Henkel

Henkel Adhesive Technologies

WHITE PAPER

THE LOWER THE TEMPERATURE – THE HIGHER THE IMPACT

HOW TO MAXIMIZE POTENTIAL COST SAVINGS WHEN PRETREATING METAL

CON-TENTS

EDITORIAL

When producing parts made of steel, aluminum or other metals, it is impossible to avoid soiling in the form of oil, oxides or dust. These deposits and residues must be completely removed during the working process – because failure to do so has a detrimental effect on downstream process steps such as the application of conversion coatings or paint. This can have a negative impact on product quality.

For this reason, cleaning parts is an important step in the pretreatment of metals and a key factor in successful production. Cleaning can only deliver its full potential benefits when chemistry, mechanics, time and temperature all come together in perfect harmony. However, there is also a hidden challenge in this respect. Traditionally, cleaning takes place in large, vapor-filled cleaning systems at temperatures of around 60 to 70 degrees Celsius. This makes cleaning one of the most energy-intensive process steps involved – and one of the biggest cost drivers. It also makes the production process less sustainable because of the high level of CO_2 emissions.

Over the past few years, the metal industry has been seeking to become more sustainable. One of the main questions is how the cleaning process for metal parts can be adapted to cut production costs and protect the environment, while still maintaining the same excellent cleaning performance. The answer companies are looking for is low-temperature cleaning, which is effective at temperatures as low as around 35 degrees Celsius.

We start this whitepaper by considering the basics of successful cleaning: What is the current situation on the market? What are the challenges? And how do cutting-edge solutions meet the industry's needs? We then outline the benefits of low-temperature cleaning for people and the environment. We also provide a checklist of the key factors involved in switching to a low-temperature cleaning process.

In our role as a reliable partner, technological expert and supplier of these safe and sustainable solutions, we provide our customers with the support they need – and play our part in helping to transform the metal industry.

We hope you enjoy reading this whitepaper. If you have any questions, please do not hesitate to contact us.

