Preliminary state of the WÄRMER project – a brief summary:

The project and its objectives:

The joint research project WÄRMER (cleaning heat exchangers mechanically and efficiently) is performed by Hammann GmbH in cooperation with the IWW water centre (Mülheim) and the Institute for Chemical and Thermal Process Engineering (TU Braunschweig).
The key objective is the further development of the COMPREX®-process. This process has already been successfully proved for cleaning municipal water pipes and house installations for potable water. The COMPREX®-process is based on water and pulsed air and allows effective cleaning. Neither the dismantling of the pipes nor chemical cleaning agents are required. The cleaning effect is caused just by high shear forces that mobilize and purge the impurities, see figure 1.

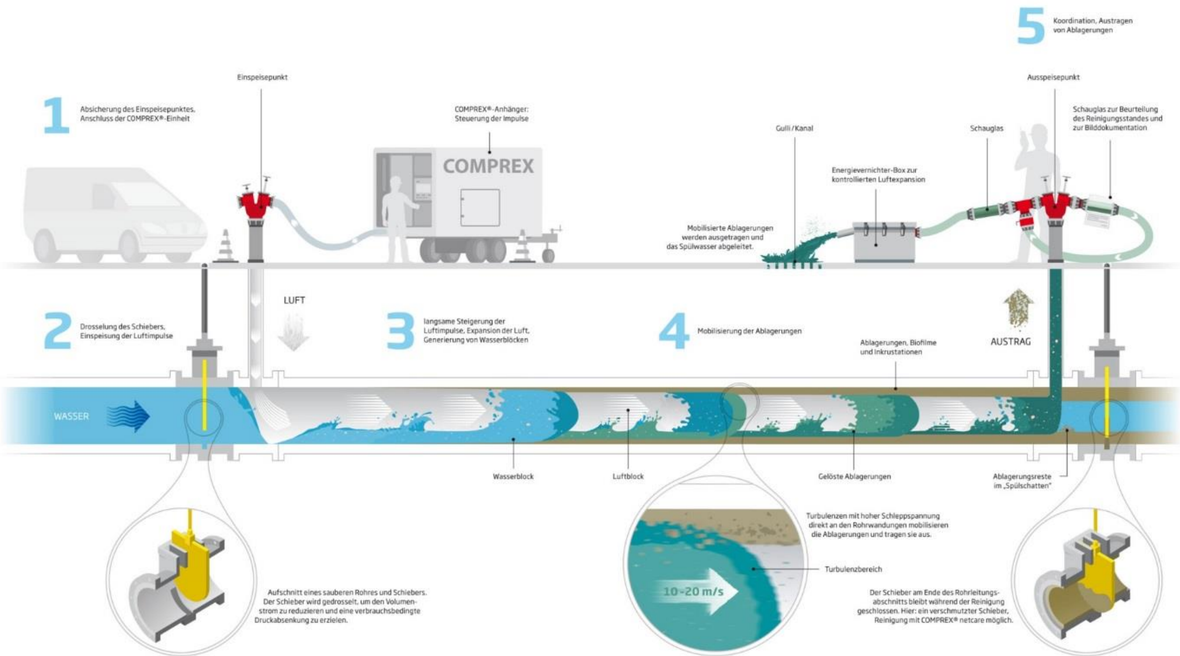

Fig.1: Principle of COMPREX®–process; illustrated on a water pipe

The application of the COMPREX®–process for cooling circuits and heat exchangers is investigated. Therefore, their cleaning will be massively facilitated, because, dismantling and re-assembly of the heat exchanger is not necessary. Furthermore, the heat exchanger can be operated more economical and energy efficient. The risk of failure is decreased.

Recent activities:

At the beginning of the project, the major efforts were set of the construction of test rigs. The Hammann GmbH has designed and built a test rig for heat exchangers, see figure 2. It is possible to clean heat exchangers of different sizes. Cleaning parameters such as times, pressures are adjustable precisely. It is equipped with a control unit with software, which has been specifically developed in this software. This test unit is transportable and requires just local supply of water and compressed air for operation.

The project partner TU Braunschweig designed and built a test rig for crystallization fouling, see figure 3. In this plant, crystalline model deposits can be produced which are representative for industrial cases. These model deposits are used in cleaning experiments which are performed on the plant shown in figure 2.

Construction of test rigs:

Fig. 2:Heat exchanger text rig

Fig. 3: Crystallization fouling test rig

Different model deposits are investigated to enable the COMPREX®-process for a broad variety of industrially relevant impurities in heat exchangers and cooling circuits. These model deposits are fixed on heat exchanger plates and afterwards cleaned on the test rig. Crystallisation fouling is realized with calcium sulfate, see fig. 4. At the IWW water centre, hydrogel deposits are produced to represent biofilms, see fig. 5. Furthermore, mud from river water is a highly relevant deposit in chemical and other industries. It is simulated by a mixture of clay-gelatine and water, see fig. 6.

