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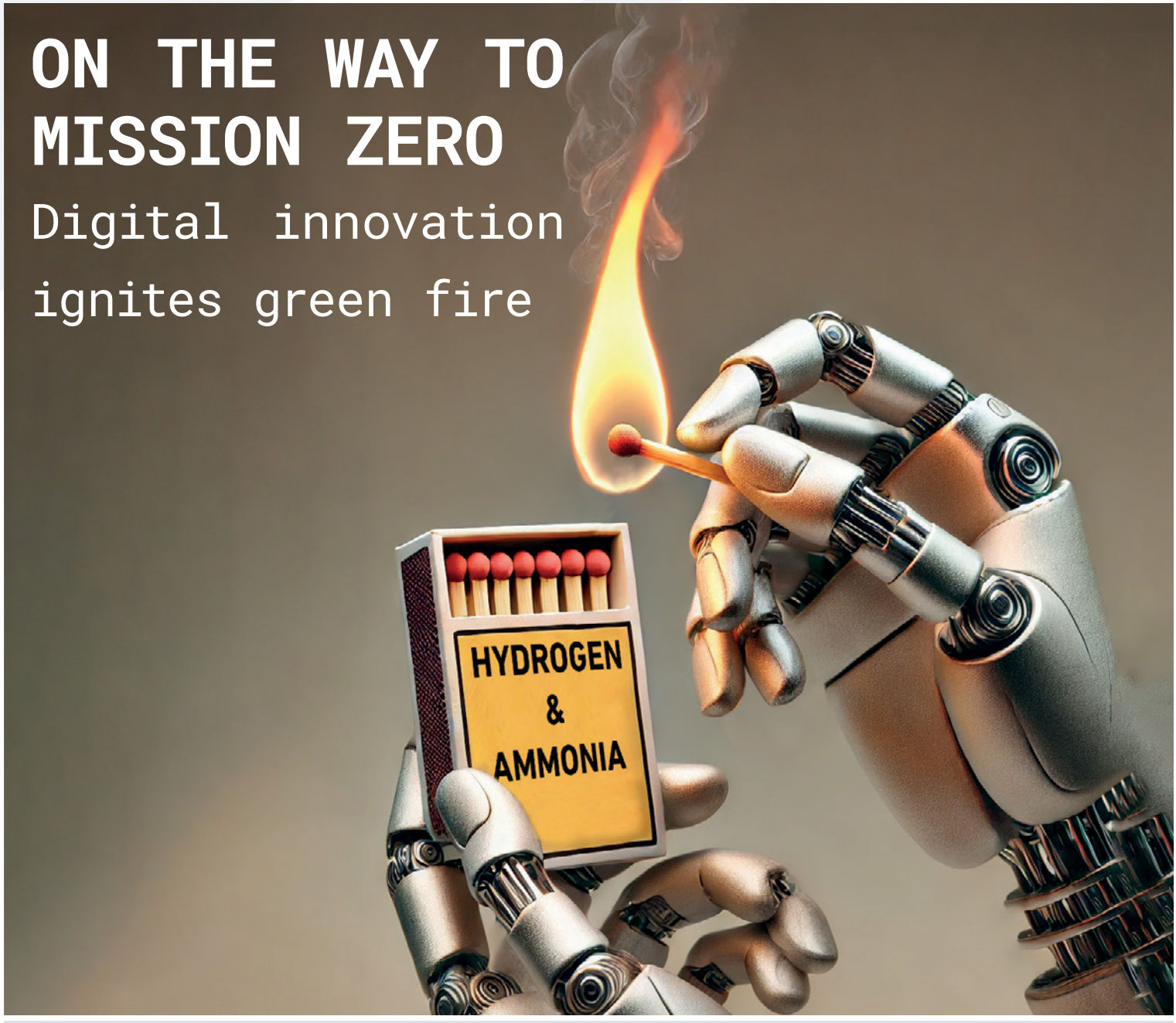
ON THE WAY TO MISSION ZERO

Digital innovation ignites green fire



"Now we finally have to say goodbye to the screwdriver."

In an interview with heat processing, **Wilhelm Homann**, Head of Development at Honeywell Thermal Solutions, urges haste in further digitalisation in heat treatment. This is the only way to exploit the full potential of hybrid heating and intelligent heating concepts.