The Henkel team

CLEANING **METAL SURFACES** – THE BASICS

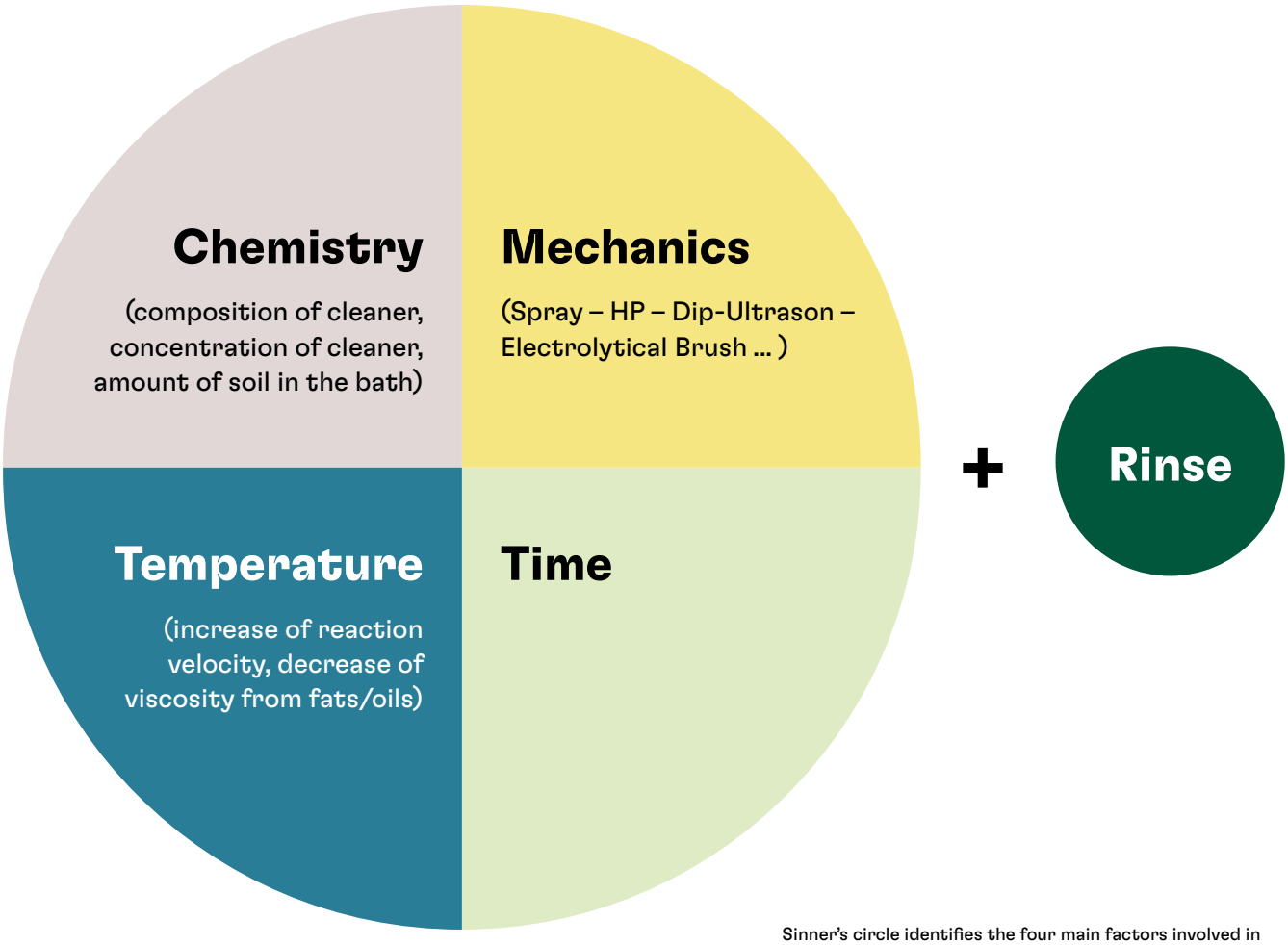
Metal surfaces are often dusty, oily or corroded before they are coated or painted. Parts need to be cleaned to ensure the surface is as free from soiling as possible in preparation for the downstream production steps. Looking at the history of how cleaners have been used in industry, there has been a clear trend away from powder cleaners and toward concentrated liquids, which really established themselves a few decades ago. The reason for this shift is the now-standard practice of using semi-automated and automated systems for cleaning, where products are sprayed with an alkaline cleaner (spray cleaning) or immersed into a bath (dip cleaning). When using these systems, liquid cleaners offer much more flexibility because they are easier to dispense automatically. The requirements are clear – they must exhibit outstanding cleaning and degreasing properties, be biostable, foam-free and compatible with the downstream processes, and ensure a high level of system availability. However, what essential factors need to be addressed in order to meet these requirements?

"Sinner's circle" – the key factors in surface cleaning

In 1959, Dr. Herbert Sinner, former head chemist of the Henkel Detergents department, identified the four main factors involved in surface cleaning: chemistry, mechanics, temperature and time. This concept is known as "Sinner's circle".

- Time refers to the duration of the production process.
- Temperature relates to energy consumption and foam formation.
- Mechanics is all about the production technology, such as whether a dip or spray cleaning system is used.
- Chemistry is the basis of the cleaner formulation, particularly the degreasing system consisting of builders and surfactants.

By changing one of these parameters, solution developers are able to offset another parameter. When it comes to cleaning, the temperature can be reduced by changing the chemistry. Sinner's circle dictates that longer cleaning times, stronger concentrations, more extensive mechanics and higher temperatures remove more of the dust that accumulates during storage, as well as oil, highly viscous greases, metallic residue, metal shavings, dirt from the surrounding environment, fingerprints, oxides and corrosion.



Sinner's circle identifies the four main factors involved in surface cleaning: chemistry, mechanics, temperature and time.

