MAFAC
Parts Cleaning. Systems and Solutions.

White Paper

Energy Efficiency for Aqueous Parts Cleaning

Reducing the amount of energy required by a machine for aqueous parts cleaning is one of the best ways to cut costs and to lower the environmental impact of production. This was the key finding of a recent study of an aqueous parts cleaning machine within the framework of the interdisciplinary research project "ETA-Factory" led by TU Darmstadt as part of its drive to enhance energy-efficient production processes.

In view of rising energy prices and constantly increasing international competition, energy-efficient production is one of the key issues for the German industry. As a result, domestic companies are called upon to reduce the energy consumption of their production, as well as their carbon footprint. To ensure companies are able to recognize their own energy saving potentials and to implement projects that exploit these potentials, the TU Darmstadt initiated the research project "Energy Efficient Factory" (ETA-Factory) together with 39 industrial partners. The aim of the research project is to develop approaches for reducing energy consumption of industrial production processes. The project forecasts that the thermal interconnectedness of industrial factories, technical infrastructure, and machinery will result in potential energy savings of up to 40%.

Parts cleaning as a field of study

Due to its increasing significance in the industry and its partly energy-intensive processes, parts cleaning is a key element of the ETA investigations. Optimization solutions and energy saving potentials for cleaning and drying processes were examined using a spray-flood parts washer with dual-wash technology. Generally speaking, three optimization steps are feasible for energy efficient parts cleaning: 1) Reducing system and internal losses of the actual machine through effective thermal insulation and shielding, 2) Minimizing internal losses through efficient energy storage, recovery, and utilization (integrated energy recuperation), and 3) Enabling and utilizing intelligent power generation beyond machine limits (interconnectedness). Within this context, four main approaches were identified in which the most energy saving potentials in terms of power costs can be exploited. These are:

1) Heating of process water through external interconnectedness,
2) Heat storage and recuperation of machine specific heat and efficient utilization for preheating the drying air,
3) Heat recuperation of waste air, and
4) Sensor-based process control.

Based on the total amount of energy required by the cleaning machine, potential financial savings of up to 35% can be achieved by the company at the current level of development and when utilizing appropriate machine equipment, process models, and intelligent interconnectedness.

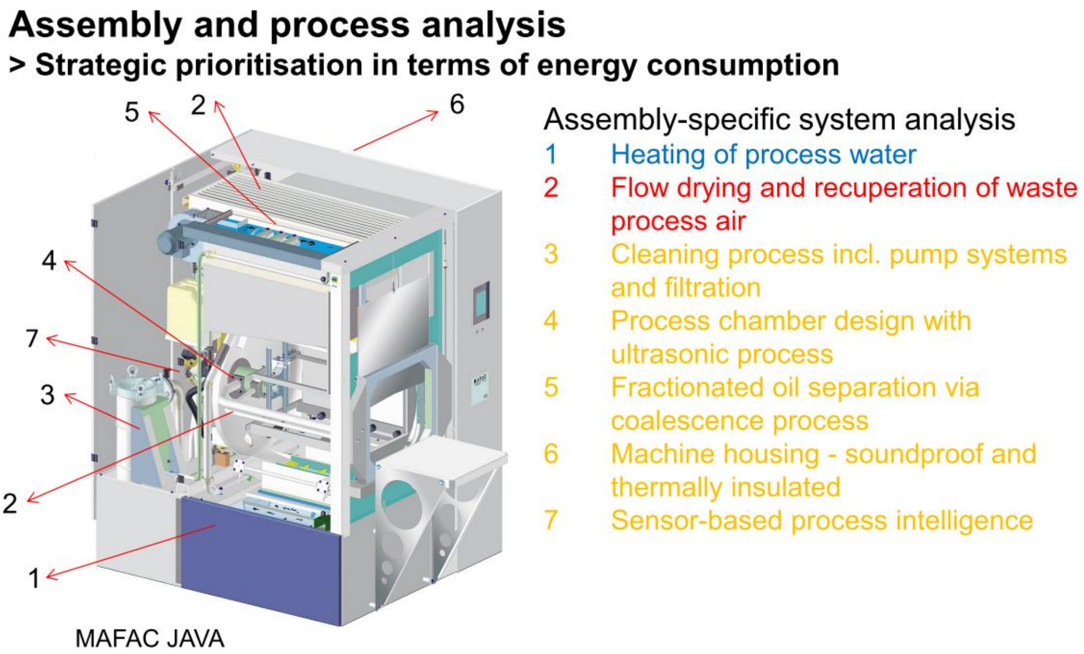

Image 1: Assembly and process analysis

In line with this hierarchy, the investigation initially focused on heating process water with the aim of developing an exchange technology for reproducible heat transfer. Further, to provide the right conditions in terms of thermal interconnectedness, it must be possible to feed existing, technical heat from the production environment into the exchange process.

