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CUTTING TOOLS WORLD

Dedicated Magazine On Cutting Tools Industry

"AT KENNAMETAL, WE TURN IDEAS INTO SOLUTIONS"

VIJAYKRISHNAN VENKATESAN
MANAGING DIRECTOR,
KENNAMETAL INDIA LIMITED.

TOP STORIES

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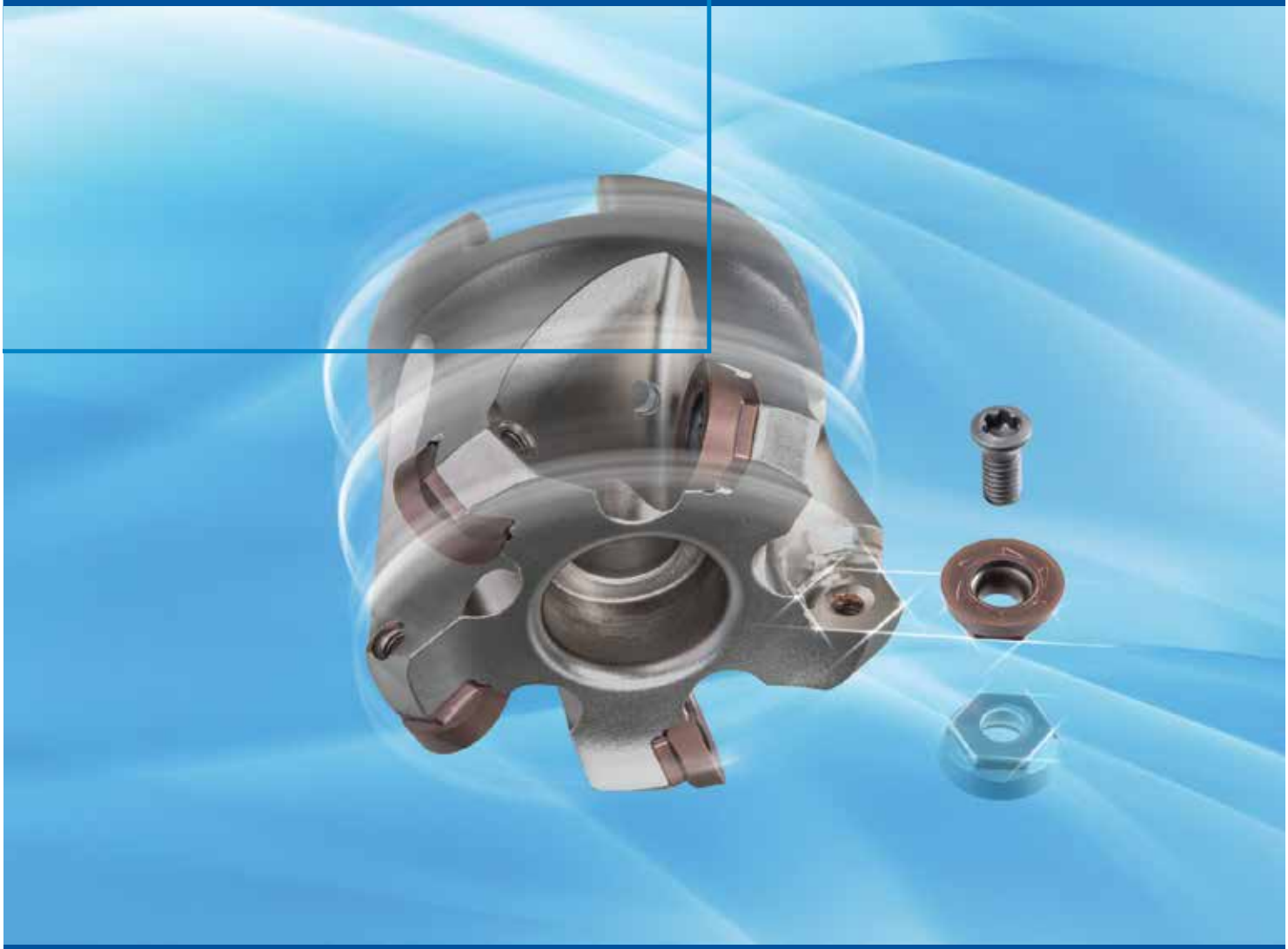

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Innovative Tooling Solutions - A Shot in the Arm for Critical Industries

In today's rapidly evolving industrial landscape, the demand for precision, efficiency, and sustainability has never been greater. As critical industries like aerospace, automotive, defense, and energy push the boundaries of what's possible, innovative tooling solutions are proving to be a game-changer. These advancements in tooling technology are not just enhancing productivity but also setting new standards in quality and sustainability.

Tooling is the backbone of manufacturing, playing a pivotal role in shaping, cutting, and finishing materials into precise components. In critical industries where tolerances are tight, and the margin for error is minimal, the right tooling can make all the difference. The aerospace industry, for example, requires tools that can handle superalloys and composites, materials known not only for their strength and heat resistance but also for their difficulty in machining. Similarly, the automotive industry, with its focus on lightweight materials and electric vehicles, demands tools that can work efficiently with aluminum and advanced polymers. In the defense industry, where reliability and precision are paramount, advanced tooling solutions have played a crucial role in producing complex components for weapons systems, aircraft, and naval vessels. The ability to machine exotic materials with high precision has given defense manufacturers a competitive edge. The energy sector, particularly in oil and gas exploration, requires tools that can operate in harsh environments. Innovations in tooling have led to the development of tools that can withstand extreme temperatures and pressures, improving the reliability and efficiency of drilling and extraction operations.

Innovative tooling solutions are indeed a shot in the arm for critical industries, providing them with the means to meet the challenges of modern manufacturing.

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Rajoo Engineer's Leadership and Innovation recognized with Double Honors at The Machinist Super Shopfloor Awards 2024

This year, the spotlight focused on Khushboo Chandrakant Doshi, Managing Director of Rajoo Engineers Ltd., who was awarded the coveted title of 'Best Woman in Manufacturing.' This accolade is a testament to her visionary leadership and relentless pursuit of excellence, driving Rajoo Engineers Ltd. to new heights of success.

Commenting on the recognition, Doshi said,"This award is a recognition of the collective efforts of the entire Rajoo team. Being honored in an industry that is rapidly evolving and increasingly inclusive is a testament to our shared vision. At Rajoo, we believe in pushing boundaries and setting new standards. Such a recognition fuels our journey by validating our innovative approaches and inspiring us to continue striving for excellence and making impactful advancements."

In addition to this individual honor, Rajoo Engineers Ltd.'s Rajkot plant in India has been awarded as runner up for 'Innovation in Manufacturing.' The Rajkot plant, known for its state-of-the-art facilities and cutting-edge technologies, has been at the forefront of pioneering advancements in the manufacturing sector for capital goods. This recognition underscores Rajoo's dedication to innovation, quality, and sustainability.

The award for innovation acknowledges the plant's successful implementation of advanced manufacturing processes for plastic processing machines that enhance productivity and reduce environmental impact. The Rajkot plant's innovative practices have set a new benchmark in the industry, demonstrating the potential of integrating technology with sustainable practices.

"The Rajkot plant exemplifies our unwavering dedication to continuous improvement and innovation. This award is a testament to the relentless hard work and commitment of our entire team, who continually strive to redefine the standards of manufacturing excellence. The addition of Rajoo's new assembly shed further opens up exciting opportunities for us to enhance our capacity and expand our capabilities," stated Utsav Doshi, Jt. Managing Director at Rajoo Engineers Ltd.

Rajoo Engineers Ltd. has always prioritized customer-centric solutions for the plastic processing industry and strives to deliver products that meet the highest standards of quality and efficiency, competing with the best of class globally. The company's philosophy of 'appropriate technology' ensures that the solutions are not just technologically advanced but also tailored to the specific needs of their clients, enhancing business value and operational efficiency.

In conclusion, the dual recognition at the Machinist Awards 2024 is a testament to the company's relentless pursuit of excellence, innovation, and customer satisfaction. These accolades reinforce the company's position as a leader in the manufacturing industry for engineering products and sets the stage for future innovations that will shape the industry landscape.

