SISTEM TEKNIK ISSUE
JANUARY - JUNE 2026 • ISSUE 13

INDUSTRIAL FURNACES

TECHNOLOGY NEWS



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FROM OUR BOARD CHAIRMAN: ON R&D AND INNOVATION

Dear Valued Readers,

It is a great pleasure to meet you once again through the 13th issue of our magazine. As we leave behind a period marked by global uncertainties, transformation, and intense competition, we are witnessing that the dynamics shaping the future of industry are accelerating more than ever before. Digitalization, sustainability, and efficiency are no longer optional—they have become fundamental requirements at the very core of how we conduct our business.

Despite these challenging conditions, as Sistem Teknik Group, we have successfully completed the year with strong performance. I am pleased to state that 2025 has been a more robust year compared to the previous one, thanks to the growth we achieved in both our total revenue and per capita productivity. Behind this success lies our expanding product portfolio—driven by our commitment to continuous improvement—as well as our increasing presence across diverse industries.

In particular, receiving high-volume orders from strategic regions such as the United States and Southeast Asia, even in areas where our marketing activities are limited, is a strong indication of the solid references we hold in our niche products and our international credibility.

At Sistem Teknik Group, we act not only as followers of change, but as pioneers shaping it. Recently, we have prioritized offering more sustainable and competitive solutions to our customers by focusing on energy efficiency, reducing carbon footprint, and process optimization.

We have declared 2026 as the “Year of Quality” at Sistem Teknik. All units contributing to our quality perception are taking action to further improve themselves. At the same time, we continue our digital transformation journey with determination. Through our investments in infrastructure that strengthen data-driven decision-making processes, we are advancing our engineering capabilities toward a more integrated, flexible, and agile structure.

In addition to our operational development, we have also carried out a significant transformation in the design of our products. The new generation vacuum furnaces featured on the cover of this issue are a concrete reflection of our modern engineering approach and design vision.

Furthermore, within the scope of our strategic partnership with Aichelin, we have established a joint venture structure and now offer our vacuum furnaces to the global market under the Aichelin ST Vacuum brand. This important step has strengthened our position in the European market and made us a more assertive player in the field of vacuum furnaces.

As part of our group restructuring, we have brought together our companies; Sistem Teknik Industrial Furnaces, Sarvion, Sistem Teknik Heat Engineering, and Vesta TP; under a single roof, creating a stronger, more integrated, and more sustainable organizational structure.

At the core of all these efforts lies an unwavering value: customer satisfaction and trust. Delivering fast and accurate solutions to our business partners’ needs and strengthening our long-term collaborations will remain our top priority.

In the period ahead, we will continue to closely follow global developments and remain committed to producing innovative, sustainable, and high value-added projects.

I would like to extend my sincere thanks to all our employees, business partners, and stakeholders who contribute to this journey and place their trust in us.

Sincerely,



Mehmet Özdeşlik
Sistem Teknik A.Ş.
Group Chairman of the Board
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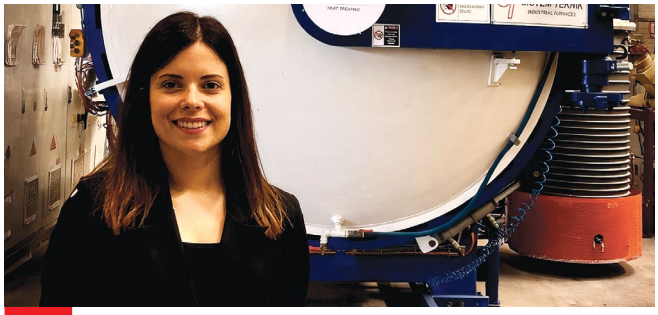

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INDUSTRIAL SISTEM TEKNIK ISSUE
FURNACES
TECHNOLOGY NEWS

Grand Holder: **Mehmet Özdeşlik** - Editorial Office Manager: **Beste Özdeşlik** - Issue Time: **Once Every Four Months** - Issue Name: **INDUSTRIAL FURNACES TECHNOLOGY NEWS** - Publishing Place: **Dinamik Basım Matbaacılık Promosyon İnş. Tur. San. ve Tic. Ltd. Şti.** - Osman Yılmaz, Kızılay Cd. No:49/A, 41400 Gebze/Kocaeli - Managament Center: **Sistem Teknik Sanayi Fırınları A.Ş. TOSB – Otomotiv Yan Sanayi İhtisas OSB 1. Cad. 15 Yol No: 1 – 41420 Çayırova / Kocaeli / TURKIYE Tel: +90 262 658 29 14 Faks: +90 262 658 18 19** - Editorial Design Team: **Asil İşler** - Mail: **fatih.mutlu@asilisler.com**

THE LARGEST VACUUM HEAT TREATMENT FURNACE IN TURKIYE COMMISSIONED

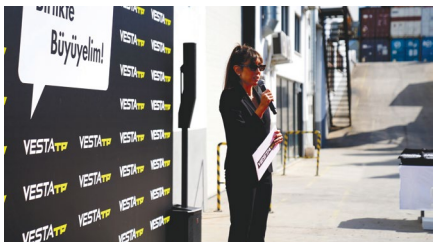
Vesta TP has ushered in a new era in the heat treatment industry, bringing a strategically significant facility to the Turkish manufacturing sector.

The opening ceremony, held on October 2, 2025, at the TOSB Organized Industrial Zone, was attended by Çayırova District Governor Ahmet Önal, President of the Gebze Chamber of Commerce Abdurrahman Aslantaş, UKUB President Şahan Eçin, representatives of MİSAD, and Sistem Teknik Board Member Levent Ganiyusufoğlu.

Vesta TP was established to address a critical gap in the heat treatment of large molds, particularly those required in the electric vehicle and aluminum extrusion industries. At the facility, molds weighing up to 3,500 kg and measuring up to 1600 × 2000 × 1000 mm can be processed to the highest standards. With AMS 2750 compliance at Class II uniformity level, 10 bar absolute quench pressure, and a maximum operating temperature of 1300°C, the facility meets the highest quality expectations in the industry. In addition, its laboratory, analysis, and R&D infrastructure support not only production but also the development of knowledge and technology.

During the opening speeches, the spirit of solidarity within the industry was emphasized. Company representatives highlighted the significance of the investment with the message: “We are confident that together we will continue to add value to the heat treatment industry. Wishing success on this journey.”

















MAKFED MACHINERY SUMMIT

Representatives of the machinery industry came together at the Machinery Summit on November 26, 2025, under the motto “New Future – Are You the Competitor?” The summit was honored by the presence of Minister of Industry and Technology Mehmet Fatih Kacır. The opening speeches were delivered by MAKFED (Turkish Machinery Federation) President Adnan Dalgakıran, TİM (Turkish Exporters Assembly) President Mustafa Gültepe, Director General of Trade Research and Risk Assessment at the Ministry of Trade Raif Can, and Deputy President of the Presidential Investment and Finance Office Zeynel Kılınç.

At the summit, our Board Member and EFSİAD President Beste Özdeşlik participated as a panelist in the session titled “From Policy to Performance: The Future Roadmap of the Turkish Machinery Industry,” moderated by MAKFED Secretary General Zühtü Bakır.





toRRvaC
TORRVAC MÜHENDİSLİK YÜKSEK VAKUM SİS. SAN. VE DIŞ TİC. A.Ş.

A vacuum pump is a highly important piece of equipment used across all sectors. Using the right vacuum pump system in your factory or production facility can save you a great deal of additional costs.

At toRRvaC, our approach is to first identify the issues and requirements, find the vacuum pump and system best suited to our customer's needs, and then integrate the system into your production facility.

The critical point here is to identify the correct vacuum pump system tailored to your needs.

toRRvaC is the authorised sales and service centre for brands such as Agilent, Pvr and Ulvac throughout Turkey.
With a very high level of expertise in maintenance, repair and service, toRRvaC provides a "full-service approach" to its
customers. Some of the services we offer include:

- Vacuum pump maintenance, repair and installation
- Vacuum system design
- Equipment supply
- Leak detection using a helium detector
- Creating process recipes through gas analysis and ensuring system control
- Maintenance, repair and calibration of helium detectors

We also provide service support for world-renowned brands such as Edwards, Leybold, Ulvac, Pfeiffer, Busch and Inficon.
As one of Turkey's largest companies, Sistem Teknik ensures that the vacuum
pumps and helium detectors used in the production facilities of firms such as Tüpraş, THY, Tubitak, Roketsan, Algida, Arçelik, Schneider, Best Transformer, Valeo and Vastaş Vana are backed by toRRvaC.



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ULVAC

Since its establishment in 1952, ULVAC (ULtimate in VACuum) has dedicated itself to the advancement of vacuum processing technology. ULVAC is an international company that designs, manufactures and markets equipment and materials for the industrial applications of vacuum techniques and technology. ULVAC's product range includes dry-type vacuum pumps, mechanical booster pumps, oil-diffusion pumps, mechanical booster pumps, valves, gas analysers, leak detectors and surface profile measurement systems.

