Milling

At the Right Angle

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In milling applications, 90° cutters are perhaps the most common tools. These versatile tools are used for milling square shoulders, slots, face operations bound by shoulders, edges, pockets, and cavities. Face mills perform machining by ramping and turn-milling. These 90° cutters prevail in the product range of tool manufacturers that produce general-purpose mills whether indexable, solid, or brazed.

In selecting 90°milling cutters, there are several factors to be examined such as the material to be machined, the removal of stock, required accuracy, surface finish, stability, and the characteristics of the machine tool in use. These factors influence the cutter type, cutting geometry, tool configuration, and more. The same factors are also the key points for choosing a cutter design on behalf of a tool manufacturer intended for its production processes. For example, solid mills provide ultimate machining accuracy while an indexable tool concept enables machining under heavy loads and provides additional cost-effectiveness per cutting edge. The cutting geometry of solid and brazed mills becomes complete only after grinding. In indexable mills, the shape of a sintered insert is the key contributing factor to achieve optimal tool geometry.

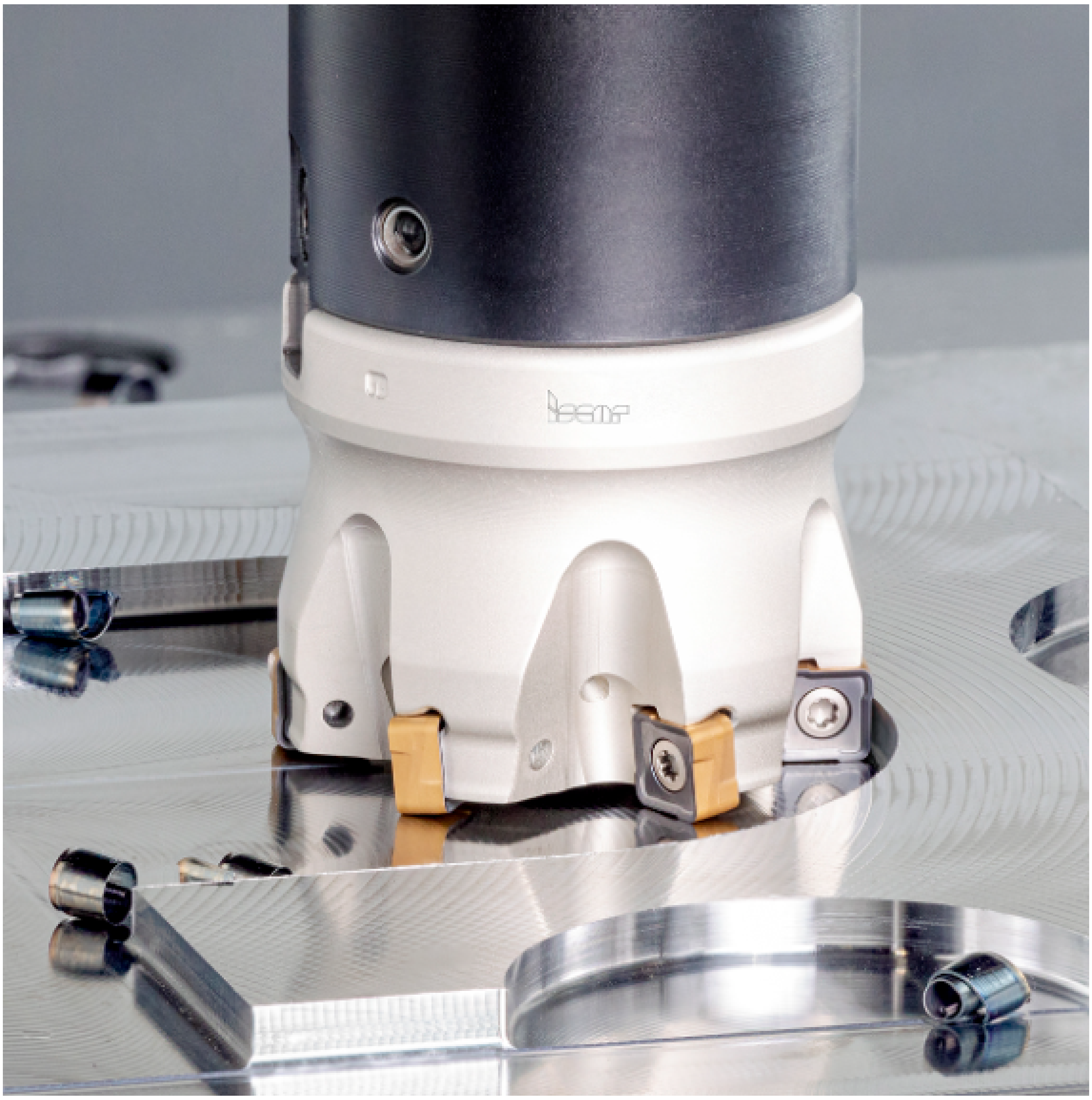

Fig.1 – The combination of a square profile with specially shaped rake and side faces is a design feature of cost-effective NEODO S890 inserts.