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Explore how Bosch Rexroth combined the Anybus Communicator with their Smart Flex Effector to bring industrial automation's most versatile compensation module to the world.

Bosch Rexroth, the automation branch of the Bosch group, has over 32,000 employees worldwide and specializes in advanced drive and control technologies. At their Customer and Innovation Center in Ulm, Germany, they develop innovative solutions for the future of automation, such as the Smart Flex Effector, a compensation module aiming to revolutionize the industry.

Smart Flex Effector – Automate the impossible

David Lehmann, System Architect at Bosch Rexroth, explains what a compensation module is and what makes the Smart Flex Effector unique:

"When you think about a robot in the factory, you usually think of a six-axis robot assembling parts or building a car, or something like that. The robots have some kind of tool at the tip, like a gripper. The compensation module is the part that goes between the robot arm and the gripper. The Smart Flex Effector stands out due to its ability to provide compliance (flexibility in response to forces) in six degrees of freedom (movement in three-dimensional space).

We can measure the deflection (change in position) of the tool with high precision with an integrated sensor system. This allows us to perform complex tasks, such as precise assembly operations, that usually only humans can do. Our slogan, 'Automate the impossible', sums it up nicely. Our goal with this product is to enable robots to perform new tasks that they are traditionally not good at, thereby increasing efficiency and productivity."

Connectivity challenges

To enable the robots to perform these new tasks, the Smart Flex Effector needs to exchange position measurement data with the robot controllers, including information about the deflection of the tool and control signals for the module's locked and unlocked states.

However, connecting the Smart Flex Effector to robot controllers was challenging, as David explains. "Our product was available, but we had difficulties installing it at our customer's sites. When we talked to our customers, the feedback was often the same: 'You have this serial interface, but I don't want to spend two weeks or more trying to connect it with my robot controller. I do not have the time or the resources to do that.'"

Simplifying connectivity with Anybus protocol converters

To solve these connectivity challenges, Bosch Rexroth turned to HMS Networks who provided the Anybus Communicator Common Ethernet, a ready-made protocol converter capable of connecting serial devices to EtherCAT, EtherNet/IP, Modbus TCP or PROFINET controllers.

A key benefit of the Anybus Communicator Common Ethernet was that the same unit can connect to all the major Ethernet protocols, as David describes "This Anybus protocol converter was the ideal solution for us because we can reconfigure it with a firmware update and with just one unit, we are able to provide the connection to the different protocols."

The Anybus Communicator's intuitive user interface also won some new fans. "The interface is really nice. Before selling it to our customers, we tested it for ourselves in our lab where application engineers completed feasibility studies, for example. They all said that it was easy and straightforward to complete the required configurations via the web interface, which was important to us as we have customers that are not experts in automation and robotics."

The fact that the Anybus Communicator could be installed via a web browser was a further plus point. “Both we at Bosch and our customers prefer not to install third-party configuration software. It adds security risks and complexity – just getting the required admin rights often delays installations.”

Smart Flex Effector + Anybus Communicator = The complete solution

The Smart Flex Effector and Anybus Communicator have worked so well together that Bosch Rexroth includes the Anybus Communicator as part of a complete solution. “We decided to create an order number for the Anybus convertor, so that customers could buy it directly from us. So, we sell both devices together as a complete solution.”

Expanded market

With the addition of the Anybus Communicator, Bosch Rexroth can easily connect to all the major Industrial Ethernet protocols, and as a result have significantly expanded its market. “Now we really can address more or less the whole market”, David concludes. “We can cover everything; we haven’t found a robot with a fieldbus connection that is not supported by this Anybus convertor yet.”

David Lehmann, System Architect Bosch Rexroth

KSB Limited’s Q2 2024 Results Demonstrate Substantial Growth in Sales Revenue

KSB Ltd. has announced its financial results for Q2. The sales revenue of Q2 2024 is INR 646 crores, which is 9.3% higher than that of the corresponding Q2 2023. There has been a significant growth in distillery and vegetable oil sectors with new prestigious orders. The Valves division achieved highest sales of INR 106.2 crore in Q2 and highest Order Intake for H1 worth INR 231.5 crore. TSG Regulation Audit carried out by CESI agency for China Export market for valves results in no major observation. Spare parts for more products like MEGA & MEGACHEM have been added in E2E Webshop. The company has received approval for KSB mechanical seals from major customers.

The company has also bagged an order worth INR 8.6 Crores for FGD pumps from Gujarat State Electricity Corp. (GSECL) – Wanakbori. It has also bagged an order worth INR 8.6 crores for combined cycle power plant in Alexandroupolis, Greece and worth INR 6.1 Crores for Abu Dhabi Waste-to-Energy Power Plant. Order worth INR 6.3 Crores has also been received for the Waste Water applications.

Prashant Kumar, VP Sales and Marketing

Nuclear Projects Division of KSB Limited (Shirwal Plant) has obtained the distinguished ISO 19443:2018 certification.

Summarizing the Q2’24 performance, Prashant Kumar, Vice President of Sales and Marketing, KSB Limited said, “With 9.3% increase in sales revenue, compared to Q2 2023, our growth momentum remains strong in Q2 2024. This growth is driven by significant order inflows from various segments.

Our contributions to the energy sector also remain robust as we continue to provide solutions that meet the industry’s evolving needs. Furthermore, our efforts to enable online ordering have shown steady progress, with an increasing number of products and spares now available online.

In strengthening our Nuclear Projects Division, we have set new industry standards by becoming the first company in India’s pump industry to be accredited with ISO 19443:2018 certification. This exemplifies our commitment to upholding highest standards of safety, reliability, and regulatory compliance, crucial in the nuclear power sector.

Q2 2024 results have demonstrated our commitment and capacity to deliver on our strategic roadmap, and with our ongoing progress and strong pipeline, we will continue to achieve such stable and profitable growth.”

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“AT **KENNAMETAL,** WE TURN IDEAS INTO SOLUTIONS”

Kennametal is a market leader and a recognized innovator, providing solutions to complex problems for its customers around the world. Its innovation advantage stems from delivering differentiated capabilities in the areas of Material Science, Additive Manufacturing, Product Engineering and Smart Factory. Evolving trends that are influencing its technological advancements range from high-speed machining to the continued focus on sustainability and now e-mobility and the use of exotic materials, among many other factors. It engineers solutions to help customers exceed productivity targets in the wake of the increasing complexities. An R&D 100 Award Winner, Kennametal's repertoire encompasses several ground-breaking innovations including the KENGold™, a proprietary next generation multi-layer CVD coating technology that has set a new standard for wear and productivity in steel turning, discovers Cutting Tools World in an exclusive interview with Vijaykrishnan Venkatesan, Managing Director, Kennametal India Limited. Excerpts:

KENNAMETAL

**VIJAYKRISHNAN VENKATESAN,
MANAGING DIRECTOR,
KENNAMETAL INDIA LIMITED**

Q. You are a formidable name in tooling and wear-resistant solutions. May we know more about your niche and standing?

Kennametal brings together materials science, technical expertise and innovation to deliver tooling and wear-resistant solutions across a wide range of industries including automotive, aerospace and defense, general engineering, transportation, earthworks, and energy. Our India team offers industry leading solutions through two segments: Hard Metals and Machining Solutions Group.

Our Hard Metals segment offers both Kennametal® and WIDIA™ brand metalworking solutions covering everything from milling, turning and holemaking, to threading and tooling systems. This business segment also offers wear-resistant solutions that deliver high performance and productivity in the toughest environments. We're customer focused, providing superior service and support to help our customers solve their most challenging problems—avoiding downtime, preventing failures and in the end, achieving cost savings and increased productivity.

Our Machining Solutions Group manufactures special purpose machines (SPM), including vertical turning lathes, deep hole drilling machines, tool and cutter grinding machines, fixtures and tooling solutions through the WIDMA™ brand. Several customers are benefiting from the expertise of WIDMA and manufacturing the most complex components with precision, from small tools to large structural parts for the railways and construction equipment industries.

Q. R & D is at the root of your innovations. Tell us something about your futuristic approach to need-based product development.