Mr. Homann, as Head of Development at Honeywell Thermal Solutions, we would like to know from you, what approach is Honeywell currently taking in the field of hybrid heating to be able to make flexible heating technology available to more customers?

Homann: I'll start with the definition of hybrid heating: We understand it to mean the combination of different heat sources. This can be the combination of different fuel gases or the combination of combustion heat with electric heating, and not to forget, the use of residual heat. The aim is to give the user the option of choosing the best heating method for him based on defined planning specifications. This option can be a procedure that is as cost-effective as possible or CO_2-avoiding or even utilisation-optimised.

Wilhelm Homann, Head of Development at Honeywell Thermal Solutions

What is your approach here?

Well, we are working, for example, on the combination of burners with electric heating elements, which can then produce certain temperature curves alternately or in combination via a corresponding control system. Furthermore, we are expanding our portfolio to be able to burn different fuels, such as natural gas and hydrogen and their mixtures, safely and efficiently, which in our case ranges from the burner to the components and the control system.

Are your customers more interested in the combination of hydrogen with natural gas or the combination of gas-fired plants with electrical energy?

Many of our customers are discovering electric heating for themselves through the hybrid heating option. Even in areas that were previously uninteresting for reasons of energy costs. A few years ago, our customers were still very fixated on the topic of hydrogen. Now many are sobering to realize that the availability of hydrogen is still a long time coming. Something similar can happen if our customers rely completely on electrical energy. When talking to energy suppliers, they are often shocked by what services can be made available and how long the grid expansion will be delayed. This alone means that more customers are opening to the combination of different fuels or with electrical energy. But residual heat must not be neglected in this area either.

Are there any other factors that push hybrid heating as a possibility?

Apart from the lack of availability of various heat sources, many companies have deliberately set their CO_2 targets much more aggressively than, for example, the EU has asked. Solutions must now be found for this as well – at least these must be considered. We cannot wait until the right infrastructure is made available somewhere. There is also potential for CO_2 savings in existing systems. For example, we still see plants where cold air burners are

used. Recuperative or regenerative air preheating is not even considered here. Here, too, the combination of electric heat and combustion heat makes a lot of sense, especially when I look at temperature profiles that only require short, strong heating and then drop to lower temperature. Here I can control much more finely with electric heating.

Is it possible and sensible to use electric heating elements in existing buildings as part of retrofit measures?

Yes, that is possible. In the existing building, however, the equipment must fit the dimensions of the system and be able to be adapted according to the existing processes. Therefore, in this environment, it is often not the approach to completely replace the combustion component, but to introduce additional electrical components at certain points – be it at the entrance or exit of a zone, for example – in order to be able to switch flexibly within the framework of the temperature profile. This means that customers can rely on the electrical power, especially in the lower temperatures or during holding processes.

"Now many are sobering to realize that the availability of hydrogen is still a long time coming. Something similar can happen if our customers rely completely on electrical energy."

Do you also have the right programs for electrically operated processes that can be used to read out the process data to make these processes even more efficient in the future?

Our expertise does not necessarily lie in the manufacturing process of our end customers. We cannot advise customers on how best to heat ceramics, for example, or what temperature profiles are best used to run a plating line. But we have good access to what concerns heat transport or the performance or controllability of our burners and can then evaluate where in this curve an electric heater can be sensibly installed. We draw on the ability of partners but also on technologies that are freely available on the market to integrate them into our control system. This allows us to offer our customers a holistic hybrid system with integrated control and to supply it completely from a sole source due to our wide range of products.

Of course, the variability of the system and the flexible controllability of it is particularly exciting. What is the main advantage for customers here?

The big advantage is that we know the strictly regulated area of gas-heated systems very well. We know how to deal with pre-flushing, for example. We know which safety measures need to be implemented and can professionally integrate the electric heating there. This means that the customer can rely on the fact that we have aspects such as service life, durability of the heating elements, but also the safety aspects concerned with combustion technology, fully in mind during development. As a result, we are now also much more flexible in controlling the furnace and consider the interaction between electric heating and gas heating.

What is the focus of your furnace control systems?