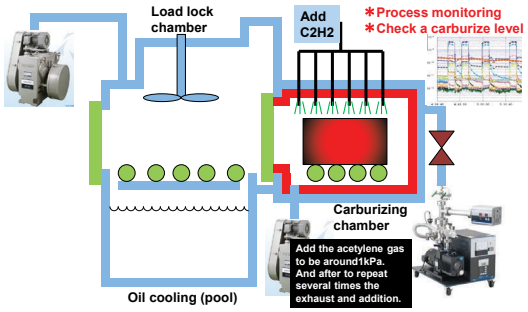
In industries with explosive and fire hazards, it is used to detect flammable gases as part of the NKPR system.
Qulee Basic Gas Monitor

"Qulee" is ULVAC's latest model for residual gas analysis. Feedback from plant engineers across various production lines has been incorporated into the new product design, resulting in significant improvements. The most suitable solution has been achieved for system control of vacuum evaporators and various types of vacuum furnaces.

Vacuum Carburising Furnace Qulee Advantages

- System leak control is ensured.
- Oxygen concentration during carburisation can be managed.
- The surface brightness of products can be maintained.
- Carburisation time is reduced and optimised.
- The number of carburisation cycles can be reduced.
- Foreign substances remaining in the system can be easily managed.

Vacuum Carburization Proces





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HEAT TREATMENT PROCESSES REQUIRE HIGH EQUIPMENT CONTINUITY AND PERFORMANCE STABILITY.

Interviewee: Gökhan Kelebek, Stabilizer Bar Production Manager / Çemtaş Çelik Makine Sanayi ve Tic. A.Ş.

First of all, we would like to introduce you to our readers. Could you briefly tell us about your company and your role within the company?

I am a mechanical engineer and have been working at Çemtaş Çelik Makine Sanayi ve Ticaret A.Ş. since 2009. Our company's main business activity is the production of specialty steel, and in addition, we manufacture stabilizer bars for the automotive industry.

I currently serve as Stabilizer Bar Production Manager. My responsibilities include planning the stabilizer bar production processes, process management, ensuring quality continuity, and increasing operational efficiency. Another important part of my role is the effective and sustainable implementation of critical technologies used in production.

Which products and services of Sistem Teknik do you utilize in your industry?

Heat treatment plays a critical role in our stabilizer bar production processes. In this context, we use heat treatment furnaces supplied by Sistem Teknik in our production lines.

These systems are particularly used in the annealing, oil quenching, and tempering processes that determine the mechanical properties of stabilizer bars. They help us achieve the targeted strength and flexibility values in a reliable and repeatable manner. In addition to the equipment itself, we also benefit from Sistem Teknik's support in commissioning, process optimization, and technical assistance.

What kind of processes do you carry out in the furnaces used in your production lines?

In the heat treatment furnaces within our production line, we perform critical processes aimed at providing the final mechanical properties of stabilizer bars. In this scope, we apply quenching and tempering processes after hot forming.

Through the quenching process, the required hardness and strength are achieved, while tempering ensures the desired balance of toughness and flexibility. As a result, both the fatigue resistance and the elastic performance characteristics required during operation are secured.

These processes are carried out in a controlled and repeatable manner thanks to the Sistem Teknik heat treatment furnaces we use, which is of great importance for maintaining consistent product performance.



Gökhan Kelebek
Çemtaş Çelik Makine Sanayi ve Tic. A.Ş.
Stabilizer Bar Production Manager

What are the main advantages of Sistem Teknik furnaces in operation?
The most important advantage of the Sistem Teknik furnaces we use in our production processes is their ability to provide a high level of process stability and repeatability.

In stabilizer bar production, heat treatment is a critical stage that directly affects product performance. At this point, the furnaces':

- Homogeneous heat distribution
- Precise temperature control
- Reliable management of process parameters

play a significant role in achieving the targeted mechanical properties.

In addition, factors such as:

- Process reliability
- Operational continuity
- Energy efficiency

also contribute to overall production efficiency.

Could you describe the contribution of the maintenance, repair, and service support provided by Sistem Teknik to your furnaces and processes?
In heat treatment processes, equipment continuity and performance stability are extremely important. In this respect, the maintenance, repair, and service support provided by Sistem Teknik significantly contribute to the reliable operation of our furnaces.

Through periodic maintenance practices, a structure supporting process continuity is established, while rapid response to potential failures helps prevent production losses. At the same time, inspections and technical improvements contribute to maintaining long-term furnace performance and ensuring stable process parameters.

This support creates value not only in terms of equipment health but also in production quality, operational efficiency, and the sustainability of planned production flow.

How would you evaluate the renovation service carried out by Sistem Teknik, which enhanced the efficiency and capacity of your existing furnace?
The renovation work performed by Sistem Teknik on our existing furnace was highly valuable in aligning the equipment's performance with today's production requirements.

Thanks to the improvements made:

- Process stability was enhanced
- A more energy-efficient structure was achieved

This contributed to production continuity and enabled our heat treatment processes to be carried out in a more controlled and repeatable manner.



Could you evaluate your cooperation with Sistem Teknik and the overall progress of the services you have received?
We consider our cooperation with Sistem Teknik not merely as equipment supply, but as a process-oriented technical partnership.

Their integrated approach—from project phase to commissioning, from maintenance and retrofit activities to technical consultancy—has contributed to the more controlled and sustainable management of our heat treatment processes.

In particular, rapid responses to our needs, solution-oriented technical approach, and close monitoring of field applications provide a significant advantage in ensuring uninterrupted production processes.

Finally, could you share with our readers the future goals and plans of Çemtaş?
As Çemtaş Çelik Makine Sanayi ve Ticaret A.Ş., our main objective is to maintain our strong position in specialty steel production—our core business—while continuing to grow in high value-added product segments.

In this direction, in stabilizer bar production our priority focus areas include:

- Improving process excellence
- Further enhancing quality continuity
- Strengthening our efficiency-oriented production infrastructure

At the same time, by closely following the transformation in the automotive industry, we aim to increase our production capabilities in line with changing customer expectations.

Our future plans are shaped around strengthening our technological infrastructure and implementing investments that will support our competitiveness on a global scale, within the framework of a sustainable production approach.



HEAT TREATMENT SOLUTIONS IN THE DEFENSE INDUSTRY

Okan Kuloğlu - Sistem Teknik, Deputy Sales Manager

Success in the defense industry is not determined solely by the right design, material, or manufacturing method. One of the most critical factors that ultimately defines performance is heat treatment processes, which have a direct impact on product reliability. Across a wide range of applications—from armored land vehicles to aerospace components, from missile and weapon systems to precision mechanical sub-parts—achieving the desired mechanical and metallurgical properties is only possible through a controlled heat treatment infrastructure.



Heat treatment is no longer just a manufacturing step within the defense supply chain; it is a defining factor for quality, reliability, and performance. The “special process” approach in the aerospace and defense ecosystem requires not only proper execution of processes but also their validation, documentation, and auditability. In this context, Nadcap accreditation serves as an important reference point; SAE AMS2750 is one of the fundamental standards that defines pyrometry requirements (system accuracy, sensor classes, and verification approach) for heat treatment equipment. In modern facilities, TUS and SAT tests, vacuum leak checks, periodic verifications, and calibrations are not “additional services” but

integral parts of process assurance. This ensures that customers are not merely purchasing equipment, but a production infrastructure where risks are minimized and audit readiness is built in.

In defense applications, the expected outcome of heat treatment is not simply "hardness." The objective is a repeatable microstructure and dimensional stability, combined with high strength, fatigue performance, and surface integrity. Even minor deviations in temperature, weaknesses in atmosphere/vacuum control, or improper cooling profiles can directly affect component life and safety. Therefore, evaluating equipment and processes requires a holistic approach, considering temperature uniformity, measurement chain accuracy, recipe management, and cycle data traceability.

Typical Process Requirements in Defense Applications

Common processes in defense projects include hardening–tempering, stress relieving, solution treatment–aging, carburizing/nitriding, brazing, and increasingly, composite curing / pressure-assisted consolidation. As part geometry becomes more complex and tolerances become tighter, the process window narrows, making control capability more critical. Therefore, process and equipment selection must consider material class and target mechanical properties alongside part size/geometry, surface integrity requirements, distortion risk, production volume, and traceability needs.

Vacuum Heat Treatment: Clean Processing and High Control

In advanced engineering materials (titanium, nickel-based alloys, highly alloyed steels, and precision components), preventing surface oxidation and decarburization is crucial. Heat treatment carried out in vacuum environments offers cleaner surfaces, more stable temperature control, and more reliable metallurgical results. Technically, success is not only about reaching the target temperature, but also managing load configuration, fixturing, temperature uniformity, and quenching characteristics together. Especially for tight-tolerance parts, distortion control is directly linked to both equipment design and process engineering.

Among vacuum processes, advanced solutions such as Low Pressure Carburizing (LPC) are becoming increasingly prominent. Cleaner environments, improved case depth control, and more uniform results in complex geometries provide significant advantages for high-performance defense components.

Composite Curing and Pressure-Assisted Processing

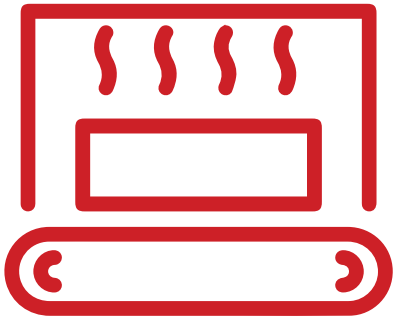
In defense manufacturing, composite structures are becoming increasingly prevalent alongside metallic parts. Advantages such as lightweight construction, high strength-to-weight ratio, corrosion resistance, and design flexibility are driving this trend. Consequently, composite curing ovens and pressure-assisted processing systems have become critical investment areas.