Kennametal is a market leader. We're a recognized innovator, providing solutions to complex problems for our customers in India and around the world and transforming how everyday life is built. Our innovation advantage stems from delivering differentiated capabilities in the areas of Material Science, Additive Manufacturing, Product Engineering and Smart Factory. Evolving trends that are influencing our technology advancements range from high-speed machining to the continued focus on sustainability and now, e-mobility and the use of exotic materials, among many other factors. We engineer solutions to help customers exceed productivity targets in the wake of increasing complexities.

We work closely with our customers, anticipating their needs and innovating to drive manufacturing efficiencies and productivity. We're helping customers achieve a competitive edge. The RIQ™ Reamer Stator Bore is a great example of how closely we worked with a customer to machine EV components and hit production targets. The RIQ Reamer recently received the Best of Industry Award (in Production & Manufacturing) from MM MaschinenMarkt– proof of its performance in the shop.

Kennametal was also named an R&D 100 Award Winner and received a bronze Edison Award for its industry-first, additive manufactured cutting tool designed with KENionic™ technology. The tool is 45 percent lighter and has demonstrated a reduced machining time by approximately 50 percent compared to conventional tooling solutions.

Q. Starting your journey in India in 1964, you have come a long way spearheading innovations. What are the technological breakthroughs you have showcased recently and with what benefits to the end-user industry?

At Kennametal, we turn ideas into solutions. Our teams' award winning innovations are driving growth in our target markets. We recently released KENGold™, a proprietary next generation

multi-layer CVD coating technology. KENGold has set a new standard for wear and productivity in steel turning with the launch of our KCP25C turning grade. Another breakthrough is Road King®. Road King provides superior milling machine performance in road rehabilitation applications. In aerospace, Kennametal's HARVI™ Ultra 8X helical milling cutter does what it's designed to do—deliver the highest productivity at the lowest possible cost per edge. HARVI Ultra 8X consistently removes up to 20 cubic inches of titanium per minute with a tool life of one hour or more.

Q. You champion in providing machining solutions. Which are the recent ground-breaking solutions you have come up with?

We're focused on building general purpose standard machines capable of performing complex operations in the most demanding environments. We recently launched MacHX800, a standard horizontal machining center (HMC) designed for large part machining across commercial vehicles, construction and farm equipment, aerospace, and general engineering. Designed with advanced next-gen features including Industry 4.0 compatibility, this new WIDMA machine delivers the rigidity, productivity, accuracy, and versatility to machine a variety of materials in the toughest conditions.

Another recent breakthrough in machining solutions is our Skiving and Roller Burnishing machine that is remarkably fast and performs two-in-one bore sizing and finishing process. It is up to 70 percent faster than traditional honing operations, making it an ideal solution for finishing hydraulic cylinder tubes in high production environments.

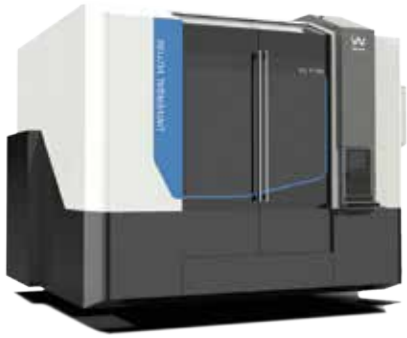
Our Tool & Cutter grinding machines show the comprehensive range of our portfolio solutions range from entry level products for tool makers transitioning from a conventional to CNC setup, to high-end machines for producing small tools with laser sharp accuracy. Hobgrind HG200, a five-axis CNC machine,is built for gear manufacturers looking to perform high-precision regrinding of hobs of varying sizes and types in-house, with end-to-end quality control and benefit from reduced inventory levels and lead time.

We recognize the need to drive productivity via connected data and have integrated IoT into our machines to provide both intuitive and data-driven analysis of machine performance and meet customer requirements in an Industry 4.0 environment.

Q. Please enlighten us on your trendsetting innovations in special purpose machines.

WIDMA's expertise in Special Purpose Machines stems from a customer first mindset and solutions-based approach to the design and building process. We've produced several high-quality machines as a result of our comprehensive manufacturing process—from concept and design to assembly and after-sales customer support. Examples of our

work include a 7-axis two-way special HMC that was delivered to a leading construction equipment manufacturer. This machine features servo pallet changer of 4.4 X 1.2 meter table size for accommodating and machining large components, weighing nearly 3 tons with quick change setup mechanism. In the die and mold sector, large machines are being increasingly used where size and complexity are in high demand. The WIDMA UGC Series Deep Hole Drilling (DHD) machine can help customers achieve deep-hole drilling depths up to 2 meters and 40mm in diameter in a single setup with high-accuracy. This machine specifically has the flexibility for multi-axis positioning, performing multiple operations like chamfering, milling and tapping operations, configurable up to 7-axes including a CNC rotary table and spindle tilting feature enabling customers to drill complex angles and structures. Another area is the machining of valves where our 5-axis CNC Multi-tasking, VU Series Vertical Turn-Mill center has been leveraged by a valve maker to machine the most complex triple offset butterfly valves meeting stringent criteria set by several global certifying agencies. This machine is ideal for components that have multiple operations to be covered with close relative tolerances between sections. The machine can cover 5 faces of the component in a single setup, optimizing productivity.



Q. We understand you have come up with a special CVD coating for wear resistance and productivity in steel turning. What's the significance of this development?

Our new KENGold™ CVD coating technology resists abrasion, provides a strong thermal barrier, improves edge

toughness, and allows for easy detection of wear due to its gold flank. Kennametal has achieved consistently tight tolerance levels with this next gen coating technology given its extreme versatility when machining steel across turning applications and materials.

Q. May we have a brief account of your wherewithal and infrastructural developments?

We have a state-of-the-art 29-acre manufacturing facility in Bengaluru developing products for both domestic and international markets. On the Bengaluru campus is also a dedicated for the production of inserts, this facility deploys advanced technology and equipment to uphold our commitment to Kennametal quality, performance, innovation and delivery. The facility,

like others globally, also adheres to Environmental, Social and Governance (ESG) standards.

Q. What's your contribution to skill development in the country?

Kennametal India's Knowledge Center provides a growing customer base with ongoing training. Our Metal Cutting Application Engineering (MCAE) course covers a wide variety of topics including the latest in manufacturing, tooling developments and strategies, tool selection and machining parameters for different applications. These highly informative and interactive sessions are conducted in person, as well as virtually to expand our reach in the Indian market and globally. This year, our Knowledge Center in India has conducted over 60 training sessions to reach more than 2,000 participants including direct customers, employees and channel partners.

Q. So how would you sum up your core competencies, and competitive advantages?

Our legacy of deep material science and technical expertise has and will continue to give us a competitive edge. We're problem-solvers. We design advanced solutions for our customers. It's this customer commitment that leads to the development of advanced products that enhances and expands on our portfolio. Leveraging Kennametal's global manufacturing facilities as well as our integrated factory at Bengaluru, we deliver performance driven tooling solutions and high-end machines; this, coupled with prompt technical support and customer service also continues to set us apart from competition.

Q. What's your outlook for the future of the metal cutting and metalworking industry?

The Indian manufacturing sector is poised to grow to 21 percent of GDP in the next 6 to 7 years; it's expected to reach $1 trillion by 2025/26*. Aligning with this trend, the Indian machine tool market is poised for remarkable expansion with a CAGR of 10 to 12 percent between 2022 and 2027, which translates to approximately $2.45 billion USD. We expect this trend to benefit both our Hard Metal and Machining Solutions businesses. The gradual shift in focus towards aluminum machining, CFRP, usage of more non-conventional materials, and additive manufacturing will increase demand for cutting edge technologies in the machining space. Plus, manufacturers will seek higher levels of sophistication, with an emphasis on finishing and tighter tolerances. We're positioned to maximize our sales and service footprint across the country to grow our customer base—while remaining focused on innovation and bringing products to market that drive our customers' businesses.