All measures for energy efficiency and CO_2 avoidance are based on an optimization problem. Imagine, for example, a heating system that can be heated electrically as well as operated by combustion heat. Parameters such as temperature requirements, CO_2 balance, energy costs, energy availability and much more are now new variables for consideration in production planning. The more immediate and autonomous the reaction to changes in these parameters, the "smarter" the furnace control must be. This means that instead of rigid control of the fuel-air mixture in a mechanical or pneumatic network, a fail-safe electronic control system is used. The aim is to digitally monitor and control the entire heating system. This includes commissioning, fault clearance and maintenance. To achieve this, we now finally have to say goodbye to the screwdriver, e. g., to adjust spring forces on pressure and mixture regulators.

In view of a very heterogeneous plant structure, it will probably not be an easy undertaking to get the digitisation of existing processes off the ground.

But that's precisely where digitalisation has an advantage. For our end customer, there is the possibility to react to the wishes of his customer, where the focus is currently on production. For some customers, reducing the CO_2 footprint in the product is the primary goal. For others, fast production may be necessary or a corresponding tonnage capacity of the plant. In addition, external parameters must be considered. These include energy prices, the availability of green electricity, for example, contracts with grid operators, the stockpiling of hydrogen that may have been produced in-house or even temperature storage systems. Putting together a best mix of these conditions, the external and the internal, is the task of our control system.

Which of these aspects are you currently focusing on primarily?
We are now taking up the external aspects more. The system is to react more quickly to falling electricity prices, for example, and then switch to electric heating. Our control software for burners has so far been designed very specifically for gas burners. In the future, we must be able to switch this heating element on or off there. This is a cascaded control system that must be organized accordingly right through to the customer's production planning. Especially when we look at the already mentioned area of mixtures, it is imperative for our customers to be able to react to the change in the energy content in the fuel. A simple position or pressure-controlled gas-air mixture control is no longer sufficient. So, we rely on the electronic network.

So pure conventional control is no longer sufficient?
All that goes on at the top of the control system is fine, but it quickly ends if you still must use a screwdriver to adjust spring pressures for diaphragms at the level of the mixture control. This means that we need proper sensors not only to secure inflows to the burner, but also to measure them continuously to react to changes. We need to record information about the fuel content of the fuel gas in question and then translate it into control signals for flaps and valves. Only when this sensor basis is implemented, I will be able to intervene automatically in the future.

What is the significance of the digital twin in this context?
Digital solutions are the basis for using software and AI solutions, such as machine learning, mathematical optimization and the use of a digital twin, to operate the heating system in a predictive, optimal and safe manner and to integrate it into higher-level production planning and process control. The collected data can then provide information for preventive maintenance or be used to cut potential failure risks, which in turn can then be input variables for the planned use of the furnace. If we want to control with foresight, the Digital Twin is recommended as a possible technical solution to be able to react flexibly to changes in mixture control or production planning via simulation.

What aspects are currently most exciting for customers in the decision-making process? The improvement of the product or the production speed? CO_2 or cost savings?
Our experience at this point is that our customers react very differently. If we manage to show a significant reduction in CO_2 emissions in the balance of the product, the customer is happy to pay a little more for it. The greatest difficulties continue to be caused by the uncertainty of how high the energy costs or the CO_2 price will be. What will be the impact of taxation or subsidies? Also exciting in this context: If we can approach best stoichiometric combustion and accordingly ensure through digital monitoring that customers with a lower air surplus drive an oxygen value that is 2 or 3 percentage points lower, this can scale up to 10 % in energy savings.

Can you explain that in more detail?
We call stoichiometric combustion the state when we have exactly as much oxygen in the fuel-air mixture for each gas molecule as is necessary for the reaction. In this case, there is neither a mixture that is too lean nor too rich.

Why is that important?
The overly rich mixture is known to pose safety risks due to carbon monoxide emissions in carbon-containing fuels or residual hydrogen in H_2 combustion. To avoid this, most plants are operated in an over stoichiometric range. They have more oxygen in their fuel-air mixture than they would need for combustion. With this increased air surplus, they introduce a large amount of nitrogen into the furnace and thus increase the loss-making exhaust gas mass flow. The reactant oxygen is abundantly available; these are energy losses that can already be reduced today with high-precision control of the mixture.

And this control cannot be implemented with a screwdriver, which is the great advantage of digital control?
Yes, because you must be able to react at once to fluctuating fuel gas properties, for example. If I currently have a gas and air pressure-controlled furnace, I can't react automatically because the pressure doesn't tell me anything about the changing energy content of the fuel gas, for example.