TEST PROCESSES FOR VERIFYING CLEANING PERFORMANCE

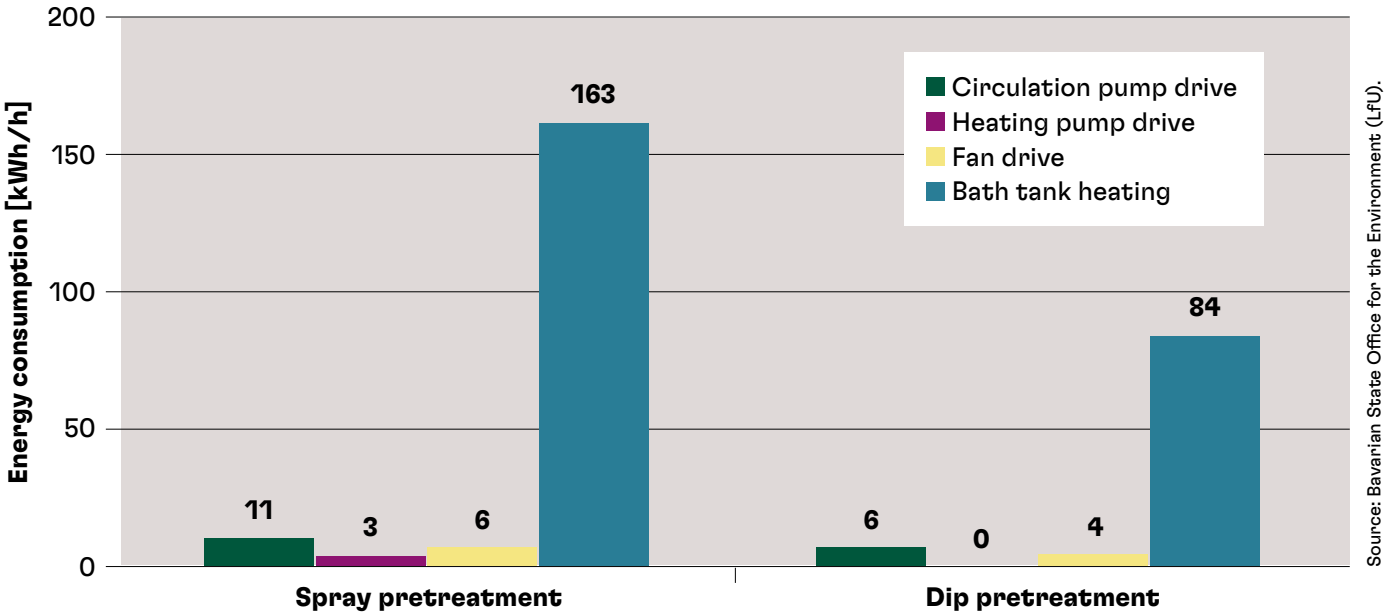
LECO analysis
This method involves placing flat metal samples inside a combustion furnace. The CO_2 produced during the combustion process is measured to determine the amount of carbon left on the metal surface. The rule: The less carbon left, the better the cleaning performance. In some industries there is a maximum carbon limit to ensure that the subsequent coating is not impaired in any way.

Water-break test
This method is used to test a cleaner's degreasing performance. Once they have been cleaned, the metal parts are dipped into water. If the water forms droplets on the metal part, this means there is still residual oil on the surface. If the surface is uniformly wet, i.e. covered by an unbroken sheet of water, this means the test piece has been fully degreased. If no water droplets form within around ten seconds, there should be no problems when paint or adhesive is applied to the parts.

CURRENT *SITUATION* – **HIGH** TEMPERATURES *ARE* DOMINATING *THE* ***MARKET***

Traditional cleaning methods require temperatures of between 60 and 70 degrees Celsius. However, this involves burning substantial amounts of natural gas and emitting high levels of CO_2. As an example, spray pretreatment accounts for around 20 percent of the total amount of energy used in a paint shop.

In pretreatment systems, heating up the enormous baths guzzles the most energy. For example, mains water needs to be heated from its average temperature of 15 degrees Celsius to 60 degrees Celsius or higher. In addition, energy gets lost due to evaporation and heat losses during the suction process. This is compounded by the fact that plants often do not have efficient heat recovery systems. The drives for circulating pumps, heat pumps and fans also use a lot of energy.