In composite manufacturing, final quality depends not only on reaching target temperatures but on managing the curing cycle (ramp–dwell–cool) in a controlled and repeatable manner. Particularly in large panels or thick sections, internal temperature gradients can affect resin flow, gel time, and cure progression—leading to voids, delamination risks, deviations in mechanical properties, and dimensional instability. Therefore, temperature uniformity, precise sensing, full-cycle data recording/traceability, and process repeatability are essential requirements.

Pressure-assisted systems help make the process window more robust and reliable for certain resin systems and specific production scenarios. The effect of pressure is valuable in terms of controlling entrapped gases/voids within the resin, achieving better consolidation, and improving surface quality.

Application-Specific Equipment and Custom Line Approach

Due to the wide variation in part sizes, geometries, tolerances, and production volumes in defense manufacturing, a one-size-fits-all furnace approach is rarely sufficient. Investment decisions should not be based solely on parameters such as maximum temperature or volume, but should also consider part families, process requirements, distortion risks, cycle times, and traceability needs. This enables efficient and controlled management of both low-volume project-based production and high-volume serial components within the same facility.



Chamber-type or car-bottom furnaces for large and heavy parts offer advantages in terms of loading/unloading ergonomics and heat transfer in high-mass applications.



Chamber-type or car-bottom furnaces are advantageous for large and heavy parts in terms of loading ergonomics and heat transfer. For long, vertically oriented parts, bell-type or pit furnaces provide more stable results, especially where deformation is critical. For high-volume continuous production, conveyor-based systems and dedicated process lines reduce cycle times and ensure standardized quality.

In defense applications, processes are rarely limited to a single furnace cycle; they form a chain of steps including pre-treatment, heating, soaking, cooling, cleaning/protection, and inspection. Therefore, a "custom line approach" is not merely about arranging equipment side by side, but about engineering the entire process flow. Elements such as proper fixturing, standardized part flow, recipe locking, user authorization, batch reporting, and inspection gates directly determine line performance.

In summary, defense manufacturers require not just off-the-shelf equipment but application-specific, verifiable, and auditable systems. This positions equipment suppliers not only as manufacturers but as solution partners with capabilities in process design, commissioning, validation, and sustainable operation.

Standards Compliance and Verification Chain

In defense projects, heat treatment infrastructure is evaluated not by equipment capacity alone, but by the ability to manage processes in a provable and controlled manner. TUS (Temperature Uniformity Survey) and SAT (System Accuracy Test), along with calibration of the measurement chain, vacuum/atmosphere condition checks, and batch-based data management, form the backbone of process assurance. This transforms production into a discipline that is not only correctly executed but also demonstrably repeatable and audit-ready.

Digitalization and Energy Efficiency

A key industry trend is the transition from operating furnaces to managing them through data. Recipe standardization, user authorization, alarm/fault history, cycle reporting, and trend analysis help detect deviations early, stabilize quality, and simplify multi-program operations. At the same time, energy efficiency and decarbonization are becoming increasingly decisive factors in new investments, driven by cycle optimization, reduced heat losses, and lower total cost of ownership.

Demilitarization: End-of-Life Management and Safe Disposal

In the defense industry, thermal processing is expanding beyond production to include demilitarization and safe disposal at the end of a product's lifecycle. End-of-life, non-compliant, or returned products must be managed in accordance with operational safety, regulatory compliance, environmental control, and traceability requirements. As a result, demilitarization facilities are becoming a critical area—not only in terms of disposal capacity but also process safety, monitoring infrastructure, and documentation discipline.

Sistem Teknik's Approach: Integrated Solutions

Within this entire framework, what the defense industry requires is not a single furnace, but integrated solutions tailored to specific applications—aligned with standards, supported by robust testing and service infrastructure, and capable of managing both metal and composite processes. Sistem Teknik offers a broad solution portfolio including heat treatment systems for defense, vacuum furnaces, composite curing ovens, pressure-assisted systems, chamber and pit furnaces, conveyor-based special process solutions, and demilitarization facilities for end-of-life management and safe disposal.

The goal of this approach is to provide not just equipment, but verifiable process assurance. TUS/SAT and vacuum leak testing, along with modernization and service capabilities, create critical value in terms of production continuity and auditable quality infrastructure.

In conclusion, heat treatment is one of the most critical and non-recoverable stages in defense manufacturing. The right microstructure, surface condition, process control, and data infrastructure form the foundation of competitiveness and reliability. Therefore, industrial furnace solutions developed for the defense sector should be viewed not merely as production investments, but as strategic investments in quality assurance, sustainable growth, and strategic capacity.



WE TOOK THE STAGE WITH TWO PRESENTATIONS AT ECHT 2025 IN PRAGUE

In 2025, we participated in the European Conference on Heat Treatment (ECHT 2025), held on June 4–6 in Prague, Czech Republic, representing Aichelin Vacuum GmbH with two presentations. Our European Sales Manager, Dominic Kraus, delivered a presentation titled “Hydrogen in High-Pressure Gas Quenching,” while our Board Member Beste Özdeşlik presented on energy efficiency and carbon emissions in vacuum processes with gas quenching.

Organized under the leadership of the Association for the Heat Treatment of Metals (ATZK) and in collaboration with various heat treatment associations across Europe, ECHT 2025 provided an important platform for bringing together industry professionals and academia, enabling knowledge sharing and the exchange of experience.

Throughout the conference, sessions, technical presentations, and networking events allowed participants to closely follow the latest industry trends. In particular, valuable insights were gained on energy efficiency, sustainable manufacturing, and digital transformation.



A New Era in Food Drying: VMI HYBRID DRYER

Dr. Alper Keleşoğlu

Food drying is one of the most effective ways to extend shelf life and preserve nutritional value. However, traditional methods (hot air, vacuum, freeze-drying, etc.) have disadvantages such as high energy consumption, long processing times, and quality loss. Sistem Teknik Industrial Furnaces Inc. combines its experience in industrial furnaces and microwave technologies and, within its R&D efforts, is working on solutions for the food industry.

The VMI (Vacuum-Microwave-Infrared) Hybrid Dryer developed by Sistem Teknik offers revolutionary solutions in terms of both energy efficiency and product quality. The VMI hybrid dryer shown in Figure 1 optimizes the drying process by operating infrared (IR) and microwave (MW) heating methods sequentially in predefined cycles, as illustrated in Figure 2. Thanks to this combination, moisture is transported from the inner part of the product (for example, an apple slice) to the surface through a "pumping effect." Moisture is efficiently removed without surface hardening or product burning. Once the critical moisture content level is reached, microwaves become the main drying mechanism.



Figure 1. VMI Hybrid Dryer

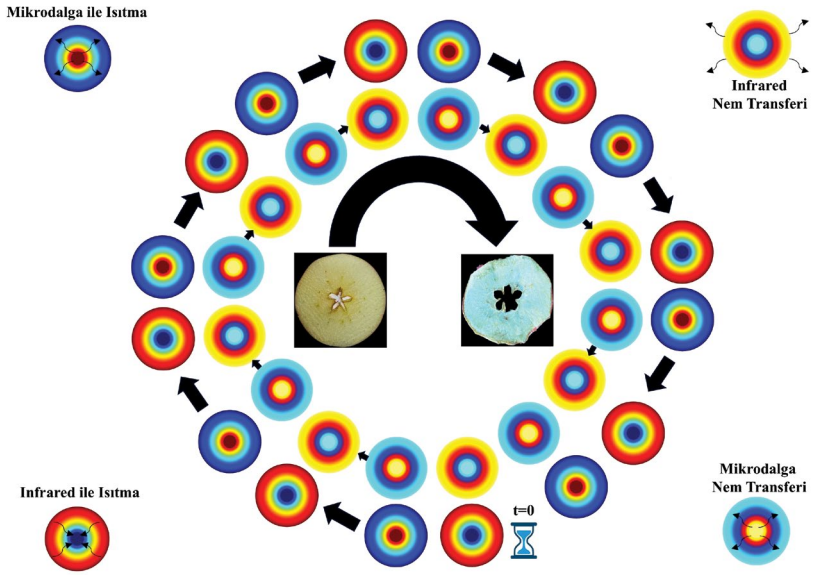


Figure 2. VMI Drying Cycle

Technical Performance Summary for an Example Cycle of 0.5 min IR + 4.5 min MW for Apple

- Drying Time: 34.3 minutes
- Moisture Extraction Rate (MER): 0.069 kg/h
- Specific Energy Consumption (SEC): 83.916 MJ/kg
- Efficiencies: Energy: 3.54%, Thermal: 29.51%, Drying: 7.54%
- Effective Moisture Diffusivity (Deff): 1.005×10^{-7} m²/s
- Shrinkage Ratio (Sr): 71.23%
- Rehydration Capacity: Peleg k_1: 4.19, k_2: 0.291

Advantages in Food Quality

Color Preservation: Darkening is minimized in L*, a*, b* parameters.