Modell systems:

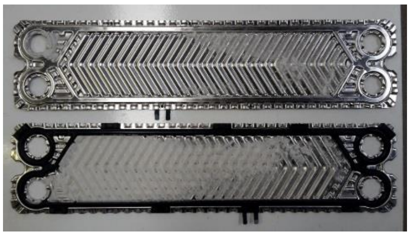

Fig. 4: Calcium sulfate Model system for crystalline deposits

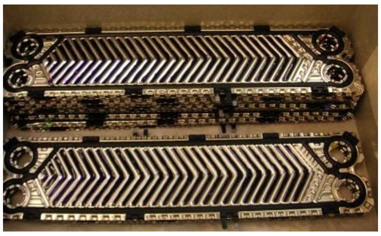

Fig. 5: Agar agar-hydrogel Model system for biofilms

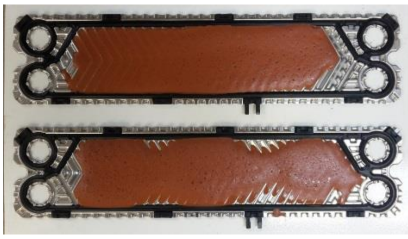

Fig. 6: Model deposit of clay, gelatine and water (Mud from rivers)

Theory and practice:

The continuous comparision of lab experiments and industrial case studies is a key issue in this project. New results can be proved and the focus be set on the most relevant problems of heat exchangers quickly. This is highly important due to the high variety of the COMPREX®-process. This variety can be found in businesses (automotive, steel, chemical industry, food, …) and in the orders of magnitude of the devices (e.g.: heat exchanger volumes of 0.1 L to 200 L).

Preliminary results:

Each of the cleaning procedures of the Hammann GmbH is started with a „pre-planning procedure“. For this procedure a technical checklist and a strategic checklist was designed in this project. The technical checklist lists details such as equipment, diameters, etc.. . The strategic checklist is a guideline to focus the specific problem and to priorise the main objectives of the particular cleaning process. Based on these data, an individual cleaning procedure can be designed.
The successful cleaning was performed with each of the three model deposits, mentioned before, see figures, 7 - 12. The model system based on clay and gelatine required more than 100 impulses for cleaning, the other two model deposits can be cleaned with less than 50 impulses.
It can be shown that changes of the flow direction and other cleaning parameters have a positive influence on the cleaning result.

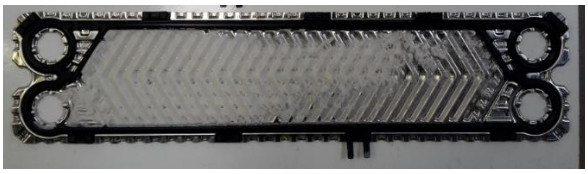

Fig. 7: Plate of heat exchanger with calcium sulfate deposit before cleaning

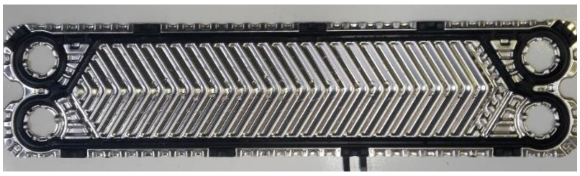

Fig. 8: Plate of heat exchanger with calcium sulfate deposit after cleaning

Fig. 9: Plate of heat exchanger with clay-gelatine-water deposit before cleaning

Fig. 10: Plate of heat exchanger with clay-gelatine-water deposit after cleaning

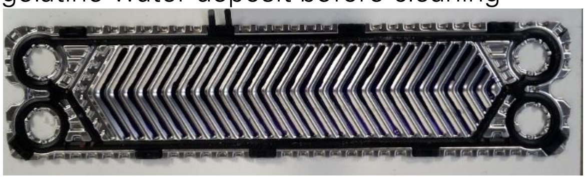

Fig. 11: Plate of heat exchanger with hydrogel deposit before cleaning

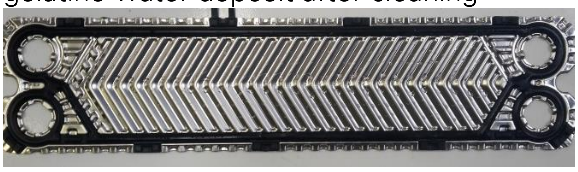

Fig. 12: Plate of heat exchanger with hydrogel deposit after cleaning

Theory and practice:

Until now, already 10 industrial case studies were performed with newly developed cleaning programmes. Cleaning programmes that have been developed in laboratory scale (heat exchanger volumes of 0.1 L to 0.5 L) were scaled up to heat exchanger volumes of up to 200 L. Based on these experiences, a set of rules for rescaling the COMPREX®-process will be designed and validated. Results from lab scale could be validated successfully in industrial scale.

