Precision and Innovation in Gear Cutting

Advanced cutting tools to meet changing market demands

NIDEC makes cutting tools in Japan, India and the United States with careful attention to base materials, coatings, heat treatment and design—all factors that affect accuracy and tool life.

Gear cutting has witnessed remarkable advancements over the years, with modern technologies transforming traditional methods into streamlined, highly efficient processes. NIDEC's tools and methodologies increase productivity and quality in manufacturing. This article delves into the technological innovations, market relevance, and advantages of their gear-cutting solutions.

Precision and Innovation in Gear Cutting

NIDEC has developed a wide range of cutting tools designed for precise gear manufacturing, including hobs, skiving tools, shaper cutters, shaving cutters, round broaches, keyway broaches, rotary cutters, chamfering tools, and fir tree broaches. These tools are utilized globally in gear production processes, particularly in sectors like automotive, aerospace, and robotics. NIDEC's emphasis is on advanced materials, coatings, and design to improve the performance and lifespan of cutting tools in gear manufacturing.

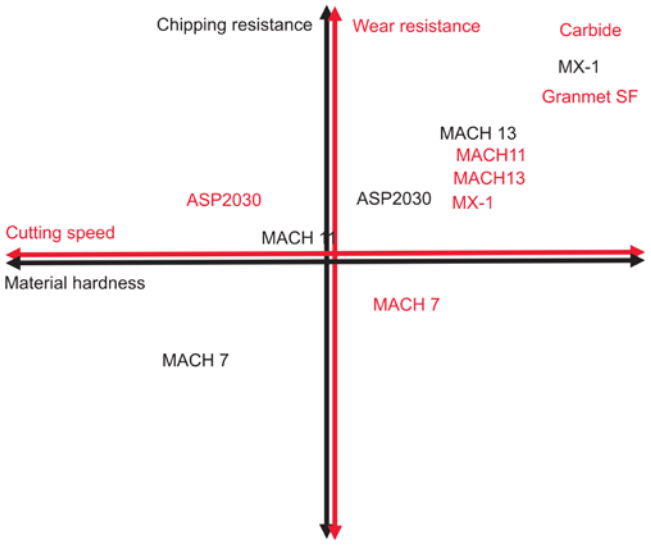
Cutting Tools Materials and Coatings for Gear Manufacturing

The performance of cutting tools in gear production heavily depends on the materials and coatings used. NIDEC has developed specialized materials and coatings to improve cutting efficiency, enhance durability, and reduce friction. For example, coatings like the Super Dry Coating are designed to improve the thermal resistance of tools used in high-speed cutting operations. These coatings prevent excessive wear by maintaining the tool's sharpness at elevated temperatures, extending tool life and enhancing productivity.

In addition, NIDEC has created coatings specifically for dry cutting, where no coolant is used. Tools with Super Dry coatings can operate effectively at cutting speeds up to 250 m/min, which contributes to reduced cycle times and lower operational costs. This technology is particularly useful in applications where traditional coolants would be difficult or undesirable to use, and it also supports environmental sustainability in manufacturing.

NIDEC's tools are also designed to be versatile, allowing them to be tailored to specific gear manufacturing requirements. The ability to customize these tools based on factors like the hardness of the material being processed and the type of gear being produced makes NIDEC's offerings highly adaptable to different production environments.

Helical broach by NIDEC.



Nidec's cutting tool material chart.

	Material	Wear Resistance	HI-Temp Hardness	Chipping Resistance	Appropriate Tool Use	Feature
Dissolution High Speed Steel	MACH3				Shaving	Improve Tool Life
	MACH5				Hob	Standard for wet cutting
	MACH7					Standard for dry cutting
	MACH11					For wet and dry use and tool life improvement
	MACH13					For wet and dry use and chipping resistance improvement
Powder Metal	MAC A				Shaping	For chipping resistance improvement
	MAC B				Shaping	Standard material
					Hob/Broach	Standard - chip. resistance
	MAC C				Hob	For hard to cut / high hardness materials
	MAC D				Broach	For hard to cut / high hardness material and tool life improvement
	MAC L				Shaping	For hard to cut / high hardness materials
	MX-1				Shaping/Hob	For hard to cut / high hardness material and tool life improvement
GRANMET SF					Hob	For high speed cutting
GRANMET BR					Broach	For broach corner wear, tool life improvement
GRANMET SK					Skiving Tool	For hard to cut / high hardness materials

Material	Type	Wear Resistance	Appropriate Use	Feature
Carbide	Series H	5 X or greater than high speed steel	Hob	High hardness material / high speed
	Series S	3 X or greater than high speed steel	Skiving and shaping	High hardness material