Rehydration Capacity: Exhibits properties close to fresh fruit.

FTIR-ATR Analysis: The structure of biological compounds is preserved.

Isotropic Shrinkage: Ensures homogeneous structural integrity.

Industrial Added Value

- Suitable for high-capacity production
- Automation with process termination criteria
- No need for additional chemicals or pre-treatment

Conclusion

The VMI Hybrid Dryer developed by Sistem Teknik offers significant advantages over existing drying technologies in terms of energy efficiency, quality, speed, and automation capability. It is particularly suitable for integration into industrial production with high product quality, especially for sensitive foods such as fruits.

Stay tuned for our developments in the food industry.

Higher-quality drying with lower energy consumption is possible with VMI.

INDUSTRY MEETING AND PANEL PARTICIPATION AT FIRE SAFETY EVENT ASIA!

A productive event where we closely followed regional developments in fire safety...

We participated in **Fire Safety Event Asia**, held from November 11–13, 2025 in Singapore. During the exhibition, we had the opportunity to meet with industry representatives from the region and discuss both ongoing projects and expectations for the upcoming period.



As part of the event, we delivered a panel session titled **"Advancing Fire Safety: Southeast Asia's Largest Resistance to Fire Testing Lab." Together with Prathipa Devi Sundraju from Setsco Services Pte Ltd and Christian Haller from Trema GmbH**, we discussed the new fire resistance testing laboratory, which is planned to be commissioned in the second quarter of 2026.

The session, moderated by our Board Member Beste Özdeşlik, provided comprehensive insights into regional testing capacity, technical requirements, and infrastructure investments. The strong interest and engagement of the participants added significant value to the session.

It was a great event for us, allowing us to reconnect with the industry and establish valuable new contacts. We would like to thank all our guests for their participation.

WE REPRESENTED THE INDUSTRIAL FURNACE SECTOR GLOBALLY

The CECOF General Assembly, held this year from September 11–13, 2025, took place in Bergamo, Italy. This important event, which brought together global representatives of the industrial furnace sector, saw strong participation from EFSİAD (Association of Industrial Furnace Manufacturers and Businesspeople). At the event, reports from each member country were presented, and Prof. Daniele Siena shared socio-economic findings. Our Board member Beste Özdeşlik, as President of EFSİAD, presented the sector report on behalf of Türkiye.





AICHELIN ST VACUUM GMBH SUCCESSFULLY COMPLETES ITS FIRST YEAR;

BOARD OF DIRECTORS MEETS IN TURKIYE

Aichelin ST Vacuum GmbH, established in 2024 through a 50-50 partnership between Sistem Teknik Industrial Furnaces Inc. and Aichelin Holding GmbH, has completed its first year of operations and held its Annual General Meeting in Türkiye, hosted by Sistem Teknik Industrial Furnaces Inc.

In addition to the Board Members of Sistem Teknik Industrial Furnaces Inc., the meeting was attended by Christopher Grosspointer, CEO of Aichelin Holding, and Wolfgang Brosche, CEO of Aichelin ST Vacuum GmbH.

The main agenda items of the meeting included a review of the past period, objectives for the upcoming term, and new projects. Shared goals—particularly in the areas of sustainability, digitalization, and international growth—were also among the key topics discussed.



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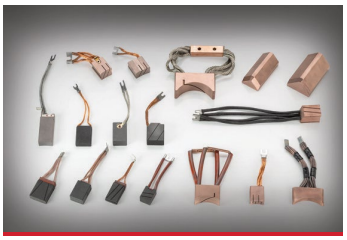
Glass Industry Applications



Aluminum Industry Applications



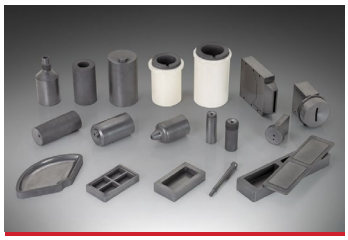
Continuous Casting Applications



Electricity and Rail System Applications



Mechanical Applications



Jewelry Applications



Plunge Erosion Applications (EDM)



Sintering and High Temperature Applications

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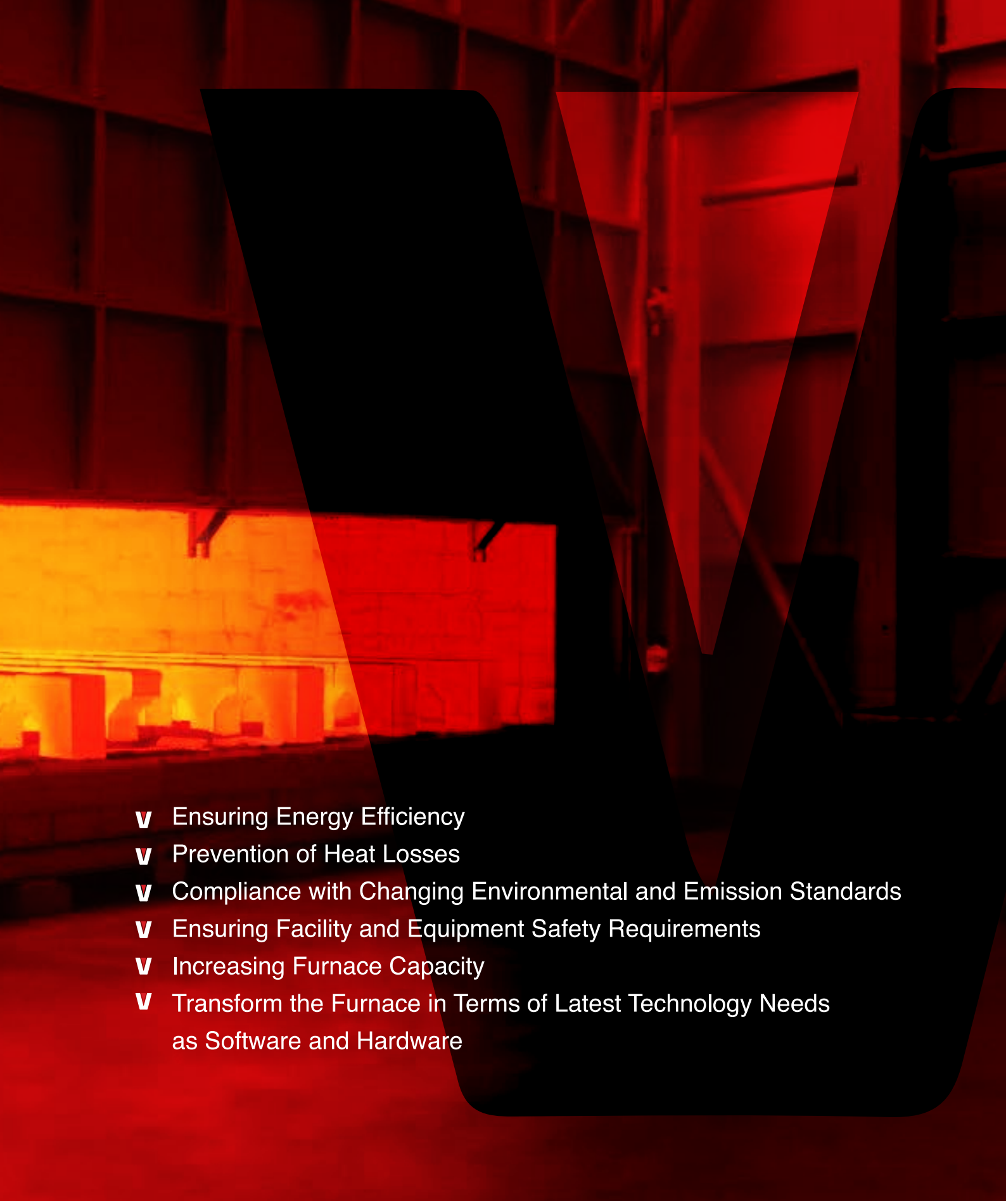


- Ensuring Energy Efficiency
- Prevention of Heat Losses
- Compliance with Changing Environmental and Emission Standards
- Ensuring Facility and Equipment Safety Requirements
- Increasing Furnace Capacity
- Transform the Furnace in Terms of Latest Technology Needs as Software and Hardware

As Sarvion, we support you in maintenance, service, revision and modernization for your furnaces of all brands and models.

