Global warming is progressing. Phoenix Contact provides cross-sector support to reduce emissions.
(Image source: Triff@shutterstock.com)

The open PLCnext Technology ecosystem in thermal processing technology

Fewer emissions with a higher overall equipment effectiveness

Learn more about

- Companies around the world are setting goals to achieve net-zero emissions and improve sustainability
- As a part of the energy transition, energy-intensive industries must find new ways to convert existing thermal processes to low-carbon or carbon-free processes
- With PLCnext Technology from Phoenix Contact, including the MLnext software solution, these companies can take a proactive approach to address this challenge

Introduction

The number of countries committing to achieving net-zero emissions in the coming decades continues to rise. The world can still limit the global temperature rise to 1.5°C. With the PLCnext Technology ecosystem and the MLnext software solution, Phoenix Contact is – among other things – helping to reduce emissions.

The EU is aiming to be climate-neutral – that is, to have an economy with net-zero greenhouse gas emissions – by 2025. This goal, which is at the heart of the European Green Deal, is in line with the EU's commitment to global climate action within the framework of the 2015 Paris Agreement. The transition to a climate-neutral society is proving to be both an urgent challenge and an opportunity to create a better future for everybody. All parts of society and economic sectors will play a role – from energy, industry, and mobility to buildings, agriculture, and forestry.

Conversion of existing thermal processes along the entire production chain

Successfully implementing long-term and sustainable climate strategies for industrial facilities requires a comprehensive approach. It involves all areas – from the raw materials warehouse and the batch house, through individual production and the packaging and warehouse area, all the way to the building itself. If this is not done, any attempts to reduce greenhouse gases and comply with directives regarding a company's environmental and materiality analysis will fail.

As a part of the energy transition, energy-intensive industries such as steel, glass, ceramics, and non-ferrous metallurgy face the challenge of converting their existing thermal processes along the entire production chain to low-carbon or carbon-free processes. Due to the geopolitical changes driven by climate catastrophes, action must be taken immediately.

This requires minimally invasive, open technologies that generate sustainable infrastructures and ensure functional safety. At the same time, security-certified, open digitalization and automation platforms must be made available. For the energy transition to succeed, the heating systems, specifically, must be designed to operate with electricity from renewable energies and other future low-carbon energy sources. This must be done without sacrificing energy and system availability, product quality, and cost-effectiveness. It is also necessary to rethink conventional heating concepts concerning low-carbon or carbon-free process heat generation (Figure 1). ■

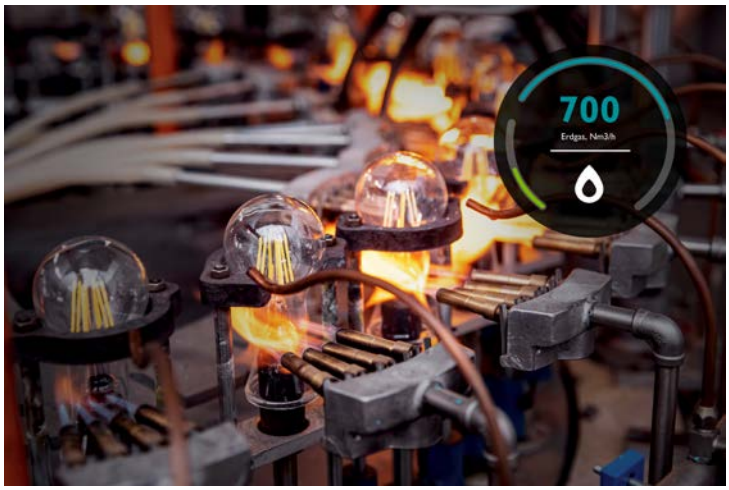

Figure 1: The Data Collection Box from Phoenix Contact makes it easy to collect data in existing systems without jeopardizing the CE marking of the machines.

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Need for change through the use of hydrogen

As a new source of gas infrastructure, the power-to-gas (PtG) principle is of great importance in modern gas and hydrogen networks. PtG refers to converting electrical energy into chemical energy (gas) through water electrolysis. The hydrogen gas produced in this process can be used for both energy and material purposes, such as in industry and its thermal processes. This results in new requirements for industrial furnaces.

