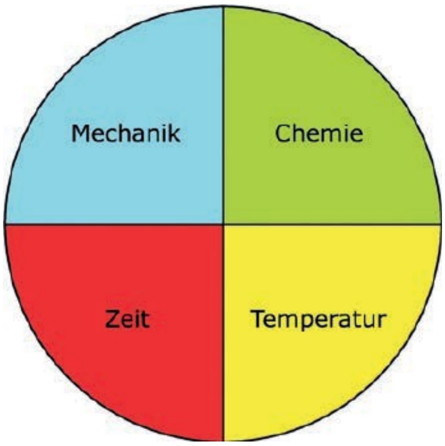

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Fig. 5: Schematic representation of the "Sinner's circle".

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Fig. 6: Checking the success of cleaning. Pure acetone is poured into the charge air cooler and removed again after five minutes. Left: Contaminated solvent indicates an internally contaminated heat exchanger. Right: Clear solvent indicates an internally clean heat exchanger.

Table 1: Tests to evaluate the cleaning performance of surfactant solutions on oil-contaminated heat exchangers.

Concentration of the surfactant	Contact time
500 hours	ppm4
50000 hours	ppm4
500 hours	ppm24
50000 hours	ppm24

of non-ionic surfactants was developed and tested. In contrast to conventional chemical cleaning agents, the amount of surfactant used is considerably lower. In addition, surfactants are superior to conventional chemical cleaning agents in terms of environmental compatibility and biodegradability.

New possibilities thanks to the soaking option

Soaking is part of many cleaning programs, even in everyday laundry or dishwashing. According to the Sinner's Circle, temperature, time and the appropriate soaking agent play a key role here. Soaking is particularly effective with the help of surfactants and enzymes. Hammann therefore carried out initial tests with these substances on the company's own test facilities. Aged mold fouling and oil-based deposits in heat exchangers, which could not be completely removed without soaking, were predestined.

For cleaning oily charge air coolers with solutions of non-ionic surfactants and surfactant mixtures were used in a chamber volume of around 4 liters. The surfactant solutions were used both in the concentration of 500 ppm (0.05 %) recommended by the manufacturer and 100 times overdosed with 50,000 ppm (5 %). For cleaning, the oiled charge air coolers were completely filled with these surfactant solutions and stored for four and 24 hours respectively. This resulted in the following test configurations (Table 1).

Following these cleaning tests, the cleaning success was checked on the heat exchangers. Since a non-destructive

Since visual testing is not possible, water and acetone were added to the heat exchanger one after the other and it was then emptied. The discoloration or particles in the solution indicated residual contamination. In all four tests, the solvents were colored black. The cleaning of the heat exchangers was not successful in any case. This showed that the surfactants used were not suitable for cleaning, regardless of the contact time or concentration.

Synergy effects

As none of the cleaning factors according to Sinner is able to clean oily heat exchangers effectively and efficiently on its own, several factors according to Sinner were combined in further tests by carrying out the Comprex process with a surfactant solution. This solution had a concentration of 500 ppm. The initially oily heat exchanger cleaned in this way was then tested for cleanliness as described above. In this case, the solvents water and acetone were clear and free of particles. The cleaning process was successful in this case. The following operational aspects are of particular interest:

- Compared to conventional cleaning chemicals, the amount of surfactant to be provided and subsequently disposed of is very small.
- Compared to previously established Com- prex cleaning programs, the cleaning parameters (e.g. pulse pressure) can be set considerably lower in combination with the use of surfactants.

- The combination of both cleaning methods leads to cleaning performance that each of the methods cannot achieve on its own.

Conclusion

The Comprex process is a gentle and disassembly-free method for cleaning system components such as heat exchangers. It is effective for cleaning various types of soiling. The area of application can be significantly extended, e.g. in the case described to oily organic soiling through the combination with environmentally friendly ten- sid solutions. These act during a soaking phase before cleaning. The use of corrosive and dangerous cleaning chemicals such as acids, alkalis or oxidizing agents is no longer necessary.

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