Q. What are your growth strategies and how do you envision the future of Kennametal India?

Kennametal's growth strategy centers around leveraging decades of metallurgy and materials science expertise, application engineering and problem solving to drive customer-led innovation that delivers superior performance. Our goal is to drive operational excellence through continuous improvement to drive efficiency, leverage state-of-the-art processes and optimize our capacity. In doing so, we will sustain our ESG efforts and focus on people-centric practices while upholding Kennametal's values and cultural beliefs. ■

* *According to a report by Colliers ("Indian Manufacturing Market has the Potential to reach USD 1 trillion by 2025-26, Colliers, December 13, 2023) https://www.colliers.com/en-in/news/press-release-indian-manufacturing-market-has-the-potential)*

New Developments in Metal Cutting Fluids

Metal cutting fluids play a pivotal role in machining processes, serving multiple functions like cooling, lubrication, chip removal, and corrosion protection. They are essential for achieving high precision, extending tool life, and improving surface finish. Over the years, advancements in machining technologies and materials have driven the evolution of cutting fluids, leading to innovations that address challenges like environmental impact, efficiency, and performance. This article explores the latest developments in metal cutting fluids, highlighting how they are shaping the future of machining.

Sustainability and Environmental Impact

One of the most significant trends in the development of metal cutting fluids is the shift toward sustainability. Traditional cutting fluids often contain mineral oils and additives that can be harmful to the environment. Disposal of these fluids poses ecological risks, leading to stringent regulations and a demand for greener alternatives.

Recent innovations include the development of bio-based and synthetic cutting fluids. Bio-based fluids, derived from renewable resources like vegetable oils, offer a more sustainable option. These fluids are biodegradable and have a lower environmental impact compared to conventional mineral oil-based fluids. Moreover, they can provide superior lubrication and cooling properties, making them a viable alternative in various machining operations.

Synthetic fluids, on the other hand, are formulated to offer consistent performance with reduced environmental risks. They are designed to have a longer service life, reducing the frequency of disposal and the associated environmental burden. Additionally, the use of advanced additives in synthetic fluids enhances their cooling and lubricating efficiency, further boosting their appeal in modern machining processes.

Nano-enhanced Cutting Fluids

The integration of nanotechnology into metal cutting fluids has opened new avenues for enhancing machining performance. Nano-enhanced cutting fluids contain nanoparticles that improve thermal conductivity, lubrication, and anti-wear properties. These nanoparticles can reduce friction between the tool and the workpiece, leading to lower cutting forces, reduced tool wear, and improved surface finish.

For instance, incorporating nanoparticles like carbon nanotubes, graphene, or metal oxides into cutting fluids has shown promising results in various studies. These particles create a protective layer on the tool's surface, minimizing direct contact with the workpiece and thereby reducing wear. Additionally, the enhanced thermal conductivity of these fluids helps in better heat dissipation, crucial for maintaining tool life and preventing thermal damage to the workpiece.

High-Performance Additives

The role of additives in cutting fluids cannot be overstated, as they significantly influence the fluid's properties and performance. Recent developments in additive technology have focused on enhancing the efficiency and

effectiveness of cutting fluids under extreme machining conditions.

For example, sulfurized and chlorinated additives have traditionally been used to improve the lubricity of cutting fluids. However, the trend is now shifting towards the use of more advanced, environmentally friendly additives. These include boron-based compounds, polymer-based lubricants, and ester-based additives. These advanced additives not only provide excellent lubrication but also enhance the fluid's thermal stability, extending its life and reducing the need for frequent replacements.

Furthermore, the development of extreme pressure (EP) additives has enabled cutting fluids to perform exceptionally well in high-speed and high-temperature machining operations. These additives form a protective film on the tool surface, preventing metal-to-metal contact and reducing tool wear. This is particularly beneficial in machining hard-to-cut materials like titanium and Inconel, which are commonly used in aerospace and medical applications.

Microemulsions and Synthetic Blends

The formulation of cutting fluids has seen a shift from conventional emulsions to microemulsions and synthetic blends. Microemulsions are thermodynamically stable mixtures of oil, water, and surfactants, offering superior cooling and lubricating properties compared to traditional emulsions. They provide better wetting of the tool and workpiece surfaces, leading to improved heat dissipation and reduced friction.

Synthetic blends, combining the best attributes of synthetic fluids and conventional emulsions, offer a balanced solution for various machining applications. These fluids provide the high lubricity of oil-based fluids with the superior cooling capability of water-based fluids. As a result, synthetic blends are increasingly being adopted in industries where both high performance and environmental compliance are required.

Dry Machining and Minimal Quantity Lubrication (MQL)

Another significant development in metal cutting fluids is the trend towards dry machining and minimal quantity lubrication (MQL). While dry machining eliminates the need for cutting fluids altogether, it is only feasible for certain materials and operations. MQL, on the other hand, represents a middle ground, where a minimal amount of lubricant is applied directly to the cutting zone.

MQL systems use small quantities of high-performance lubricants, often delivered in a fine mist, to provide the necessary lubrication without the need for flood cooling.

This approach reduces the consumption of cutting fluids, minimizes waste, and lowers disposal costs. Additionally, MQL can improve the working environment by reducing the amount of airborne mist and the potential for fluid-related health hazards.

The development of specialized MQL fluids, designed to work efficiently at low volumes, has further propelled the adoption of this technique. These fluids are engineered to provide maximum lubrication with minimal residue, ensuring clean machining operations and reducing the need for post-process cleaning.

Digitalization and Smart Fluids

The advent of Industry 4.0 has brought digitalization to the forefront of manufacturing, and cutting fluids are no exception. Smart fluids, integrated with sensors and monitoring systems, are being developed to provide real-time data on fluid condition, performance, and consumption. These smart systems enable predictive maintenance, optimizing fluid usage and reducing downtime.

For example, smart sensors can monitor the pH, concentration, and temperature of cutting fluids, providing valuable insights into their condition and effectiveness. This data can be used to adjust fluid parameters in real-time, ensuring optimal performance and extending the fluid's life. Moreover, digital platforms can integrate fluid management with overall production systems, offering a holistic approach to machining efficiency.

Health and Safety Considerations

The health and safety of workers are paramount in any machining operation. Traditional cutting fluids can pose health risks due to the presence of harmful chemicals, such as chlorinated paraffins and sulfurized oils. Recent developments have focused on formulating cutting fluids that are safer for workers, reducing the exposure to hazardous substances.

Innovations in cutting fluid formulations have led to the reduction or elimination of toxic additives, without compromising performance. Furthermore, advancements in fluid delivery systems, such as MQL and mist control technologies, have improved the working environment by reducing airborne contaminants and fluid splashes.

Conclusion

The field of metal cutting fluids is witnessing rapid advancements, driven by the need for improved performance, sustainability, and safety. From bio-based and nano-enhanced fluids to smart systems and MQL, these developments are transforming machining processes, making them more efficient, environmentally friendly, and worker-safe. As industries continue to push the boundaries of precision and productivity, the role of cutting fluids will remain crucial, with ongoing innovations ensuring they meet the evolving demands of modern manufacturing. ■

INNOVATIONS IN METAL CUTTING: The Role of Inserts in Enhancing Speeds and Feeds

In the rapidly evolving world of manufacturing, metal cutting has remained a fundamental process, pivotal to various industries such as automotive, aerospace, and machinery. As demands for higher productivity, precision, and efficiency grow, innovations in metal cutting have become essential. Among the most significant of these innovations is the development of cutting tool inserts, which have dramatically transformed the landscape of metal cutting, particularly in enhancing speeds and feeds.

Understanding Metal Cutting and the Importance of Speed and Feed

Before delving into the role of inserts, it's essential to understand the concepts of speed and feed in metal cutting. Cutting speed refers to the distance that the cutting tool moves across the material surface per unit time, usually measured in meters per minute (m/min). Feed rate, on the other hand, refers to the distance the tool advances into the material with each revolution, measured in millimeters per revolution (mm/rev). Together, these parameters influence the rate of material removal, surface finish, tool life, and overall efficiency of the metal cutting process.

Traditionally, increasing the cutting speed and feed rate often led to higher material removal rates, improving productivity. However, this also posed challenges such as increased tool wear, heat generation, and potential compromise in surface finish. This is where cutting tool inserts have made a significant impact.