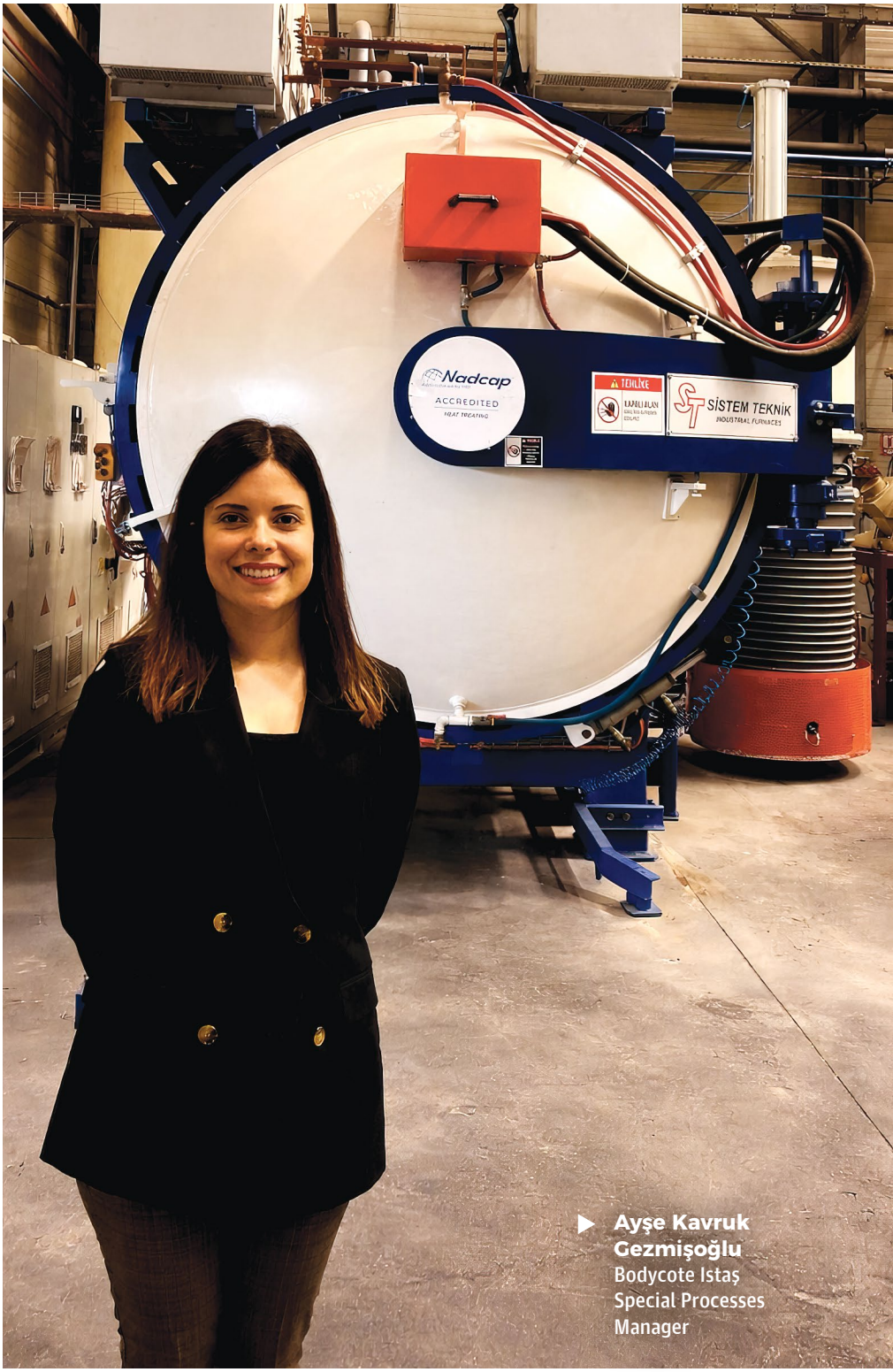
WE HAVE A STRONG COLLABORATION WITH SISTEM TEKNIK BASED ON MANY YEARS AND MUTUAL TRUST.

Interviewee: Ayşe Kavruk Gezmişoğlu, Special Processes Manager / Bodycote Istaş Gebze

The Sistem Teknik all-metal furnace enables us to achieve reliable results in the heat treatment of critical parts thanks to its high temperature uniformity and process stability. In addition, we receive technical support from the Sistem Teknik team when needed, which helps us ensure the continuity of our processes.

First of all, we would like to introduce you to our readers. Could you briefly tell us about your company and your role within the company?

As Bodycote Istaş Isıl İşlem San. ve Tic A.Ş., we provide heat treatment services with high-quality standards to the aerospace and defense, automotive, and general industry sectors. Our facility holds AS9100 and Nadcap quality management system accreditations, as well as ISO 14001 and ISO 50001 certifications, and adopts an environmentally conscious and energy-efficient production approach. As a Metallurgical and Materials Engineer, I work as the Special Processes Manager at our Gebze facility. At our site, we provide both conventional and special process heat treatment services; I am involved in process management, quality assurance, customer technical support, and audit processes. Our goal is to manage each process in compliance with international



Ayşe Kavruk Gezmişoğlu
Bodycote Istaş
Special Processes Manager

standards and to deliver reliable and repeatable results to our customers.

Which products and services of Sistem Teknik do you utilize in your industry?
We actively use a vacuum all-metal furnace manufactured by Sistem Teknik at our Gebze facility.

This furnace enables us to achieve reliable results in the heat treatment of critical parts thanks to its high temperature uniformity and process stability. Additionally, we receive technical support from the Sistem Teknik team when needed, which helps ensure the continuity of our processes.

This long-standing collaboration plays a significant role in maintaining the sustainability of our process quality.

What kind of processes do you carry out in the furnaces used in your production lines?
Our vacuum all-metal furnace in the production line is primarily used for the heat treatment of titanium, Inconel, and stainless steel materials. In this furnace, we perform specialized processes such as vacuum hardening, solution treatment, aging, stress relieving, and brazing with high precision. Operating under high vacuum conditions, this furnace allows us to achieve repeatable and reliable results, especially in applications that require tight tolerances and traceability, such as in the aerospace and defense industries.

What are the main advantages of Sistem Teknik furnaces in operation?
One of the key reasons we prefer Sistem Teknik furnaces is our commitment to supporting local manufacturing. Working with domestic manufacturers is valuable to us, as it contributes to the development of engineering and production capabilities in our country.

In addition, the strong communication of the Sistem Teknik team and their accessibility in terms of technical support create a reliable collaboration environment in our operations. This close communication ensures the smooth continuation of our daily processes and enables us to obtain quick solutions whenever needed.



Could you describe the contribution of the maintenance, repair, and service support provided by Sistem Teknik to your furnaces and processes?
Sistem Teknik's maintenance and service support plays a significant role in maintaining the continuity of our furnaces and the reliability of our processes. The service team's quick response and solution-oriented approach ensure that our planned production processes proceed without interruption.

Could you evaluate your collaboration with Sistem Teknik and the overall progress of the services you have received?
In our collaboration with Sistem Teknik, their ability to respond to our requests as quickly as possible and the clear distribution of responsibilities within their team ensure that matters are resolved quickly and effectively. This harmonious way of working creates a strong partnership environment built on mutual trust.

Finally, could you share with our readers the future goals and plans of Bodycote?
As the Bodycote Istaş Türkiye team, just like with our vacuum all-metal furnace, we closely follow technology and continue to invest across all sectors, particularly in compliance with aerospace and defense industry standards.

With the commissioning of our vacuum all-metal furnace, we have further advanced our capabilities in heat treatment and brazing applications for materials requiring high precision, such as titanium and Inconel alloys. This investment is a tangible reflection of our commitment to continuous improvement, innovation, and quality for the future.

At Bodycote Istaş, our goal is to continue providing our customers with reliable and sustainable heat treatment solutions at high-quality standards. We are continuously working to make our production processes more efficient and environmentally conscious, in line with rapidly evolving technologies.

WORKING PRINCIPLE OF GEAR-TYPE FLOW METERS, THEIR HIGH-PRECISION DOSING CAPABILITY, AND IMPORTANCE IN INDUSTRIAL APPLICATIONS

Cüneyt Erkuş - Hipaş, Vice President



Abstract

This study evaluates the operating principle of gear-type flow meters, which belong to the class of positive displacement flow meters used in industrial flow measurement, as well as the interpolation approach employed in high-precision models and their application potential across various industries. In gear-type flow meters, the fluid is transported within enclosed volumes formed between the gear teeth and the meter body; each gear passage is converted into a digital pulse, and the volumetric flow rate is determined based on these pulses. In high-resolution models, increasing the interpolation factor divides the measurement volume into smaller increments, enabling more precise evaluation—particularly at low flow rates, in bidirectional flow monitoring, and in small-volume dosing applications. The findings indicate that these flow meters provide an effective solution for precise feeding, ratio control, filling control, and process validation in sectors such as automotive, chemical and petrochemical, pharmaceutical and biotechnology, process technology, electronics manufacturing, and test & measurement. When flow meters are not used or sufficient accuracy cannot be achieved, issues such as dosing errors, quality fluctuations, raw material losses, and reduced process reliability may arise. Consequently, gear-type flow meters are not merely flow measurement devices but strategic components for industrial processes that require precision, repeatability, and digital traceability.

Introduction

Flow measurement is considered a fundamental engineering requirement in industrial systems involving liquids, gases, and steam, particularly in terms of process control, energy management, safety, quality consistency, and commercial metering. Today, differential pressure, variable area, turbine, ultrasonic, electromagnetic, thermal mass, Coriolis mass, and positive displacement flow meters are widely used depending on process conditions. Furthermore, in applications involving viscous fluids, low flow rates, pulsating flows, and precise volumetric dosing requirements, positive displacement flow meters are of particular importance. Within this category, gear-type flow meters—whose internal structure is illustrated in Figure 1—are regarded as prominent measurement solutions in applications requiring precise volumetric measurement and high repeatability.