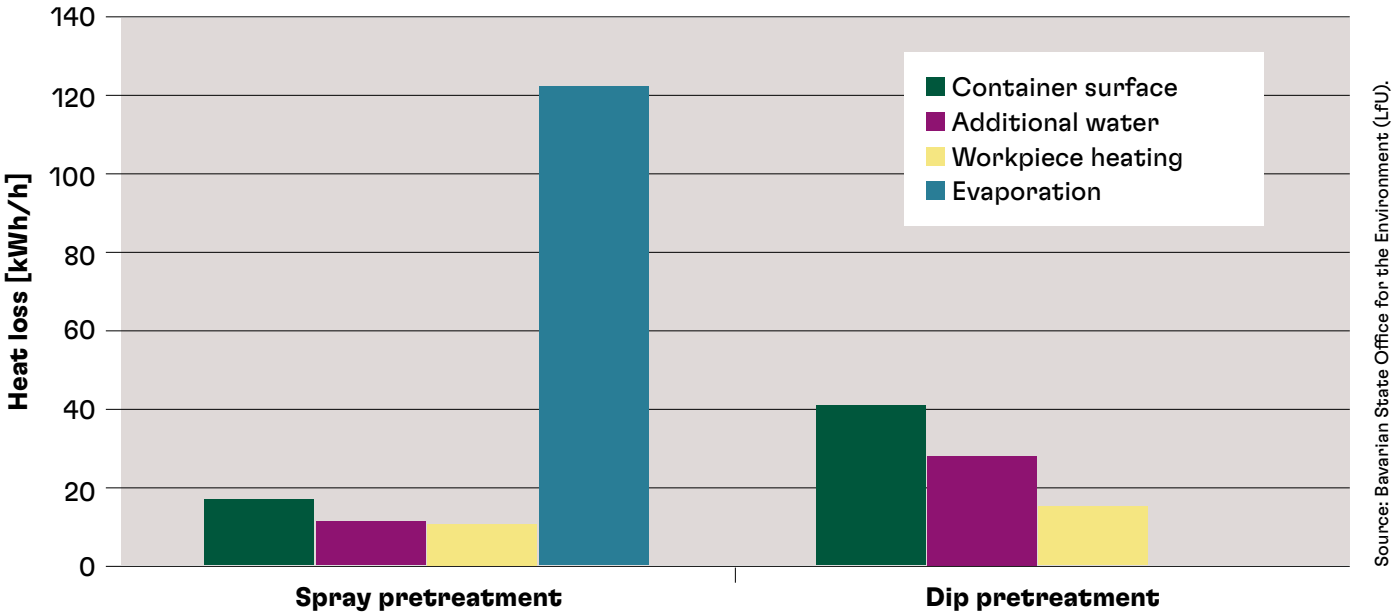


Total electrical and thermal energy consumption of dip pretreatment and spray pretreatment systems (model system for metal office furniture).[1]

1 Source: Bavarian State Office for the Environment (LfU)

Energy consumption – a comparison of spray-type and dip-type processes

When comparing dip-type and spray-type systems, it becomes apparent that the biggest share of heating energy consumption can be attributed to the spraying of process chemicals. In the case of spray cleaning, the majority of the energy used is lost through the atomization process (approx. 120 kWh/h). Up to 80 percent of the energy is used to maintain the temperature of the bath to compensate for evaporation losses. Smaller amounts of energy are lost during the process via the container surface and hot water. Depending on both the temperature difference and the system configuration, much of the energy supplied migrates from the heated zones to the colder rinsing baths in the neutral zones via the air circulation. Heat loss from other factors such as bath surface, water replenishment and part heating is below 40 kWh/h, which is slightly higher in dip-type systems than in spray-type systems.



Heat losses in spray and dip pretreatment systems (model system for metal office furniture).[2]