The Evolution of Cutting Tool Inserts

Cutting tool inserts are replaceable tips made from various materials, designed to withstand the extreme conditions of metal cutting. Over the decades, the development of these inserts has been marked by innovations in material science, geometry, and coatings, each contributing to improved cutting performance.

Material Advancements: Early inserts were typically made from high-speed steel (HSS), known for its toughness and wear resistance. However, the development of carbide inserts marked a significant leap in performance. Carbide, a composite material made of tungsten carbide and a metallic binder, offers superior hardness and heat resistance, enabling higher cutting speeds and feeds. Further advancements include cermet, ceramic, and cubic boron nitride (CBN) inserts, each offering unique properties for specific applications.

Geometry Innovations: The geometry of inserts, including the rake angle, clearance angle, and chip breaker design, plays a crucial role in determining cutting efficiency. Modern inserts are designed

with optimized geometries that reduce cutting forces, improve chip evacuation, and minimize heat generation. For example, positive rake angles help reduce cutting forces, while specially designed chip breakers control the size and direction of chips, enhancing surface finish and tool life.

Coating Technologies: Coatings have revolutionized the performance of cutting tool inserts. Coatings such as Titanium Nitride (TiN), Titanium Aluminum Nitride (TiAlN), and Diamond-like Carbon (DLC) provide a protective layer that reduces friction, enhances wear resistance, and improves heat dissipation. These coatings allow for higher cutting speeds and feeds by minimizing the adverse effects of heat and wear, thereby extending tool life and improving productivity.

Enhancing Speeds and Feeds with Cutting Tool Inserts

The primary objective of using advanced cutting tool inserts is to push the limits of speeds and feeds without compromising tool life or surface quality. Several factors contribute to the ability of inserts to enhance these parameters.

Heat Management: One of the most significant challenges in metal cutting is managing the heat generated during the process. Excessive heat can lead to rapid tool wear, dimensional inaccuracies, and poor surface finish. Advanced insert materials and coatings are designed to withstand higher temperatures, allowing for increased cutting speeds. For instance, ceramic and CBN inserts can operate at much higher temperatures than traditional carbide inserts, enabling them to cut at faster speeds without degrading.

Wear Resistance: Tool wear is inevitable in metal cutting, but its rate can be significantly reduced with the right insert material and coating. The wear resistance of inserts directly influences the feed rate; more wear-resistant inserts can maintain sharp cutting edges for longer, allowing for higher feed rates without sacrificing precision. Coated carbide inserts, for example, offer excellent wear resistance, enabling manufacturers to increase feed rates while maintaining acceptable tool life.

Chip Control: Efficient chip evacuation is critical to maintaining high speeds and feeds. Inserts with optimized geometries, particularly those with advanced chip breaker designs, help control chip formation and evacuation. This reduces the chances of re-cutting chips, which can damage the workpiece and tool, and ensures a smoother cutting process. Improved chip control also means that higher feed rates can be sustained without clogging or damaging the tool.

Surface Finish: Maintaining a high-quality surface finish while increasing speeds and feeds is a challenge that advanced inserts are designed to address. Inserts with specific geometries and coatings reduce friction and wear, minimizing surface roughness even at higher cutting speeds. For instance, inserts with DLC coatings provide a smoother cutting action, reducing the friction between the insert and the workpiece, which results in better surface finish at higher speeds.

The Impact of Industry 4.0 and Smart Manufacturing

As Industry 4.0 and smart manufacturing concepts gain traction, the role of cutting tool inserts in metal cutting is also evolving. The integration of sensors and real-time monitoring systems in cutting tools allows for adaptive control of speeds and feeds based on real-time data. This ensures optimal cutting conditions, further pushing the boundaries of what can be achieved with modern inserts.

For example, smart inserts equipped with embedded sensors can monitor parameters such as temperature, vibration, and wear in real-time. This data can be used to adjust cutting conditions dynamically, optimizing speeds and feeds for maximum efficiency and tool life. The result is a more intelligent, responsive manufacturing process that can adapt to varying conditions, further enhancing productivity.

Case Studies and Applications

Several industries have benefitted from the innovations in cutting tool inserts. In aerospace, where materials like titanium and Inconel present significant machining challenges due to their toughness and heat resistance, the use of advanced ceramic and CBN inserts has enabled higher cutting speeds and feeds while maintaining tight tolerances and surface integrity.

In automotive manufacturing, the push for faster production cycles has been supported by the use of coated carbide inserts. These inserts have allowed for higher feed rates and faster material removal in the machining of engine components, gears, and other critical parts, without compromising on quality.

Conclusion

The role of cutting tool inserts in enhancing speeds and feeds in metal cutting cannot be overstated. Innovations in material science, geometry, and coatings have enabled these inserts to push the boundaries of what is possible in modern manufacturing. As industries continue to demand higher productivity and precision, the ongoing development of cutting tool inserts will remain a cornerstone of metal cutting innovation.

With the advent of smart manufacturing and Industry 4.0, the future of metal cutting will likely see even greater integration of technology with cutting tools, further enhancing the capabilities of inserts. As manufacturers continue to explore the limits of speeds and feeds, cutting tool inserts will undoubtedly play a crucial role in shaping the future of metal cutting. ■

The Crucial Role of Tool Inspection in Ensuring **QUALITY AND PRECISION** in **METALWORKING**

In the world of metalworking, the pursuit of quality and precision is paramount. Whether it's the fabrication of intricate components for aerospace, the production of automotive parts, or the creation of heavy machinery, every aspect of metalworking hinges on exactness. At the heart of achieving this precision lies the often underappreciated yet critical process of tool inspection. Tool inspection plays a crucial role in maintaining the integrity of metalworking operations, ensuring that every cut, grind, and weld meets the highest standards.

The Foundation of Precision: Understanding Tool Inspection

Tool inspection in metalworking refers to the systematic examination of tools and equipment used in the machining and fabrication process. These tools include cutting tools, dies, molds, jigs, fixtures, and gauges, all of which must be maintained in optimal condition to guarantee the accuracy and quality of the final product. The process involves measuring wear and tear, checking alignment, assessing the sharpness of cutting edges, and ensuring that all components are functioning correctly.

This inspection process is not a one-time activity but an ongoing practice that must be performed at regular intervals. By doing so, metalworking facilities can prevent deviations that could lead to substandard products, equipment failures, and costly downtime.

The Impact of Tool Wear on Quality

One of the primary reasons for regular tool inspection is to monitor and manage tool wear. Over time, tools experience wear and tear due to friction, heat, and the physical stress of cutting through metal. If not properly managed, this wear can lead to a range of issues that directly affect the quality of the workpiece.

For example, a worn-out cutting tool can result in poor surface finish, inaccurate dimensions, and even tool breakage, which can damage both the tool and the workpiece. In industries like aerospace and automotive, where the tolerance levels are incredibly tight, even the smallest deviation can lead to component failure, which may have catastrophic consequences.

By regularly inspecting tools, metalworking facilities can detect early signs of wear and take corrective action, such as re-sharpening or replacing tools before they fail. This proactive approach not only ensures consistent product quality but also extends the life of the tools, leading to cost savings in the long run.

Precision Measurement: The Backbone of Quality Control

In metalworking, the adage "measure twice, cut once" is a guiding principle. Precision measurement tools such as micrometers, calipers, and coordinate measuring machines (CMMs) are essential in ensuring that both tools and workpieces meet exact specifications. These tools are themselves subject to regular inspection and calibration to maintain their accuracy.

Calibration of measurement tools is particularly important because even the most precise tool can drift out of specification over time. Regular calibration against traceable standards ensures that measurements remain

accurate, which is crucial for quality control. A miscalibrated tool can lead to incorrect assessments of both the tools and the workpieces, resulting in defective products.

The Role of Inspection in Tool Life Management

Effective tool life management is essential for optimizing production processes and maintaining quality. Tool inspection plays a critical role in this by providing valuable data on tool performance and wear patterns. By analyzing this data, manufacturers can predict tool life more accurately and schedule maintenance or replacement at the optimal time.