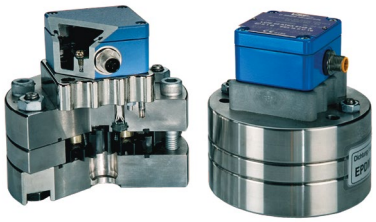


Figure 1. Internal Structure of a Gear-Type Flow Meter

The operating principle of gear-type flow meters is based on the rotation of two precisely positioned gears within the meter body. The fluid is trapped in enclosed spaces formed between the gear teeth and the inner surface of the housing, and is transported from the inlet to the outlet as the gears rotate. In this way, the fluid is measured in discrete and repeatable volume increments (Vm). Each gear tooth passage is detected as a pulse signal by a non-contact sensing system, and the total transferred volume and flow rate are determined based on the number of pulses obtained. Furthermore, in high-resolution flow meters, the vol-

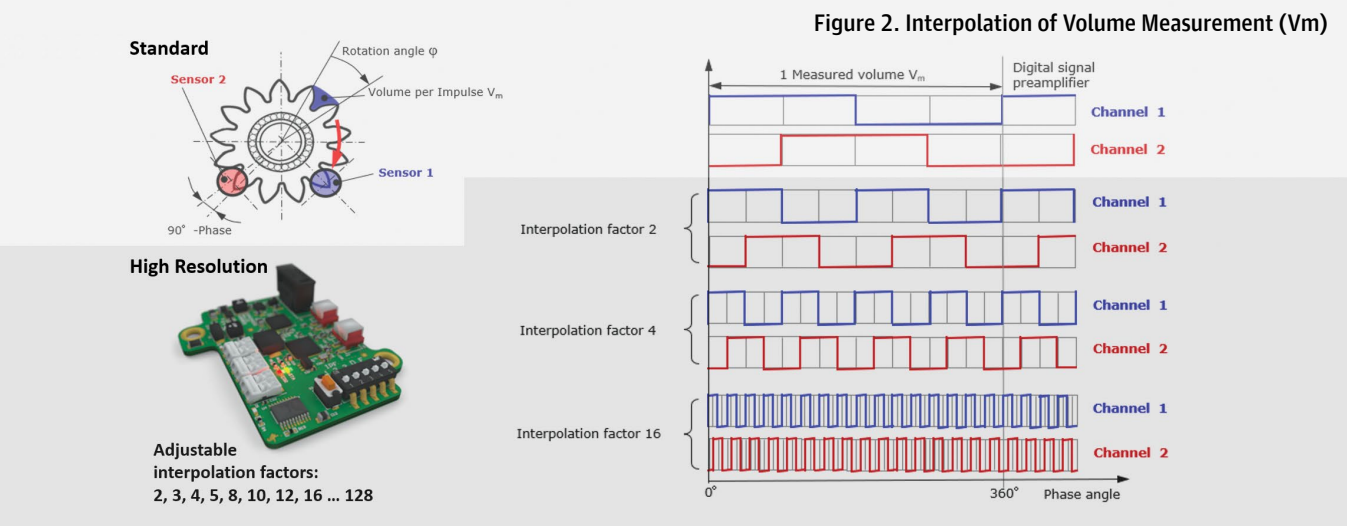


Figure 2. Interpolation of Volume Measurement (Vm)

ume corresponding to a single gear tooth passage can be subdivided into smaller measurement increments, as illustrated in Figure 2.

By means of the interpolation method used for this purpose, the number of signals obtained per unit volume is increased, thereby enhancing measurement resolution. In high-resolution, interpolation-supported models, phase-shifted signals are obtained through two channels, allowing the flow direction to be distinguished. This enables more precise measurements, particularly at low flow rates and under highly limited flow conditions, including bidirectional flow monitoring, small-volume dosing, and filling operations.

In this context, gear-type flow meters offer significant application potential in industries such as automotive, chemical and petrochemical, oil and gas, coating systems, pharmaceutical and biotechnology, process technology, water management processes, and electronics and electronic component manufacturing. They are widely used in applications including precise fluid feeding, additive ratio control, small-volume dosing, monitoring of coating and paint flows, control of solvent and chemical transfer, sample preparation, and production line validation.

In these fields, the absence of flow meters or the inability to achieve sufficient measurement accuracy may lead to disruptions in precise fluid feeding rates and additive ratio control. Additionally, issues such as errors in small-volume dosing, irregularities in coating thickness, loss of control in chemical transfer, batch-to-batch quality variations, increased raw material consumption, and reduced process reliability may arise.

This study provides an in-depth examination of gear-type flow meters—offering solutions to the aforementioned challenges—in terms of their operating principles, precision, accuracy, dosing capability, and application potential.

Industrial Application Areas

Automotive: Gear-type flow meters can be used for precise dosing and flow control in applications such as paint circulation systems, glass coating, underbody coating, adhesive and epoxy applications, lubrication systems, as well as engine and brake testing.



Figure 3. Application Areas - Automotive

Chemical and Petrochemical: Gear-type flow meters can be used in applications such as chemical injection, water separation, oilfield management, hydraulic system monitoring, fuel measurement, defoaming processes, and chemical additive injection.



Figure 4. Application Areas - Chemical and Petrochemical

Pharmaceutical and Biotechnology: Gear-type flow meters can be used in applications such as disinfectant spraying, dosing of bleaching pastes, and precise dosing of ointments and creams.



Figure 5. Application Areas - Pharmaceutical and Biotechnology

Process Technology: Gear-type flow meters can be applied in areas such as liquid silicone, rubber systems, resin transfer molding systems, polyurethane systems, cooling circuits, and equipment manufacturing.

They are considered a suitable solution for precise dosing, feeding, transfer, and flow measurement in industrial processes involving fluids with varying viscosities, temperature conditions, pressure levels, as well as those containing fillers or exhibiting corrosive properties.



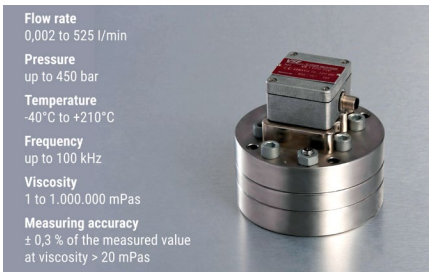
Figure 6. Application Areas - Process Technology

Test and Measurement: Gear-type flow meters can be used in applications such as fuel measurement, liquid level monitoring, brake test rigs, and hydraulic test benches. They are considered a high-accuracy measurement solution for reliably testing components, vehicles, machinery, and equipment under demanding conditions in industries such as automotive and aerospace.

Figure 7. Application Areas - Test and Measurement









Position Control / Hydraulic Cylinder Position Control:
In hydraulic systems, it may be necessary to control the position of cylinders that provide movement. This control is typically achieved using sensors. In situations where position sensors cannot be used—for example, with long-stroke cylinders—position control can be performed using a flow meter. The required flow rate per unit distance of cylinder movement is known, allowing the movement to be calculated based on the flow passing through the meter. Speed and position control can be achieved through these calculations. This approach has been successfully implemented in casting cylinder applications.

Results and Discussion:
Gear-type flow meters have been found to excel in applications that require highly precise measurement, dosing, monitoring, control, and process stability. Studies have also shown that measurement performance is not solely dependent on the basic operating principle, but is directly affected by variables such as gear geometry, clearances, internal leakage, fluid properties, viscosity, abrasiveness, and process conditions.

Therefore, when interpreting results, it is clear that gear-type flow meters should be considered not just as measurement devices, but as process components that must be selected and evaluated according to industry-specific requirements.

When examining the main challenges faced by industries without flow meters, and the solutions provided by gear-type meters, it becomes evident that, despite variations in fluid type, viscosity, process conditions, and quality expectations across sectors, a common requirement emerges: precise dosing, low-flow measurement, high repeatability, and process traceability.

Gear-type precision flow meters meet these common requirements, and the interpolation feature further enhances their value by producing more stable, detailed, and application-suitable measurement signals in areas where extremely high accuracy is needed. In conclusion, gear-type flow meters are not merely flow-measuring hardware; they are holistic measurement and control solutions that contribute to preventing industry-specific problems, maintaining product quality, reducing dosing errors, and strengthening digital process reliability.

Conclusion
Within the scope of this study, gear-type flow meters have been found to stand out among positive displacement meters in applications requiring high-precision volumetric measurement, low-flow monitoring, and high repeatability. Considering industry-specific applications collectively, gear-type flow meters have demonstrated broad utility across automotive, chemical and petrochemical, oil and gas, coating systems, pharmaceuticals and biotechnology, process technology, water management, electronics manufacturing, and testing and measurement sectors, serving purposes such as precise feeding, ratio control, filling, coating monitoring, and production verification.

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Interviewee: Oğuz Sönmez, Board Member / Sönmez Trafo



Oğuz Sönmez
Sönmez Trafo
Board Member

First of all, we would like to introduce you to our readers. Could you briefly tell us about Sönmez Trafo and your role within the company?

My name is Oğuz Sönmez. I serve as a Board Member and Co-CEO at Sönmez Trafo.

Since 1976, Sönmez Trafo has been a high-engineering company manufacturing custom-designed transformers used at critical points in the energy and railway sectors.