Material	Wear Resistance	Heat Resistance	Process	Type/Advantage	Hob	Shaping	Shaving	Broach
TiN			Wet	General purpose coating for wet cutting	○	○		○
Nano Dynamic			Wet	Coating for broaches, hard to cut material/anti-wear				○
Nano Dynamic II			Wet	Coating for broaches, improve surface, anti-wear				○
MightyShield ε			Wet	Coating for shaving tools, anti-wear, edge preservation			○	
SuperDry			Dry	General purpose coating for dry cutting	○	○		
SuperDry II			Dry	Coating for dry cutting, anti-wear	○	○		
SuperDry III			Dry	Coating for dry cutting, anti-wear	○	○		
MightyShield ∑			Wet & Dry	Anti-wear coating, suitable for all machining areas from wet to high-speed dry.	○	○		
MightyShield μ			Wet & Dry	Coating for fine pitch, anti-wear (thin film, even coating)	○	○		
MightyShield ∑II			Wet & Dry	Anti-wear coating, suitable for all machining areas from wet to high-speed dry.	○	○		
MightyShield α			Wet & Dry	Coating for carbide tools	○	○		

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Nidec's material and coatings chart.

Applications of Advanced Cutting Tools in Gear Production

Gear production involves a variety of processes, each with its own set of challenges. Hobbing, for instance, is commonly used for generating gear teeth, but it leaves behind tool marks that can affect the gear's performance. To address this, gear shaving is employed to refine the tooth profile, improving both precision and surface finish. The use of advanced materials in shaving cutters enhances their surface hardness, leading to longer tool life and more efficient operation.

After heat treatment, some gears require additional finishing processes, such as gear grinding or honing. Tools like carbide hob cutters have gained acceptance for finishing small-diameter gears post-heat treatment, as these gears may be too small to be processed on a gear grinding machine. Carbide hob cutters offer a combination of ultra-fine carbide particles, a specialized coating, and material that withstands the challenges of finishing after heat treatment.

Dry Cutting in Gear Manufacturing

The move toward dry cutting has become more prominent as manufacturers look to improve productivity while reducing costs associated with coolant usage. Dry cutting eliminates the need for coolants by using tools designed to withstand high temperatures generated during cutting. NIDEC's Super Dry Coating, which is used in gear hobbing, has been developed to improve the heat resistance of cutting tools, allowing them to perform at higher speeds without excessive wear. This enables gear manufacturers to achieve higher cutting speeds—up to 250 m/min—while increasing tool life and productivity.

In addition to improving tool performance, dry cutting also offers environmental benefits by reducing the reliance on coolant oils, which can be costly and difficult to manage. By utilizing coatings that improve the thermal properties of cutting tools, dry cutting systems can operate effectively without the need for lubrication or cooling fluids, leading to cleaner and more sustainable manufacturing processes.

Advanced Gear Cutting Techniques

In response to growing demands for high-precision gears, particularly in industries like automotive and aerospace, NIDEC has developed tools that support the latest gear manufacturing techniques. These techniques, such as gear grinding and honing, are used more frequently after heat treatment to achieve the desired accuracy and reduce gear noise and vibration. While grinding and honing typically involve additional post-heat treatment processes, these techniques ensure that the gears meet strict precision standards.

NIDEC's carbide hob cutters, designed for finishing post-heat treatment, are particularly effective in producing small-diameter gears. In contrast to gear grinding, which may not be suitable for these smaller gears, carbide hob cutters are capable of handling the complexity of post-heat treatment finishing. Their use has become increasingly common, especially in steering pinions and other components that require high precision.

Cutting Tool Design for Enhanced Precision

The precision of gear cutting tools is critical for ensuring that gears meet the necessary specifications for performance. Tool wear and vibration can lead to inaccuracies in gear profiles, which in turn affect the operation of transmission systems. To mitigate these issues, NIDEC designs its tools to minimize wear and enhance stability during machining.

For example, NIDEC's surface-treated shaving cutters are designed with increased surface hardness, which reduces wear and extends tool life. These cutters are also engineered with high rigidity, taking into account the elastic deformation of gear teeth during the cutting process. This combination of materials and design enhances tool performance and improves the consistency of the gear-finishing process.

The development of advanced cutting tools by NIDEC has significantly contributed to improvements in gear production, particularly in terms of precision, efficiency, and tool life. By focusing on specialized materials, coatings, and the integration of advanced manufacturing techniques, NIDEC has created cutting tools that meet the evolving demands of industries that require high-performance gears. These innovations help manufacturers achieve more precise, cost-effective, and environmentally sustainable gear production processes.

Conclusion

Cutting tools engineered for the gear industry continue to evolve rapidly, with innovations from companies like NIDEC driving efficiency and precision. By adopting advanced cutting tools, manufacturers can meet changing market demands and enhance competitiveness.

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