Hydrogen and its mixtures also reduce the air requirement, a change in the calorific value, higher combustion speeds, higher flame temperatures, and an increase in nitrogen oxides (NO) and nitrogen oxides (NO2). This primarily affects the "machine." Depending on the thermal process, this machine could be the melting tank, the furnace or boiler, the supply technology (piping, stations, valves, sensors, mechanical actuators, storage, and control elements), the burner, and, above all, the thermal process's controller and automation system. ■

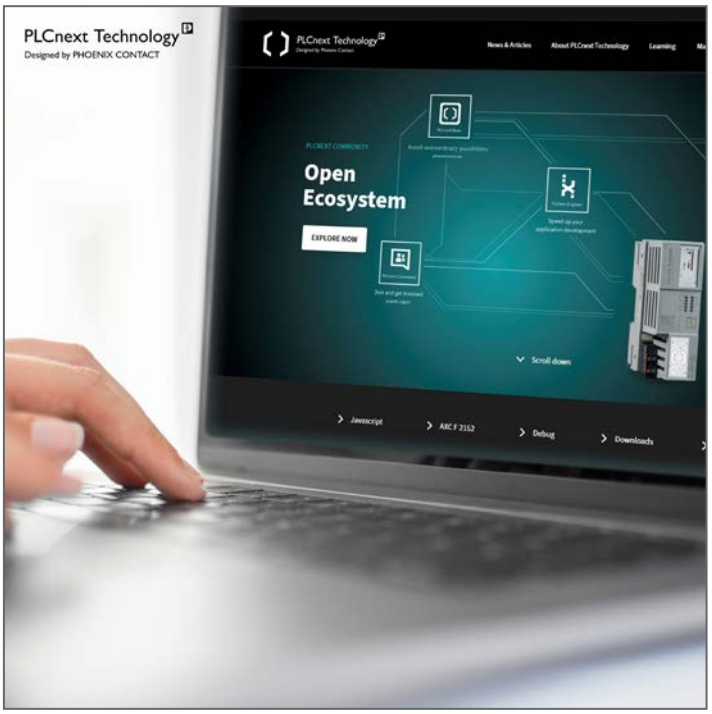

Figure 2: Open ecosystems have a decisive advantage when switching to new combustion processes.

Requirements on the thermal processing technology

The thermal processes must be integrated into the existing systems in a minimally invasive and highly efficient manner. In the past, when it came to digitalization, the stakeholders usually thought of DCS, ERP, and MES systems, sensors, and factory machinery and equipment. The conventional, in part still mechanical equipment responsible for the fuel-air ratio, reignition, ignition temperature limits, valve tightness, top furnace temperatures, flame monitoring, minimum fuel consumption, and maximum flow rates and pressures were either overlooked or forgotten in bulky, decentral systems.

In the future, thermal processing technology will have to meet the following requirements:

- Mixed firing systems, control processes, exhaust gas recirculation, fuel-line flushing processes, and many more processes must be operated on open, holistic ecosystems/platforms (Figure 2).
- The subsequent and effective integration of sensors for combustion and exhaust gas analysis and new generations of sensors are scalable regardless of the communication protocol.
- The functional safety of the furnace, melting tank, or boiler meets the cybersecurity requirements IEC 62443 and NIS 2.0.
- The operator can introduce machine learning (ML) and industrial IoT (IIoT) across the board for condition-based monitoring and process optimization in their systems, both off- and on-premise.
- The agility can be increased through low- or no-code applications for the simple, individual, and scalable adaptation to changing fuel lines by using standardized configuration platforms, such as the open-source Grafana tool. ■

Machine learning for fuel and process optimization

Early detection of unusual behavior patterns can help prevent malfunctions and changes in the combustion process. Examples include gas fluctuations, the adjustment of load curves, and the effective control of actuators and butterfly valves. PLCnext Technology from Phoenix Contact, including the MLnext software solution, is ideal for this purpose. This proactive approach also features further potential economic and sustainability benefits:

- Higher overall equipment effectiveness (OEE) in thermal processing machines, such as an IS machine in the glass industry, can reduce the number of rejects
- Effective and smart operation of fuel-air ratios and electric heating systems by saving on expensive external hardware, such as automatic devices, tightness control systems, and temperature controllers
- Intelligent and condition-based cross-factory monitoring of the process with the integration of safety-relevant sensor technology for measuring emissions, the oven, chimney draught, and oven chamber pressure, the classic safety of machinery, and various temperatures and pressures.

The MLnext machine learning system is one of many apps available via the ecosystem's online PLCnext Store marketplace. Among other things, it supports experts in controlling malfunctions in industrial furnaces and proactively improving emissions. For process optimization, MLnext just needs a controller or an edge device with container visualization, such as the Docker-enabled PLCnext Control.

Figure 3: As an open ecosystem, PLCnext Technology combines functional and data security in one platform.

To ensure that these methods can be easily and cost-effectively integrated into thermal processing machines and systems installed worldwide at a later date, Phoenix Contact has developed the Digital Factory now initiative, which follows the guiding principle of the All Electric Society. This guiding principle describes a world in which energy from renewable resources is available in sufficient quantities everywhere and is affordable.