A significant part of our portfolio consists of:

- High-voltage special type power transformers
- Project-specific transformers engineered for industrial facilities
- Traction transformers for railway applications
- Fully customized products designed according to customer processes

As the majority of our production consists of non-standard, project-based transformers requiring detailed engineering, customers typically choose us for the combination of customized design + high quality + end-to-end solutions.

How do you differentiate Sönmez Trafo in the industry?

The key factor that differentiates us in the industry is this:

We have built a fully project-based engineering ecosystem that operates in a closed loop from design to testing, providing complete A-Z solutions.

Rather than working from a standard product catalog, we design each transformer from scratch according to the customer's technical requirements and validate it in accordance with international testing and quality standards.

Our distinguishing strengths include:

- Deep engineering capability, particularly in railway and high-voltage transformers
- In-house detailed design and simulation capabilities
- Comprehensive testing infrastructure capable of performing type and routine tests in line with international standards
- An A-Z solution approach: design, mechanical analysis, production, drying, oil filling, testing, and commissioning are all handled internally
- A process discipline that operates with an extremely low margin of error

Especially in the railway sector, OEMs prefer us not only because of our quality, but also due to our speed in developing customized solutions and our strong process control.

What operations are carried out in your furnaces? How critical are these processes?

In transformer manufacturing, the furnace is one of the most critical stations determining product quality, lifetime, and reliability.

Particularly for special transformers, drying quality directly affects field performance.

The following processes are carried out in our furnaces:

- Deep vacuum drying: removing even micron-level moisture from the active part
- Controlled heating: optimizing thermal expansion and insulation behavior

> For special transformer manufacturers, process repeatability is critical. In this respect, Sistem Teknik has provided us with reliable process stability.

- Continuous dew point monitoring: precise measurement of real moisture levels
- Stepwise process management: special drying programs lasting 24–36 hours or even longer for large transformers

For some special transformers, drying time can be considerably long depending on insulation type and size. The difference between 99% and 99.9% drying may determine whether a transformer operates trouble-free in the field for years.

In short:

Furnace quality is one of the most critical variables determining a transformer's lifetime.

What advantages have you gained by working with Sistem Teknik?

The new furnace system we procured from Sistem Teknik provided exactly the structure we needed, especially for large power transformers and high-voltage special products.

Key advantages include:

- Design flexibility suitable for large-volume transformers
- A powerful vacuum infrastructure capable of maintaining deep vacuum stability
- Highly homogeneous heat distribution, which is critical for large transformers
- Energy efficiency, providing significant benefits in long processes
- A fully integrated automation system compatible with our production management

For special transformer manufacturers, process repeatability is critical. In this respect, Sistem Teknik has provided us with reliable process stability.

What is the contribution of continuous dew point monitoring and SCADA integration to your production processes?

Dew point is the clearest parameter



indicating the actual quality of the transformer drying process.

In older systems, moisture levels were estimated indirectly. Today, we are able to monitor them scientifically and continuously.

The new system provides us with:

- Real-time dew point monitoring
- Full data recording via SCADA
- Trend analysis and recipe optimization
- Remote monitoring and control
- Operator-independent, reliable process control

The greatest contribution of this system is that:

Drying quality has now become measurable, reportable, and repeatable.

This represents a major quality assurance advantage for us, especially in high-voltage transformers.

6. How do you evaluate your collaboration with Sistem Teknik?

Our collaboration has been entirely technical, professional, and solution-oriented.

We observed:

- Clear project engineering scope
- Precise timing during installation
- A knowledgeable technical team during commissioning
- Detailed and structured training

At this stage, the installed system is not merely a piece of equipment;

it has become a process management tool that perfectly aligns with our production philosophy.

What are Sönmez Trafo's future goals?

As we approach our 50th anniversary, our strategy is very clear:

- To stay one step ahead in innovation within special transformer projects
- To strengthen our global position in railway and special power transformers
- To implement fully digitalized and traceable production processes
- To expand our testing, engineering, and automation infrastructure
- To further reinforce our A-Z solution capability

We are not a company that produces standard products.

Our motivation is to become the manufacturer that anyone in the world who requires innovative and customized solutions can confidently turn to.



WE TOOK OUR PLACE AT FABEX SAUDI ARABIA – METAL & STEEL KSA 2025!

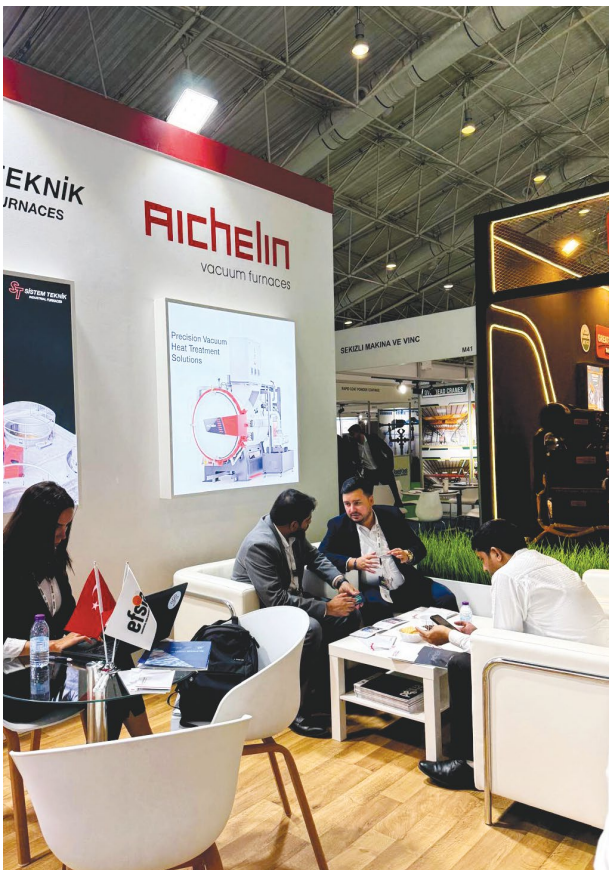
In line with Saudi Arabia's Vision 2030 industrial strategy, the rapid increase in new facility investments is driving a significant transformation in the region's manufacturing infrastructure.

We participated in **FABEX Saudi Arabia – Metal & Steel KSA**, held from October 12–15, 2025, together with **AICHELIN ST VACUUM** GmbH and **AICHELIN UNITHERM**.

Throughout the exhibition, which we attended to closely follow the development of the metal and steel sector in the region, we met with industry representatives and held discussions on technical evaluations and potential collaborations.

Our participation this year focused not on short-term results, but on closely analyzing the industrial dynamics in the region and establishing future-oriented connections.

We would like to thank all industry representatives and business partners who visited our stand. We will continue to closely monitor developments in the region.





SISTEM TEKNIK MET WITH THE GLOBAL FIRE SAFETY COMMUNITY AT INTERFLAM 2025

interflam 2025
Royal Holloway College, Nr London, UK

With its expertise in fire resistance test furnaces and a strong position in the international market, **Sistem Teknik Sanayi Fırınları A.Ş.** participated as a sponsor in **Interflam 2025**, one of the world's leading fire safety conferences, held in London from June 30 to July 2. Through its exhibition stand in the foyer area, Sistem Teknik showcased its engineering capabilities in fire resistance testing technologies to international stakeholders.

Established in 1979, Interflam is recognized as one of the most prestigious global events in the field of fire science and safety. Now in its 46th edition, the conference hosted a wide range of participants—including engineers, scientists, regulatory authorities, and industry professionals—over three days. With parallel technical sessions, poster presentations, scientific papers, and a comprehensive social program, the event provided an extensive platform for knowledge exchange.

Throughout the conference, Sistem Teknik presented its product portfolio in fire resistance test furnaces, its solutions across different scales, and its long-standing engineering experience. The discussions held at the stand went beyond product and technology presentations, laying the groundwork for future collaborations.

The technical sessions of the conference also offered valuable insights into the latest developments in testing methods and standards. This participation once again demonstrated that Sistem Teknik is not only a manufacturer of advanced systems, but also an active contributor to the global development of the fire safety industry.

With its strong engineering capabilities and technical expertise, Sistem Teknik will continue to take an active role in international events that shape the future direction of the industry.

AUSTRIAN SEMICONDUCTOR MANUFACTURER SELECTS AICHELIN VACUUM FURNACES

A leading company and one of the most recognized names in semiconductor manufacturing, the Austrian manufacturer has selected Aichelin Vacuum Furnaces for its new vacuum furnace investment.

The furnace, installed at the company's factory in northern Austria, has completed all commissioning and training activities, and final acceptance has been achieved.

Capable of performing both bonding and hardening processes in a single operation, the furnace completes the entire heat treatment cycle at one location without interruption by carrying out subsequent tempering processes in the same unit.

Thanks to its advanced SCADA system with comprehensive reporting and energy control, the company can monitor all process parameters and energy consumption in a single report.

With a vacuum level of 10^{-3} mbar, cooling pressure of 10 bar, and useful dimensions of 600×900×600 mm, the furnace also features motor-integrated drive controls, making it one of the most efficient furnaces in its class.