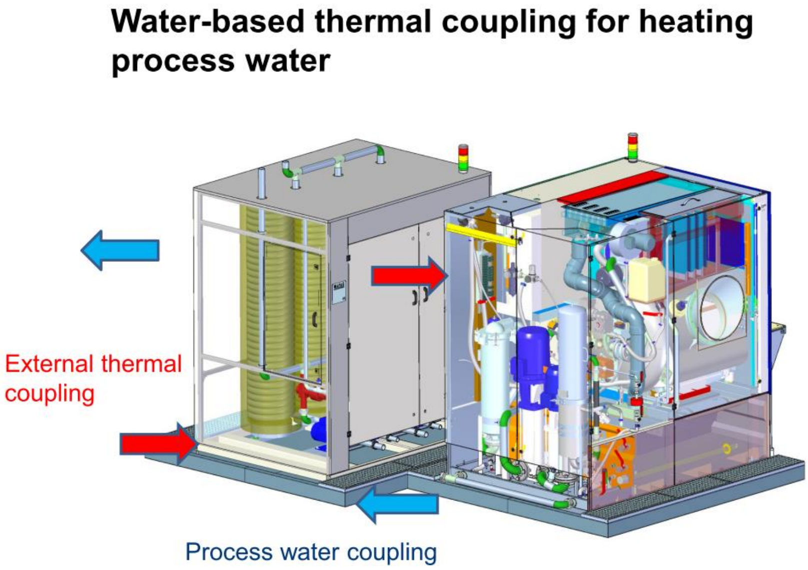

Image 2: Process water coupling (prototype)

Parameters of heat exchange for heating process water

Parts cleaning represents a heat sink within a manufacturing chain. In other words, energy has to be supplied to the process to achieve the required level of parts cleanliness using heated cleaning baths. In order to be able to determine the energy consumption of the investigated parts cleaning machine, a standard process was defined and the influence of media temperature, batch sizes, process model (cleaning, rinsing, drying), and operating time on overall energy consumption systematically analyzed. The focus then turned to the energy behavior of the companies: in other words, which type of energy and state-of-the-art techniques are applied for heating process baths – either conventional electricity for heating or alternative energy sources such as available water heated from solar power, co-generation or technical heat from a district heating network.

The investigation resulted in the following definition of requirements:
The envisaged exchange technology must provide a constant temperature of up to 75°C without the need of electricity for heating while guaranteeing reliable operation without any negative implications for the cleaning

capacity and quality of the process water. It should also be able to respond flexibly to various heat sources and additionally transmit heat faster and more efficiently than conventional power sources. This would ensure shorter lead times and compensate any temperature losses in a faster and more efficient way, for instance when cleaning larger components. Moreover, there should be virtually no losses during heat transfer in order to provide a maximum energy saving potential of up 35%.

The heat exchange module

The knowledge gained was used to develop a heat exchange module that uses heat from external sources to heat up cleaning media. In counterflow principle, a highly efficient heat exchange technology utilizes coaxial tubes to ensure the waste heat of the heating agent is transferred to the cleaning agent virtually without losses before being returned to the cleaning process. To enhance flexibility, it was made sure that electricity for heating can be replaced efficiently with hot water from alternative energy sources and that heat (hot water) can be supplied from the following three energy sources:

1. Heat treatment processes,
2. Existing co-generation processes or
3. Regenerative water heating applications (solar heat).

The results show that an efficient heat exchange module can help to reduce power consumption for media heating by more than 90% and cut the relevant CO_2 emissions proportionally.

Exploiting energy saving potentials

The newly developed heat exchange technology enables a direct supply of waste heat from the production environment to the sub-process parts cleaning, thus optimizing a company's energy balance in line with EMAS pursuant to DIN EN ISO 50001.

As mentioned at the beginning of this white paper, there are a number of approaches besides heating process water that can improve the energy consumption of parts cleaning. Research and development work in the area of thermal insulation and shielding provide us with new insights:

Consequently, it is possible to guarantee the said energy saving potentials through efficient thermal machine shielding and the intelligent provision of internal machine heat for drying processes in combination with interconnected process water heating. These energy savings additionally enhance heat emission from machinery and help to improve working conditions in the machine environment. It additionally reduces concentrations of air pollutants inside the factory. As a result the typical costs for factory air disposal and conditioning can be saved.

Detailed investigations into recuperating waste air heat and sensor-based process intelligence are planned for 2016/17. Looking ahead, researchers have already identified a number of interesting system approaches with additional energy saving potentials.

The holistic approach of the ETA project makes it quite clear that machine optimization is not the only way to cut energy costs and that, potentially, there are much greater savings to be achieved by thermally interconnecting the machine, the factory, and the production environment.

The Eco-Management and Audit Scheme (EMAS) of the European Union

The Eco-Management and Audit Scheme (EMAS) is a voluntary EU initiative designed to improve a company's environmental performance pursuant to EMAS DIN EN ISO 50001. EMAS acknowledges organizations that improve their environmental performance on a continuous basis. Since July 2015, large companies that employ at least 250 staff and have an annual turnover of more than €50 million must be EMAS certified. The EMAS certificate is also a requirement for partial exemption from certain renewable energy surcharges and future relief of the electricity and energy tax for energy-intensive companies in the manufacturing sector.

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