This approach, often referred to as predictive maintenance, helps avoid unexpected tool failures that can lead to production halts and costly rework. Additionally, it allows manufacturers to maximize the use of their tools, reducing waste and improving overall efficiency.

Advanced Techniques in Tool Inspection

With advancements in technology, tool inspection has evolved from manual checks to sophisticated automated systems. Modern metalworking facilities now employ advanced techniques such as laser scanning, 3D imaging, and computer-aided inspection to ensure the highest levels of precision.

Laser Scanning: Laser scanning is a non-contact method that uses laser beams to capture the precise dimensions of a tool or workpiece. This method is highly accurate and can detect even the smallest deviations from the desired specifications. Laser scanning is particularly useful for inspecting complex geometries that are difficult to measure using traditional methods.

3D Imaging: 3D imaging technology creates a digital representation of the tool or workpiece, allowing for detailed analysis of its shape and surface features. This technology is invaluable for inspecting tools with intricate designs, such as molds and dies, where precision is critical.

Computer-Aided Inspection: Computer-aided inspection systems use software to compare the measured dimensions of a tool or workpiece against the original design specifications. These systems can quickly identify discrepancies and provide real-time feedback, enabling immediate corrective action.

These advanced inspection techniques not only improve the accuracy of inspections but also speed up the process, allowing for more frequent checks and faster response times.

Tool Inspection and Compliance with Industry Standards

In many metalworking sectors, compliance with industry standards is not just a matter of quality but also of safety and legal requirements. Standards such as ISO 9001, AS9100 (for aerospace), and IATF 16949 (for automotive) include stringent requirements for tool inspection and calibration.

Adhering to these standards is essential for maintaining certifications and meeting customer expectations. Regular tool inspection ensures that all tools and processes conform to the necessary standards, reducing the risk of non-compliance and the associated penalties.

The Human Factor: Skilled Inspectors and Continuous Training

While technology plays a significant role in modern tool inspection, the human factor remains crucial. Skilled inspectors with a deep understanding of metalworking processes are essential for interpreting inspection data, making informed decisions, and ensuring that quality standards are met.

Continuous training and education are vital to keep inspectors updated on the latest tools, techniques, and industry standards. This ongoing investment in human capital ensures that metalworking facilities maintain the highest levels of precision and quality.

The Cost of Neglecting Tool Inspection

Neglecting tool inspection can lead to a cascade of negative consequences, starting with diminished product quality and escalating to equipment failure, production delays, and increased costs. In the worst-case scenario, it can result in catastrophic failures that endanger lives, particularly in industries such as aerospace and defense.

The cost of regular tool inspection is minimal compared to the potential losses from defective products, rework, and unplanned downtime. By prioritizing tool inspection, metalworking facilities can safeguard their reputation, ensure customer satisfaction, and maintain a competitive edge in the market.

Conclusion: A Pillar of Quality in Metalworking

In conclusion, tool inspection is a critical pillar of quality and precision in metalworking. It ensures that every tool used in the process is capable of performing to the required standards, thus guaranteeing the quality of the final product. Through regular inspection, proactive maintenance, and the adoption of advanced technologies, metalworking facilities can achieve the highest levels of precision, reduce costs, and enhance their overall efficiency.

As the demands for quality and precision continue to grow across industries, the role of tool inspection will only become more significant. By recognizing its importance and investing in the necessary tools, technology, and training, metalworking companies can continue to meet the challenges of the future while maintaining their commitment to excellence. ■

Trends and Challenges in Machining for AEROSPACE Applications

The aerospace industry is one of the most demanding sectors in manufacturing, requiring extreme precision, high reliability, and the use of advanced materials. As the industry continues to evolve, so do the machining processes that support it. From the development of lightweight, high-strength materials to the integration of Industry 4.0 technologies, the landscape of aerospace machining is rapidly changing. This article explores the key trends and challenges in machining for aerospace applications, shedding light on how manufacturers are adapting to meet the sector's ever-increasing demands.

Advanced Materials and Their Machining

Aerospace components are increasingly being made from advanced materials like titanium alloys, nickel-based superalloys, and carbon fiber-reinforced polymers (CFRP). These materials offer exceptional strength-to-weight ratios and high-temperature resistance, making them ideal for aircraft engines and structural components. However, their unique properties also pose significant challenges for machining.

- **Titanium Alloys:** Titanium's low thermal conductivity and high strength can lead to rapid tool wear and difficulties in heat dissipation during machining. To address this, manufacturers are adopting techniques such as high-pressure coolant systems, cryogenic cooling, and specialized tooling materials like polycrystalline diamond (PCD) and cubic boron nitride (CBN).
- **Nickel-based Superalloys:** Used primarily in turbine engines, these superalloys retain their mechanical properties at high temperatures. However, their hardness and work-hardening tendencies make them difficult to machine. Advanced cutting tools with wear-resistant coatings and adaptive machining strategies are essential to overcome these challenges.
- **Carbon Fiber-Reinforced Polymers (CFRP):** CFRP is valued for its lightweight and high strength, but its abrasive nature can cause rapid tool wear and de-lamination. Machining CFRP requires diamond-coated tools, specialized cutting techniques, and sometimes hybrid machining processes that combine conventional and non-conventional methods.

Industry 4.0 and Smart Machining

The adoption of Industry 4.0 technologies is revolutionizing the aerospace machining sector. Smart machining involves the integration of IoT devices, sensors, and data analytics to enhance manufacturing processes.

- **Predictive Maintenance:** By using sensors to monitor the condition of machining tools and equipment, manufacturers can predict when maintenance is required, reducing downtime and preventing unexpected failures. This is particularly critical in aerospace, where precision and reliability are paramount.
- **Digital Twin Technology:** Digital twins create a virtual replica of the machining process, allowing engineers to simulate and optimize operations in real-time. This technology helps in reducing the trial-and-error phase, improving product quality, and accelerating time-to-market.
- **Adaptive Machining:** Adaptive machining systems use real-time data to adjust cutting parameters dynamically. This is especially useful in machining complex aerospace components, where variations in material properties can impact the machining process. Adaptive systems ensure consistent quality by

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Additive Manufacturing and Hybrid Machining

Additive manufacturing (AM) is gaining traction in the aerospace industry, particularly for producing complex geometries that are difficult or impossible to achieve through traditional machining. However, AM is not a replacement for machining but rather a complement to it.

- **Complex Part Production:** AM allows for the creation of intricate parts with internal channels, lattice structures, and other complex features. These parts often require post-processing through traditional machining to achieve the required surface finish and dimensional accuracy.
- **Hybrid Machining:** The combination of additive and subtractive manufacturing processes is becoming more common in aerospace applications. Hybrid machines can build up material using AM techniques and then perform precision machining on the same platform. This approach reduces lead times and allows for the production of highly complex components with tight tolerances.

Quality Control and Inspection

In aerospace machining, maintaining the highest levels of quality is non-negotiable. With components often subjected to extreme conditions, any deviation from the specified dimensions or material properties can have catastrophic consequences.

- **Non-Destructive Testing (NDT):** NDT methods like ultrasonic testing, X-ray inspection, and computed tomography (CT) scanning are used to detect internal flaws in machined components without damaging them. These techniques are crucial for ensuring the integrity of aerospace parts, especially those made from advanced materials.
- **Automated Inspection Systems:** Automated systems equipped with high-precision sensors and cameras are increasingly being used for in-line inspection during the machining process. These systems can detect defects in real-time, allowing for immediate corrective actions and reducing the risk of defective parts reaching the assembly line.

Challenges in Machining for Aerospace Applications

While advancements in technology have improved aerospace machining, several challenges remain.

- **High Costs:** The cost of machining advanced materials and the need for specialized tooling and equipment can be prohibitively expensive. Additionally, the stringent quality requirements and the need for extensive testing and validation add to the overall cost of production.
- **Skill Shortage:** The aerospace machining industry requires a highly skilled workforce proficient in both traditional and advanced manufacturing techniques. However, there is a growing shortage of skilled machinists, which poses a significant challenge for the industry.
- **Sustainability:** Aerospace machining generates a considerable amount of waste, both in terms of material and energy consumption. The industry is under increasing pressure to adopt more sustainable practices, such as recycling materials, optimizing energy use, and reducing emissions.
- **Supply Chain Disruptions:** The global supply chain for aerospace components is complex and highly interconnected. Any disruption, whether due to geopolitical tensions, natural disasters, or pandemics, can have a ripple effect on the entire industry. Ensuring a stable supply of raw materials, tooling, and equipment is a constant challenge.