2 Source: Bavarian State Office for the Environment (LfU).

THE CHALLENGE – ACHIEVING *THE SAME* PERFORMANCE AT LOWER *TEMPERATURES*

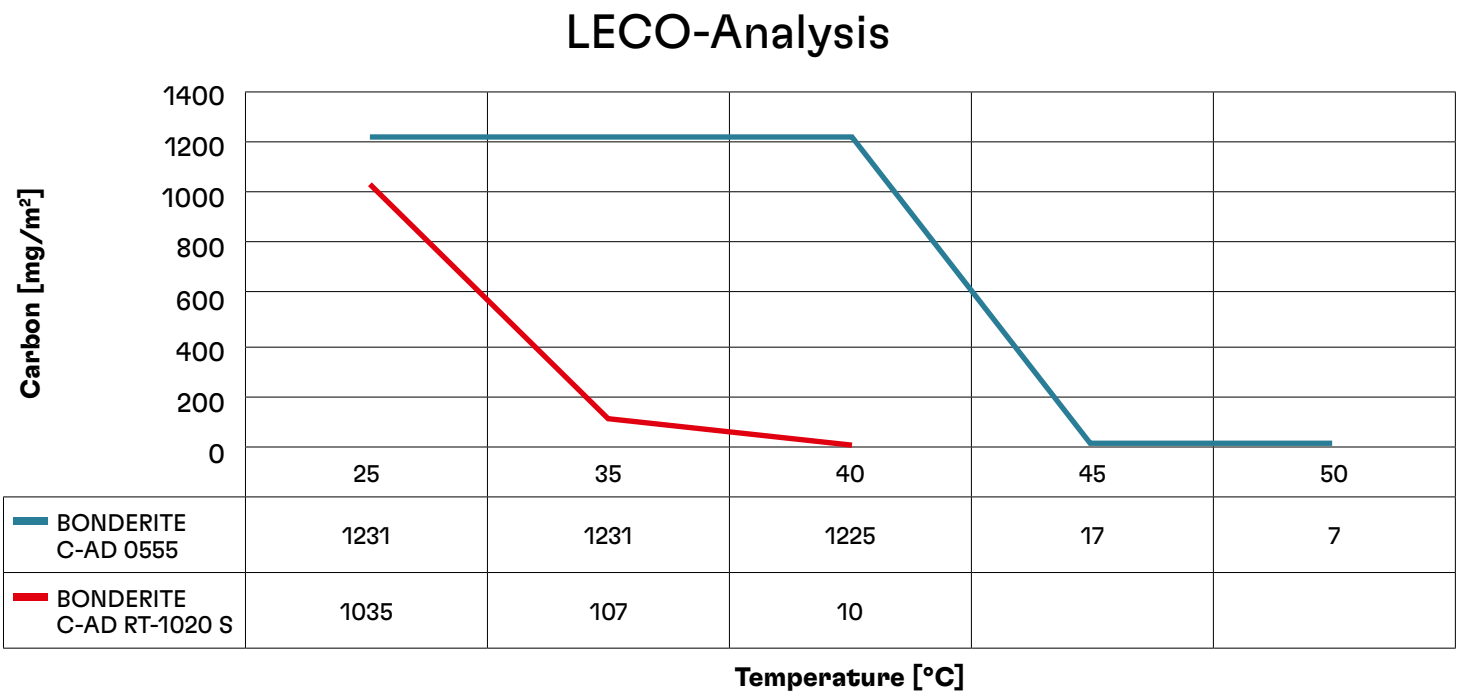
Traditionally, good cleaning performance goes hand in hand with huge energy consumption and high production costs. As a result, the aim is to develop new solutions that ensure effective cleaning at lower temperatures and enable users to save energy and reduce their CO_2 emissions. This means maintaining – or even improving – the quality of the cleaning in the existing system by lowering the temperature, but without making any changes to the mechanics or treatment time.

Lower temperatures are often regarded with suspicion because many people believe that they compromise the cleaning performance of existing products and increase foam formation, especially in spray cleaning. These suspicions are both confirmed if standard cleaners, which are normally applied at 60 degrees Celsius or higher, are used at lower temperatures. Nowadays, however, innovative formulations utilizing new process chemicals mean baths can be operated at low temperatures with consistent cleaning quality.

LOW-TEMPERATURE CLEANING: EFFICIENT AND ENVIRONMENTALLY FRIENDLY

Low-temperature cleaning systems can be used at much lower temperatures than the traditional level of 60 degrees Celsius. The combination of increased chemical energy and low foaming surfactants can replace most of the dip cleaning and spray cleaning methods available on the market. These technologies can be used for all types of cleaning, such as cleaning between individual processes, the final cleaning stage prior to warehousing or the cleaning step before applying a conversion coating, adhesive or paint.

Comparison by LECO analysis shows that when using a conventional cleaner, the amount of carbon only starts to decrease at temperatures above 40 degrees Celsius. A clean metal surface is only achieved at a temperature range of 45 to 50 degrees Celsius. However, a low-temperature cleaner already takes effect at a temperature as low as 35 degrees Celsius.