A quantum leap was achieved in the world of metalworking during the early 1990s with the introduction of the ISCAR HELIMILL – a family of 90° milling tools that introduced helical shaped edged inserts. A highly effective edge was generated by the intersection of the insert's top (rake) face and the helical insert side (relief) surface. This milestone geometric design formed a constant positive rake and a constant relief along the length of the insert's cutting edge. The groundbreaking feature caused a significant reduction in power consumption and ensured a very smooth cut. ISCAR's HELIMILL concept heralded a new design approach and benchmarked indexable milling by anchoring the geometry of an insert at the forefront of milling technology.

A polygon comprises the shape of inserts in 90° milling cutters. These inserts may be rectangular, square, parallelogram, rhombic, triangular or trigon (broken triangle). The shape of an insert determines the number of indexable cutting edges. There are additional important insert features, which relate to the insert's shape. A square or triangular insert features greater width compared to a rectangular insert shape. Increasing the insert width facilitates a larger central hole and enables using greater clamping screw sizes to improve the securing function of an insert. However, increasing the insert width limits the minimal diameter of a milling cutter and requires larger chip gullets, which reduce the strength of the cutter body. This is just one factor to consider when designing 90° milling cutters with indexable inserts. At the same time, there are other contributing elements such as the mounting method (radial, tangential), range of corner radii, a wiper flat, chip splitting functions, and more. It is imperative to consider the type of material being processed and the type of milling operation for which the cutter is designed.