Future Outlook

The future of aerospace machining lies in further integration of advanced technologies, such as artificial intelligence, machine learning, and robotics. These technologies will enable even greater levels of automation, precision, and efficiency. Additionally, the continued development of new materials and machining techniques will push the boundaries of what is possible in aerospace manufacturing.

One area of particular interest is the potential for greater use of AI-driven process optimization. By leveraging vast amounts of data collected from machining operations, AI can identify patterns and suggest optimizations that humans might miss. This could lead to significant improvements in productivity and quality.

Another promising trend is the increased focus on sustainability. As environmental concerns become more pressing, aerospace manufacturers will need to find ways to reduce their environmental impact. This could involve the use of more eco-friendly materials, the implementation of closed-loop manufacturing processes, and the adoption of energy-efficient technologies.

Conclusion

Machining for aerospace applications is at the forefront of technological innovation, driven by the need to produce highly complex, reliable, and lightweight components. While the industry faces several challenges, including high costs, a shortage of skilled labor, and sustainability concerns, the ongoing advancements in materials, smart machining, and hybrid manufacturing offer promising solutions. As the aerospace industry continues to evolve, so too will the machining processes that support it, ensuring that the sector remains at the cutting edge of manufacturing excellence.

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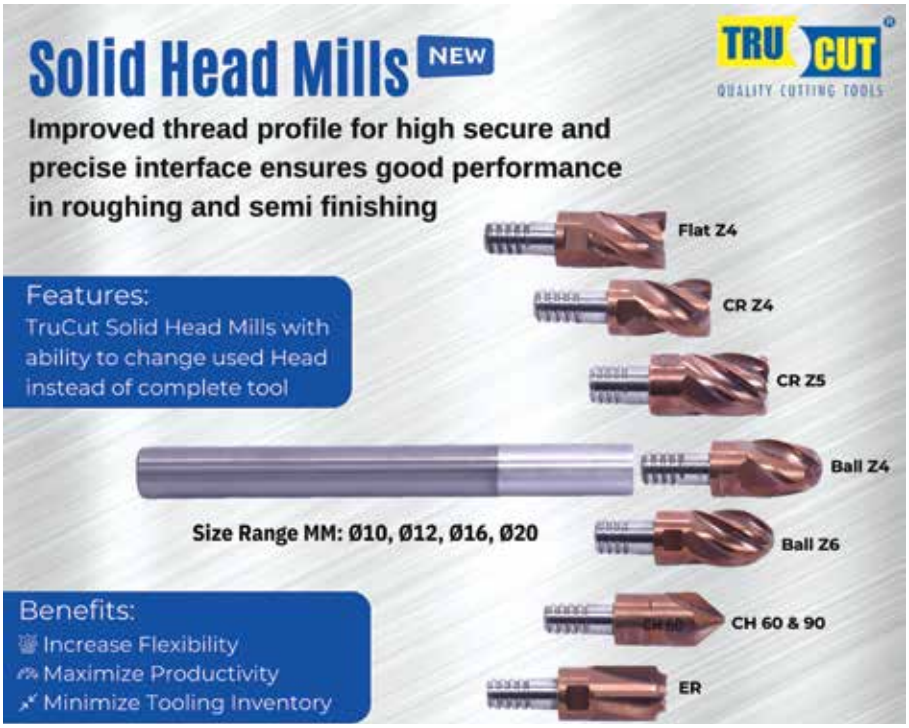
Quick Changeable Solid Carbide Head for Multiple Milling Process

TruCut Solid Head Mills are capable of milling operations by enabling quick head changes instead of replacing the entire tool, reducing tooling costs significantly. With high wear resistance, enhanced performance, and precision, these mills optimise productivity and flexibility, making them good for various applications and difficult-to-cut materials.

TruCut Solid Head Mills offer an innovative solution to reduce tooling costs by allowing the exchange of used heads instead of the entire tool. With an improved thread profile for a secure and precise interface, these mills offer excellent performance in roughing and semi-finishing, catering to various milling operations.



One tool for multi milling options

The TruCut Solid Head Mills tool facilitates quick head changes for diverse milling operations. By utilising Exchangeable Head Mills, significant cost savings are achieved through the ability to change the heads instead of changing the entire tool.

Features

The use of a highly secure solid head mills with shank interface ensures better performance for both in roughing and semi finishing. The solid carbide shank offers the highest levels of precision and stability, mainly for deep pocketing and long overhang applications. The exchangeable heads have higher wear resistance and the maximum level of tool life for machining titanium alloys, stainless steels and other difficult to cut materials.

Benefits

Quick and easy exchange between different solid carbide milling head profiles and types optimises milling operations while reducing manufacturing costs. Productivity is increased with the use of exchangeable solid head mills. Furthermore, the use of multiple heads enhances flexibility and minimizes the need for extensive tooling inventory.

Constant and predictable tool life

Consistent and predictable tool life ensures better tool life performance across a range of materials with resistance to builtup edge. The coating features strong adhesion to the carbide substrate, preventing delamination. The alternating layers are designed to prevent cracks from propagating to fracture, offering resistance to wear and oxidation.

New high-feed milling head

The enhanced tool lineup expands the series machining capabilities. It features an optimized cutting edge that facilitates smooth chip evacuation from the cutting area. This head is suitable for a broad range of applications, from precision machining to handling large size parts.

Optimal tool combination for Maximum productivity

Significantly reduced tool indexing time improves machining efficiency and productivity. The head indexing is easy and highly accurate with the precision thread. End users can choose the most suitable combination based on the machining parameters, length and application required. Carbide shanks are most preferred for maximum accurate machining due to excellent rigidity. Since only the head is indexed the setup is simplified and the Machine downtime is decreased considerably. Repeatability and accuracy are maintained due to full contact of both taper and face.

Application

Performs additional grinding of straight shank tools to fit customer applications for undercut taper neck types. The taper neck with a thick relief offers high rigidity, demonstrating stable cutting performance during deeper machining. This design is ideal for vertical wall machining because undercut type has a relief neck.

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Revolutionizing Tool Manufacturing: The VHybrid 260 - A Marvel of Precision and Adaptability

In an exclusive interview with Alexander Schmid, the visionary product manager at VOLLMER Werke Germany, we delve into the cutting-edge world of the VHybrid 260 sharpening machine, a technological masterpiece that seamlessly merges grinding and erosion processes.

Unraveling the "Hybrid" Essence

Derived from the Greek term for crossing or mixing, the term "hybrid" in the VHybrid 260 encapsulates the fusion of the best from both worlds – grinding and eroding. This technological marvel, inspired by VOLLMER's VGrind tool grinding machine, boasts two vertically configured spindles. The upper spindle is dedicated to grinding, while the lower spindle handles both erosion and grinding, making it a true hybrid in the realm of tool manufacturing.

Versatility At Its Core

The VHybrid 260 caters to the dynamic needs of tool manufacturers pursuing flexibility in their operations. Supporting the sharpening of both carbide and diamond tools, it stands as the epitome of adaptability. As global demand for intricate tools like full-head PCD tools rises, the VHybrid's combined machining prowess proves essential for precise and cost-efficient production.