To make the All Electric Society a reality, the Digital Factory features scalable, standardized, and both functionally and data-secure automation solutions based on the open PLCnext Technology ecosystem. These cover network and communication technology, network segmentation, data acquisition, and data evaluation with IIoT and ML concepts. The solutions enable machine and system manufacturers, system integrators, and operators to implement products and systems tailored to the respective application. ■

Certification of functional and data security

In this context, the OT Security certification of the PLCnext Control product family by TÜV Süd in accordance with IEC 62443-4-2 in conjunction with the existing safety certification sets new standards. IEC 62443 is the leading international standard for OT security. The functional safety of the controllers complies with the IEC 61508, ISO 13849, and IEC 62061 safety standards. To implement successful automation solutions, both aspects must be linked together in the future. Due to the requirement for protection against manipulation and the inclusion of remote access to machines and systems, the focus is increasingly on the aspect of OT security in the upcoming Machinery Regulation. The certified PLCnext Control product family already meets these requirements (Figure 3). ■

Signal connection through intelligent isolators

Practice shows that users must adapt the existing fuel-air ratio to new fuels. In the ongoing process, they use a parallel sensor system that does not impair operation, the functional and process reliability, or, alternatively, the DCS or MES system. There is also a growing need for artificial intelligence (AI) to increase efficiency. At the same time, the existing infrastructures must be converted into a network segmented in accordance with IEC 62443 to prevent data collisions or illegal remote access.

Both can be achieved in parallel. For this purpose, the field signals are connected to a PLCnext Control or a PLCnext Technology edge device using the compact and safe signal isolators from the Mini Analog Pro product family in combination with the freely available “PLCnext IIoT Framework” app.

Phoenix Contact also provides turnkey, freely configurable thermal processing control cabinets. The signals can be directly processed, normalized, and standardized in a safety-oriented manner and sent bidirectionally in real time via the free framework and without further data silos to the corresponding devices on the IT/cloud, ERP/MES, or DCS side. This saves the user space, hardware, and – above all – engineering time. Where necessary, the MLnext app can virtualize the information from the various media, sensors, actuators, fuels, and systems on-premise or in the downstream server of a cloud, such as Profi-cloud.io from Phoenix Contact (Figure 4). ■

Figure 4: Mini Analog Pro: rated in accordance with SIL IEC 61508 and PL DIN EN ISO 13849, EX i-tested and made intelligent using the PLCnext IIoT framework.

SOLUTIONS FOR SUSTAINABLE COMBUSTION TECHNOLOGY

For industrial thermal processing technology, Phoenix Contact offers ready-to-use, secure, and scalable solutions that include certified hardware, software, on-premise, and cloud applications:

Automation and digitalization based on the PLCnext IIoT framework for standardizing data

- From MLnext for predictive and preventive process heating optimization
- Standardized, open, and ready-to-use Smart Production automation library of the Proficloud.io cloud system for analyzing and reporting the media, consumption, and machines, among other things
- Certification in accordance with IEC 61508 and IEC 62443.

Compact, 6-mm narrow signal conditioners and amplifiers with connectivity in the PLCnext IIoT framework

- For use in the Ex i area with functional safety up to SIL 3/PL e.

Services for industrial security (IEC 62443)

- CE marking
- Occupational safety and process reliability

Conclusion

Thermal processing technology is undergoing a rapid transition. Automation manufacturers must enable their customers to meet the standards of modern environmental, safety, security, and IIoT applications. For this reason, Phoenix Contact provides an ecosystem for controllers, I/O systems, and edge software applications. For over 100 years, the portfolio has covered almost all user requirements in the control cabinet and field installation sector – from terminal blocks to smart services.

For more information, visit:

www.plcnext-community.net

www.phoenixcontact.com/digitalfactorynow

www.Proficloud.io

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About Phoenix Contact

Phoenix Contact is a global market leader based in Germany. Since 1923, Phoenix Contact has created products to connect, distribute, and control power and data flows. Our products are found in nearly all industrial settings, but we have a strong focus on the energy, infrastructure, process, factory automation, and e-mobility markets. Sustainability and responsibility guide every action we take, and we're proud to work with our customers to empower a smart and sustainable world for future generations. Our global network includes 22,000 employees in 100+ countries. Phoenix Contact USA has headquarters near Harrisburg, Pa., and employs more than 1,100 people across the U.S.

For more information about Phoenix Contact or its products, visit **www.phoenixcontact.com**, call technical service at **800-322-3225**, or email **info@phoenixcontact.com**.