Wilhelm Homann graduated from Münster University of Applied Sciences in 1997 with a degree in Electrical Engineering - Telecommunications. From 1998 to 2014, he worked for various companies in the mobile communications sector. After working for Siemens and Vodafone, he moved to Elster GmbH (Kromschröder) in 2014 and took over the management of the Technical Training department. With the takeover of Elster GmbH by the American Fortune 500 company Honeywell, Homann took over the management of the project management office for the new Honeywell Thermal Solutions business unit. Since 2020, he has been responsible for global research and development at Honeywell Thermal Solutions as Chief Technology Officer.

What would the ideal fuel gas of the future look like? 100 % hydrogen or 100 % natural gas or is there an ideal mixing ratio?
The ideal fuel gas can be any mixture, but it is an advantage if the mixture remains constant and does not change over time. However, if this cannot be avoided, a variable fuel mixture can be controlled, but the effort is considerable. From the perspective of the decarbonization of fuel gases, significant effects on the CO_2 content in the exhaust gas only occur at remarkably high concentrations of hydrogen – from about 75-80 %. Nevertheless, some customers have concerns about possible disadvantages due to high hydrogen concentrations in their process. Many users still want to protect themselves with the option of other mixtures. We must always remember that temperature is a means to an end for our customers. At the end of the day, behind the heat treatment is a product whose requirements go beyond the CO_2 footprint or the temperature beha-vior of the furnace. The quality of the product and the impact on the oven itself must not be neglected.

"All that goes on at the top of the control system is fine, but it quickly ends if you still must use a screwdriver to adjust spring pressures for diaphragms at the level of the mixture control."

When we look at digitalisation, the topic naturally goes beyond the flexibility aspect of hybrid heating. How do you use digital processes during commissioning or troubleshooting?
Unfortunately, we find repeatedly that some operators are literally flying "blind", which can limit not only the efficiency but also the safe operation of the thermal processing equipment. We see repeatedly systems in which pressure values have been adjusted for whatever reason. In the worst case, it can happen, for example, that the release pressure on the blow-off valve has been set incorrectly and natural gas gradually escapes over the roof. We have seen customers who did not even notice this. Therefore, the first step of our Sustainability & Energy Audit is to review the status with the customer. The system is then supported, incorrect settings are corrected, defective components are replaced to achieve safe and best operation of the existing system. With our cloud solution "Thermal-IQ", which can record all important device and sensor data, we enable our customers to gain constant transparency about productivity, energy consumption, CO_2 emissions and the condition of the heating system.

The next step will be the modernization.
Yes, exactly, the 3rd phase is about a possible modernization of the plant. For example, the replacement of cold air burners with recuperative or regenerative burner solutions or the expansion of the control range in low-load operation. Here we find repeatedly: Even in the modernization of the natural gas-heated stock, there is still great optimization potential for CO_2 reduction, which could be realized with modern technology. Once the system has been optimized, digital processes can automatically monitor critical parameters and corresponding target values. For me, this is also a major reason to push ahead with digitalisation, especially in view of the shortage of skilled workers.

Which brings us back to the topic of flexible energy supply. Different gases, arbitrary mixing ratios, connection of heat storage systems combined with electrical energy pose completely new control requirements. How do you react to this?
This is the biggest change we are currently experiencing in the market. If we think about the last 35 years, we used to be able to rely on 80-90 % of our customers to burn natural gas. So, our products were primarily related to natural gas, and we knew that we would reach a large part of our customer base. Now we must be very flexible. We must have diversified offers, and above all we must remain open to technology, because many offers, contracts of suppliers or even changes in energy supply will only now develop.

How can digitisation help here?
Well, as I mentioned, we are already able to measure media and energy flows and use them to determine or calculate emissions. It becomes interesting when it comes to recording these values in real time or forecasting them in advance and selecting the best use under the economic and ecological boundary conditions between the possible variables and processes. This requires digitization and automation. It is our task to offer this technology at competitive conditions and with the required safety.

In summary: If you want to run your plant at the best in an energy-efficient and economical way, there is no way around complete digitization of your processes?
You can only react to what you have recognized. And accordingly, the heating system or the complete furnace must be made more transparent in the process. This is only possible with digitalisation.

Thank you very much for the interview, Mr. Homann.