	25	35	40	45	50
BONDERITE C-AD 0555	1231	1231	1225	17	7
BONDERITE C-AD RT-1020 S	1035	107	10		

BONDERITE C-AD 0555: conventional builder concept / multipurpose surfactant
BONDERITE C-AD RT-1020 S: conventional builder / new surfactant formulation

General industries – low-temperature cleaner for the construction and furniture sectors

Many customers in the general industries sector are already using an established Henkel solution to clean metal with great success – such as an alkaline cleaning booster that contains the BONDERITE C-AD RT 1020S surfactant. This surfactant activates the cleaner at a temperature of 35 degrees Celsius instead of at around 60 to 70 degrees Celsius. Lowering the temperature for cleaning steel or aluminum substrates from 65 degrees Celsius to 35 degrees Celsius helps to reduce energy consumption by 46 percent. The steel or aluminum surface shows no water breaks, and the residual carbon on the surface is significantly reduced. The cleaning technology contains low-foam surfactants that are beneficial for operational sequences.

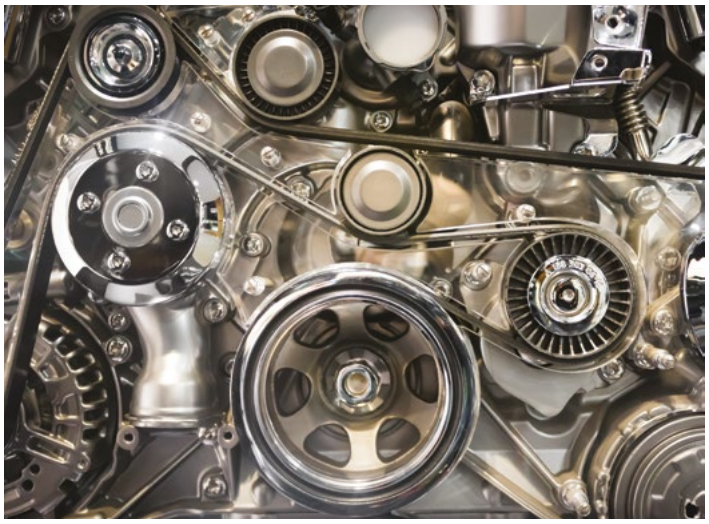
THE BENEFITS OF LOW-TEMPERATURE CLEANING

Reducing production costs – and cutting energy use, CO_2 emissions and maintenance

More than 90 percent of metal-working businesses still clean at high temperatures that exceed 60 degrees Celsius. This is primarily because they are not aware of how efficient low-temperature cleaners are or just how much potential these technologies offer for saving energy and reducing CO_2 emissions. However, given that cleaning accounts for such a high proportion of the overall costs in metal pretreatment, companies should consider switching in the short to medium term. With energy costs rising – steeply in some regions – the benefit of lowering the cleaning temperature should not be underestimated. Energy savings of 15 percent can be achieved for every reduction of 10 degrees Celsius in the temperature of the cleaning zone. Maintenance costs are also reduced because heating systems, heat exchangers and pumps are all operated at a much lower level and rate.

Sustainable production and a safe working environment

More and more companies in the metal industry are striving to reduce their Scope 1 and 2 emissions. This can help to make their production operations sustainable. By optimizing their energy consumption, companies can reduce their overall carbon footprint and help protect the environment. What's more, the lower temperature is also important from the viewpoint of health and safety. Less alkaline vapor and less heat make the production area a safer and more pleasant environment for operators and reduce the corrosive effects on ventilation systems, ceilings and other steel structures. The reduced level of heat also works to the maintenance team's advantage because they no longer need to wait for the system to cool down before replacing a part.