ADVANCED ENERGY RESPONDS TO THE NEED FOR 1.5 MW POWER EFFICIENCY IN KILNS

Selçuk Şevket Demirel - Multi Proses Otomasyon ve Kontrol Sistemleri Tic. Ltd. Şti., Sales Manager
Engin Sever - Katsimtaş İzolasyon Metalurji Dış Tic. Ltd. Şti., Managing Sales & Technical Products



Challenge

As a leader in the lithium-ion battery recycling industry, the customer faced the need to upgrade their equipment to support increased capacity demands. Their existing kilns couldn't adequately support the 1.5 MW power requirement for the new kiln. This new kiln featured nickel-iron-based heating elements, arranged in a WYE configuration with 13 heating zones, and required a system capable of quick SCR shutdowns to ensure safety.

Solution

To address these challenges, Advanced Energy suggested Thyro-PX® SCR Power Controllers as a solution for the end customer. The Thyro-PX offers easy-to-use performance for heating elements, resistive loads, and transformer loads in heating, melting, drying, and forming applications.

Additional features:

- Comprehensive operating and control modes to minimize harmonic distortion and utility costs
- High-efficiency, wear-free design with integrated soft starting for usage with downstream transformers
- Premier performance control accuracy to maximize end-process repeatability
- Multi-zone capability that independently controls multiple single-phase loads from a single controller

Result

The implementation of dASM cards significantly improved load management. By desynchronizing the heating zones, Thyro Power Manager and dASM reduce heating simultaneously, lower energy costs, minimize copper losses and effective current, and help prevent flicker or other line issues.

The Thyro-PX controllers, configured in a WYE arrangement, enhanced the system's safety and its ability to shut down in one AC cycle provided an additional layer of safety, crucial for the larger kiln design.

Conclusion

Advanced Energy's engineering team conducted a comprehensive review of the control method, power delivery, limit control, and system integration. The customer was extremely pleased with the support provided and the thorough addressing of their safety concerns related to the new kiln design. The successful upgrade of the kiln not only increased capacity but also ensured enhanced safety and efficiency for the client's operations. AE's commitment to delivering innovative and reliable solutions and providing world-class support fulfilled the client's evolving needs, while ensuring the highest-quality recycling operation.

Fig. 1: dASM dynamic grouping of Thyro-PX 2PX SCR devices

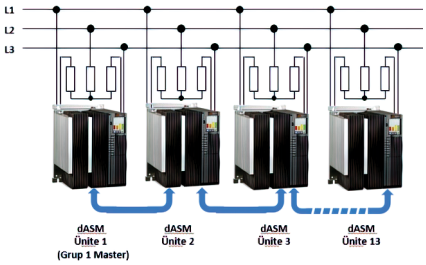


Fig. 2: Without dASM

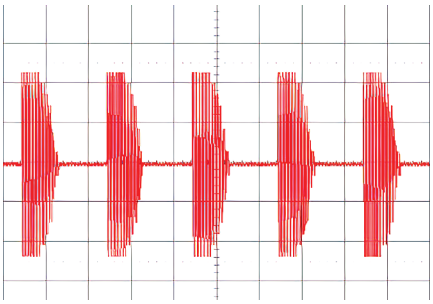
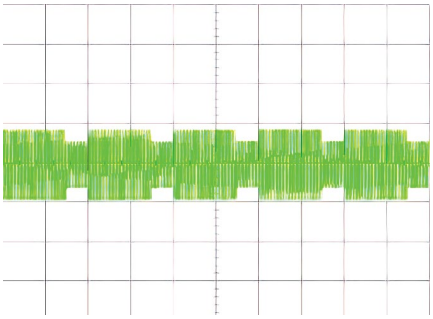


Fig. 3: With dASM



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Katsimtaş İzolasyon Metalurji ve İnşaat San. Dış Tic. Ltd. Şti.

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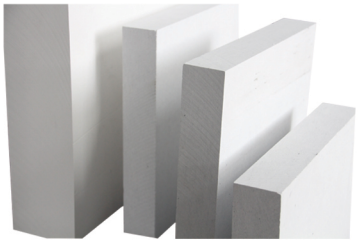
Heat Resistant Fabric



LBK-KTS Series Bricks / Calcium Silicate Plates



Monolite Plates



Isolite LBK Series Bricks



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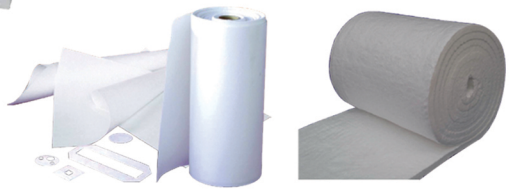



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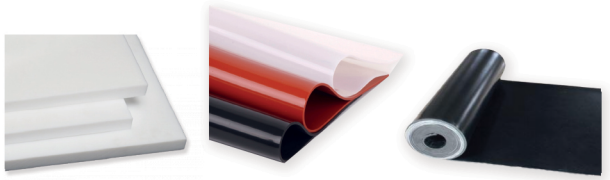

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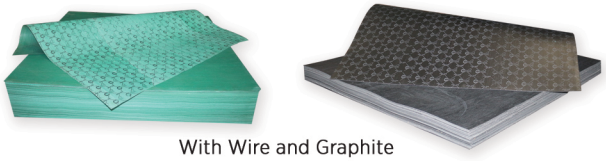

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PID CONTROL APPLICATIONS IN HEAT TREATMENT FURNACES

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Abstract
Temperature control in industrial heat treatment furnaces plays a critical role in terms of product quality and energy efficiency. The high thermal inertia of furnaces makes conventional control methods insufficient. This study examines the applicability, advantages, and limitations of the PID (Proportional–Integral–Derivative) control algorithm in heat treatment furnaces.

1. Introduction
Heat treatment furnaces operate according to specific temperature profiles to modify the mechanical and microstructural properties of materials. In processes such as annealing, hardening, and tempering, the accuracy of furnace temperature control directly affects the quality of the final product. The PID control algorithm, widely used in industry, is preferred to maintain furnace temperature at a desired setpoint and to ensure stable system operation.

2. Control Challenges in Heat Treatment Furnaces
Heat treatment furnaces, due to their high thermal capacity, exhibit slow dynamic behavior. This makes it difficult to respond quickly to sudden temperature changes. In addition, issues such as overheating risk, fluctuations in energy consumption, and reduced production repeatability may arise. Therefore, an advanced control approach is required.

3. Structure of PID Control and Its Application to Furnaces
The PID control algorithm operates based on three main components: proportional (P), integral (I), and derivative (D).

$$u(t) = Kp * e(t) + Ki \int e(t)\,dt + Kd\, de(t)/dt$$

Here, e(t) represents the error between the reference temperature and the measured temperature.

- Proportional component (P): Adjusts the power supplied to the furnace according to the magnitude of the error.
- Integral component (I): Eliminates steady-state error by compensating accumulated temperature deviations over time.
- Derivative component (D): Prevents sudden overheating by considering the rate of temperature change.

4. Application Examples
PID control is used in various heat treatment processes:

- Annealing: Since operation is maintained at a constant temperature for long durations, the integral component is critical.
- Hardening: The derivative effect plays a key role in achieving rapid heating to the target temperature while avoiding overshoot.
- Tempering: A proper balance between P and I components is essential to prevent sensitive temperature fluctuations.

5. Advantages and Limitations
5.1 Advantages

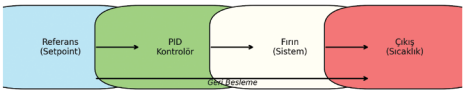
- Ensures repeatability of the temperature profile.
- Optimizes energy consumption.
- Improves occupational safety by reducing the need for manual intervention.
- Easy to implement in industry and cost-effective.

5.2 Limitations

- If parameters (Kp, Ki, Kd) are not properly tuned, the system may become oscillatory or slow.
- Adaptive control may be required under varying load conditions.
- Sensor noise at high temperatures can negatively affect the derivative component.

6. Conclusion and Future Approaches
The PID control algorithm is an effective and reliable method for temperature control in industrial heat treatment furnaces. With proper parameter tuning, high product quality and energy efficiency can be achieved. Furthermore, the combined use of PID with AI-based adaptive control algorithms represents an important research area for achieving more precise and efficient temperature management in the future.

Figures
Figure 1. PID Control Block Diagram.



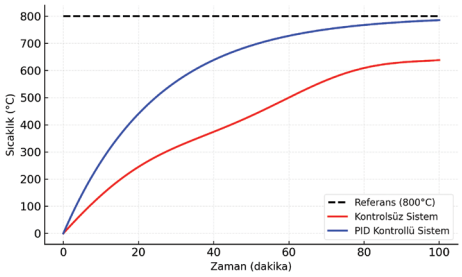


Figure 2. Temperature-Time Curve of a Heat Treatment Furnace (Comparison of PID-Controlled and Uncontrolled Cases).

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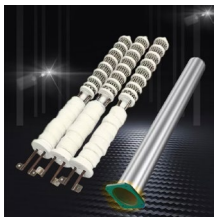













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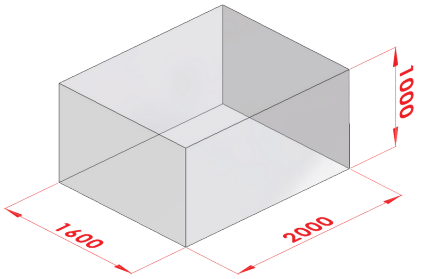

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