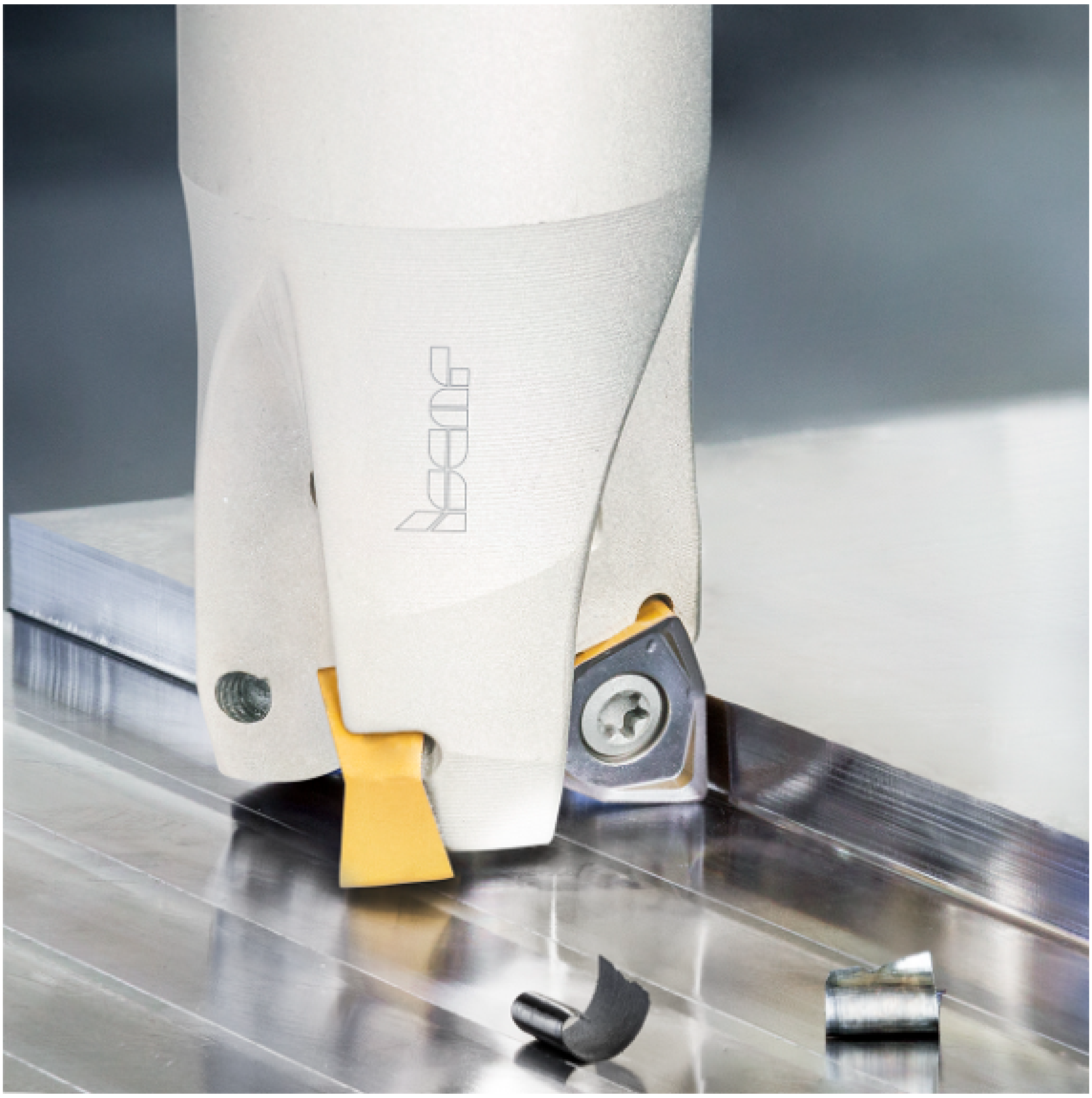

Fig.2 – A double positive cutting geometry characterizes HELIDO Trigon milling cutters that carry double-sided inserts of a "broken-triangle" profile.

A parallelogram shape provides an optimally harmonious combination of the cutting-edge length, varied corner radii, ramping-down capabilities, and additional parameters of the cutting geometry and insert strength. This explains why the parallelogram shape remains common. A significant disadvantage of the shape is the number of cutting edges – limited by two in a traditional design configuration. A double-sided, reversible insert concept seems to be the simple way to increase the number of edges on an insert more effectively. There are additional attributes to think about when considering a double-sided insert configuration. Additional limitations affect the relief angle and increase the axial rake of a milling cutter after the inserts are assembled on the tool body.

The examples mentioned must be considered when developing indexable milling cutters. The careful study of contributing factors and understanding the relationship between the intricately engineered elements can lead to a winning tool solution. To provide a wide array of solutions for 90° milling cutting, tool manufacturers develop multiple cutter shapes and innovative single- and double-sided indexable inserts.

With the many forms and shapes of cutters in the tool market, the creation of new geometries has become an obsolete task. ISCAR's NEOLOGIQ campaign has given birth to unique innovative milling solutions in an effort to conquer new quests for fast and productive milling solutions. ISCAR's prolific R&D design engineers invented the new NEODO S890 milling cutters designed for rough, semifinishing, face and square shoulder milling operations primarily for steel and cast iron (Fig. 1). The 90° cutter design places cost-effectiveness and productivity at its forefront, intended for milling under unfavorable conditions. The tool utilizes a strong-structured double-sided insert. The insert features a square profile, while the top, bottom and side face of the insert are specially shaped by ISCAR's unique pressing technology. This provides 8 helical right-hand cutting edges, 4 from the top and 4 from the bottom. When mounted on the cutter, the insert guarantees positive radial and negative axial tool rake angles, which promise smooth cutting and reduced power consumption for milling under diverse machining conditions and interrupted cuts. A dovetail profile of the insert pocket enables very rigid clamping that substantially increases cutter stiffness. The insert has a built-in wiper flat to improve surface finish. A new look on a square insert profile in combination with the advantages of pressing technologies has resulted in effective and economical solutions for face milling, particularly for machining close to shoulders where work holding constraints exist.

Fig. 3 – Multi-Master heads facilitate both spot drilling and chamfering.

The double-sided 90° HELIDO Trigon tool was derived from a trigon shape (Fig. 2). The insert configuration provides 6 indexable cutting edges and ensures higher tooth density for increased feed rate and maximized productivity. The tools have a double-positive cutting geometry: positive axial and radial rake angles. These attributes contribute to lower power consumption and allow rough milling applications on machines with limited power. The versatile HELIDO Trigon tools are suitable for milling shoulders, slots, side plunging and ramping by use of helical interpolation. The main advantage of these tools are the combination of 90° profile accuracy, productivity, and cost efficiency.

Efficient milling of aluminum alloys and other nonferrous materials (ISO N group of application) requires a sharp cutting edge and a polished rake face. The chip-splitting capability of a cutting edge is an additional tool to improve performance. The serrated edge geometry of the single-sided triangular HELI3MILL inserts, which have proven themselves as real workhorses in 90° milling, are cost-effective tools.

Case studies convincingly confirm the conclusion that the possibilities for improving 90° indexable milling cutters are not exhausted. A fresh right-angle on the cutter design will lead to an attractive solution, even when considering the redundancy in developing new insert geometries.

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