The following figures show the documentation of successful cleaning procedures. The success was monitored by pressure drop curves. Figure 13 depicts the pressure drop curves before and after cleaning of a small heat exchanger (volume: 0.3 L) which was contaminated by printer´s ink. The cleaning procedure was finished after 15 minutes. Figure 14 shows a similar situation for the cleaning of a large heat exchanger (volume: 130 L) from automotive industry.

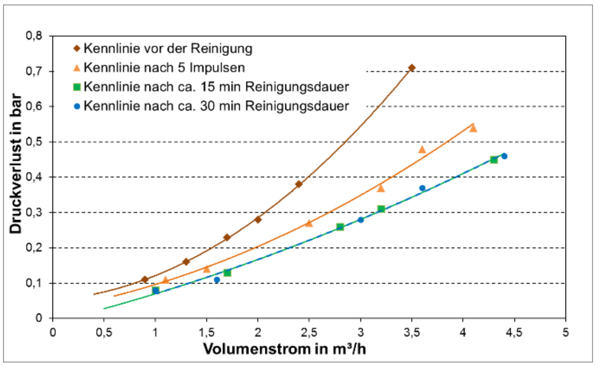

Fig. 13: Small heat exchanger

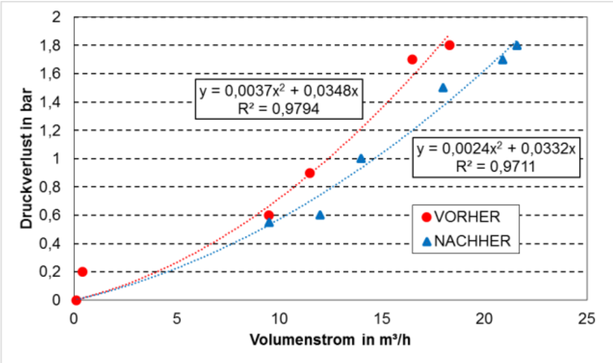

Fig. 14: Large heat exchanger

The next steps in this project focus the extension of the limits of the COMPREX®-process. Until now, strongly aged deposits are hardly to clean. Figures 15 and 16 show heat exchanger plates after cleaning. Strongly aged deposits of clay-gelatine and river water were cleaned just partially. The figures below show a good comparability of the clay-gelatine mixture with mud from river water. Currently, new modifications and extensions of the COMPREX®-technology are developed to get along with that problem.

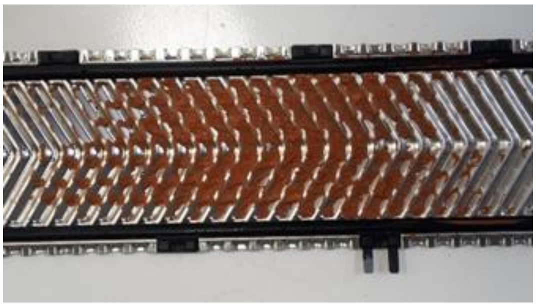

Fig. 15: Aged deposits after cleaning, model: clay-gelatine-water (Laboratory)

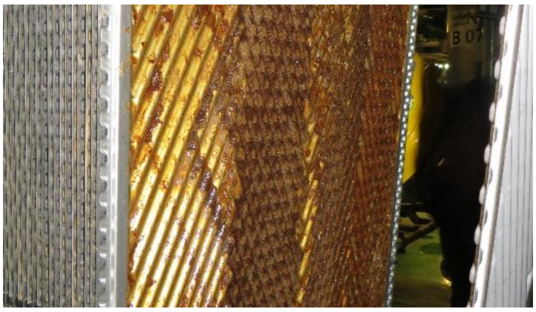

Fig. 16: Aged deposit after cleaning, model: mod from river water (Case from industry)

Further information:

Website of Hammann GmbH with numerous references and applications of the COMPREX®–process.	www.comprex.de
Project partner: IWW water centre Mülheim:	www.iww-online.de
Project partner: Institute for Chemical and Thermal Process Engineering / TU Braunschweig:	www.ictv.tu-bs.de
Zentrales Innovationsprogramm Mittelstand. (Funding institution: Central innovation program for SME´s)	www.zim-bmwi.de

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