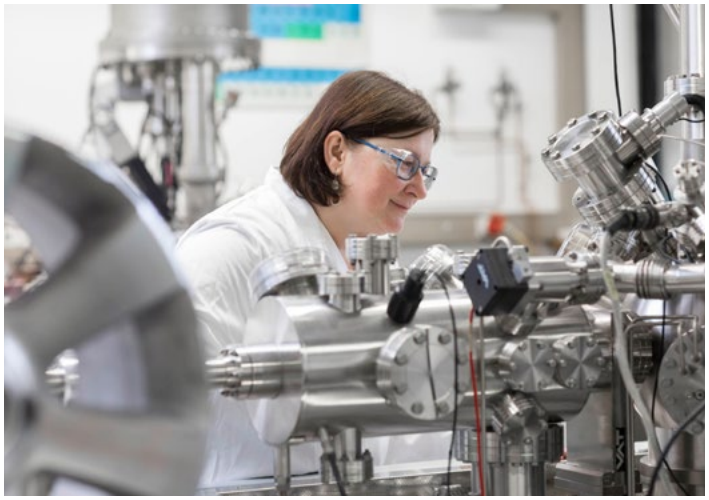


A high level of system availability and optimum product quality

Using low-temperature cleaning systems helps avoid detrimental factors such as foam formation, surface discoloration and reject parts. There is also a lower risk of aluminum surfaces being pickled to excess, and parts that are left in the cleaning bath for longer than intended are less likely to be damaged. Since parts dry at a slower rate, fewer deposits accumulate inside machinery and pipes, so the machine itself needs less cleaning. There is also a saving in terms of production time, since cold mains water no longer needs to be heated up to such high temperatures. What's more, the temperature drop over the weekend is not as dramatic, which delivers further savings when it comes to starting up operations again. Overall, there is a huge increase in the system's level of availability.

No system downtime because the solution is easy to replace

Many companies view the replacement of an existing solution with a new cleaning system as a risky step because they are worried about downtime. In practice, however, switching from high-temperature to low-temperature cleaning couldn't be easier – it is simply a case of draining off the old solution, cleaning the system and then adding the new solution. In the case of aluminum beverage cans, it is possible to do a soft conversion where the bath and temperature is converted over time without draining the old solution. Once the conversion has been done, production can continue straight away. The only essential requirement is to check in advance that the system can operate properly at a different temperature. The Henkel Application Engineer team can assist with this by analyzing the existing cleaning procedure, the upstream and downstream processes, and the substrates involved, and then adjusting the bath parameters accordingly. It may also be possible to simplify the new pretreatment line, for example, by introducing smaller pumps or fans.



THE OUTLOOK — LOWERING TEMPERATURES AND MEETING SUSTAINABILITY TARGETS

Companies in the metal industry that switch to low-temperature cleaning will gain several benefits – and there is no downside. They can significantly cut their costs in various areas such as energy and maintenance, while also enhancing the quality of their products and creating a more pleasant working environment for their staff. The new solution couldn't be easier to implement. As a supplier of pretreatment systems, Henkel is a reliable partner that supports its customers every step of the way. Lowering the temperature in production is an important step in boosting the success of the entire company on a long-term basis. It also represents a milestone in terms of sustainability, helping users to further develop their business in a responsible and profitable manner – all within the context of an industrial transformation for the benefit of the environment and future generations.

ABOUT HENKEL

With its brands, innovations and technologies, Henkel holds leading market positions worldwide in the industrial and consumer businesses. The business unit Adhesive Technologies is the global leader in the market of adhesives, sealants and functional coatings. With Consumer Brands, the company holds leading positions especially in hair care and laundry & home care in many markets and categories around the world. The company's three strongest brands are Loctite, Persil and Schwarzkopf. In fiscal 2022, Henkel reported sales of more than 22 billion euros and adjusted operating profit of around 2.3 billion euros. Henkel's preferred shares are listed in the German stock index DAX. Sustainability has a long tradition at Henkel, and the company has a clear sustainability strategy with concrete targets. Henkel was founded in 1876 and today employs a diverse team of more than 50,000 people worldwide – united by a strong corporate culture, shared values and a common purpose: "Pioneers at heart for the good of generations." More information at **www.henkel.com**

AUTHORS

Nils Bongartz: Manager Product Development Surface Treatment

Lee Sheppard: Manager Product Development Lubes & Cleaners

Andreas Maslowski: Senior Application Engineer General Industry

Thank you.

CONTACT

Your Team of Henkel Experts: **marketing.metals@henkel.com**

An expert team at Henkel is always available to answer your questions.
We will be happy to help you.

Henkel AG & Co.KGaA
40589 Dusseldorf
Phone +49 211 797 0

Henkel - Metals - MC - 01.v14