Simplicity Meets Innovation

Addressing concerns about the complexity of operating a dual-technology machine, Schmid assures that VOLLMER relies on a proven concept. The machine's intuitive

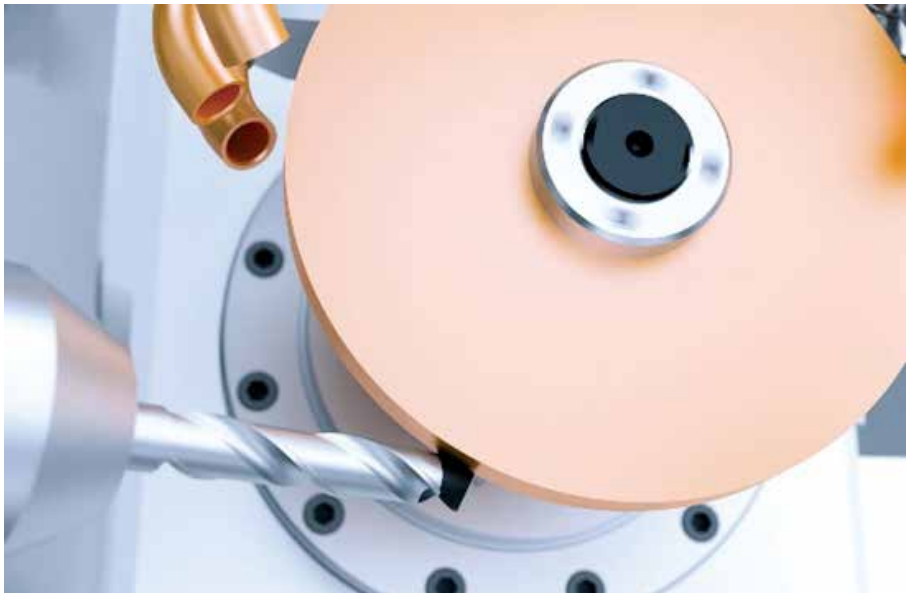
operation, coupled with familiar software solutions, ensures a seamless transition for users. The emphasis on unmanned operation further underscores the machine's user-friendly design.

Technology Behind the Advantages

The heartbeat of the VHybrid is the Vpulse EDM erosion generator, a technological marvel developed in-house. With a surface quality reaching an astonishing 0.05 µRA, the generator offers users the flexibility to prioritize efficiency or surface quality. The introduction of software-based V@ boost performance packages, enhancing machine performance by up to 35 percent, adds an extra layer of customization for tool manufacturers.

Charting New Frontiers

Targeting the global manufacturing industry's demand for PCD tools with diameters under 150 millimeters, the VHybrid 260 is positioned as a game-changer. At EMO 2023 in Hannover, VOLLMER showcased its ability to produce microtools with diameters as small as 0.45 millimeters, meeting the precision demands of industries such as electronics and medical technology.



Future Forward

For Alexander Schmid and the VOLLMER team, the journey doesn't stop at innovation. The focus remains on continual improvement, with an emphasis on automation and digitalization. Initiatives like the IoT gateway and V@dison underscore the commitment to leveraging smart technologies for enhanced flexibility and efficiency in sharpening processes. In the ever-evolving landscape of tool manufacturing, the VHybrid 260 stands as a beacon of ingenuity, blending tradition with cutting-edge technology to redefine what's possible. As the industry advances, VOLLMER's commitment to growth through smart technologies remains unwavering, heralding a future where precision and adaptability coalesce seamlessly. ■

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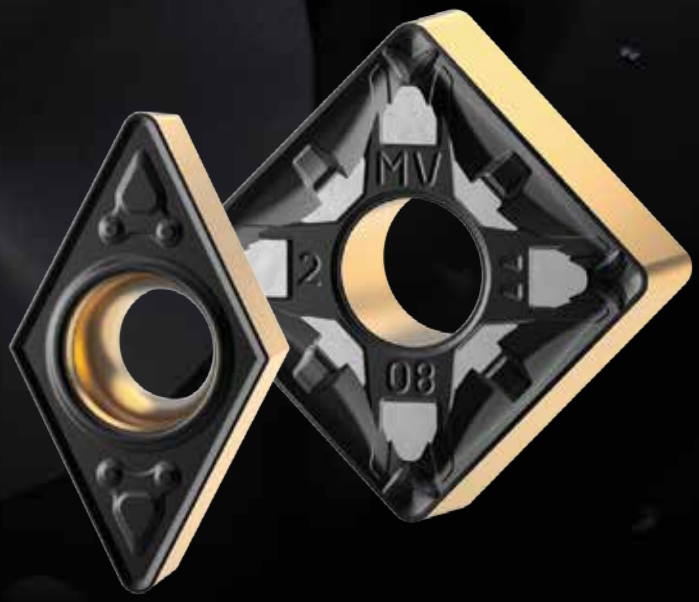

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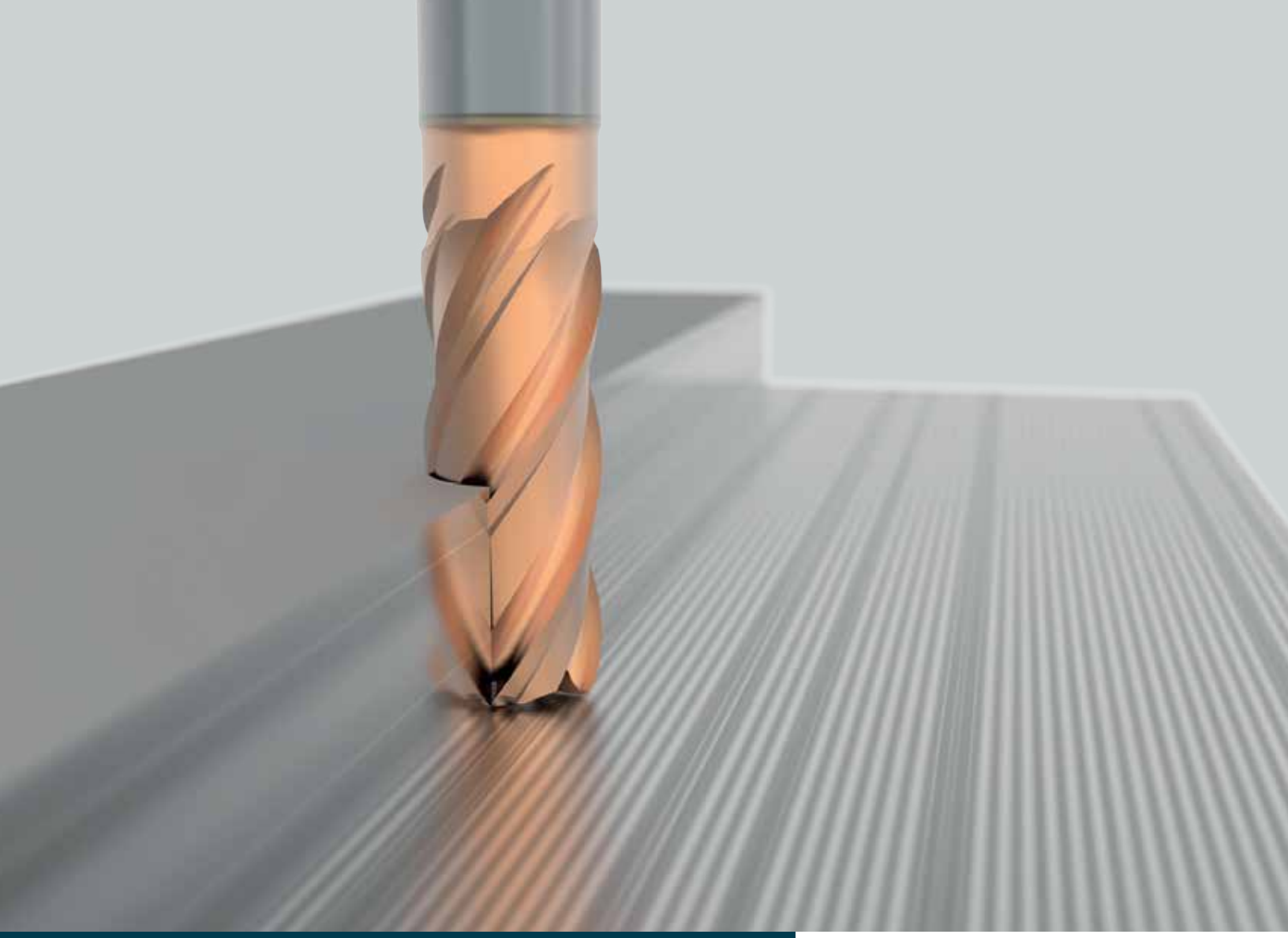

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