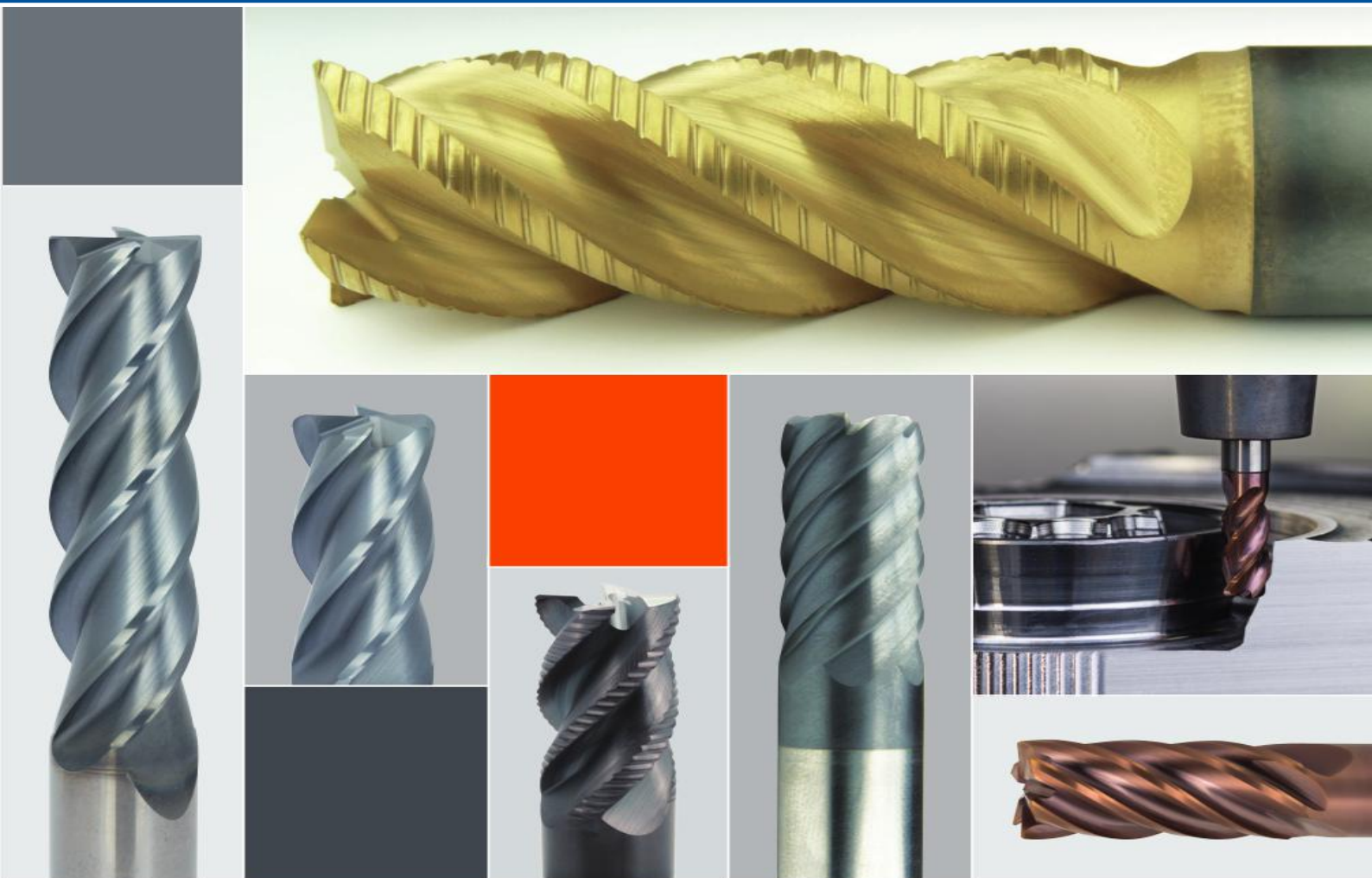


The introduction of end mill and application



The Modern CNC milling centers can use various tools to make the machine operators familiar with different types of milling cutters and how to apply them to daily milling.

This paper is aimed at helping customers to be able to identify different types of milling cutters and their uses.



Introduction

The rotating multi-blade milling cutter is used to produce three-dimensional shapes. Cutting tools can be programmed in almost any direction on the fixed artifacts. The milling cutters are used in the machine to remove the material movement and shape.

The audience

This paper is applicable to basic mills and milling machines with basic knowledge of milling machines and their operations. For anyone interested in the metal processing industry, this lesson is useful and they want to know about the material removal of CNC machining.

Purpose

Learn how to intuitively identify the most commonly cutting tool types in CNC milling operations and how these tools are applied in the daily milling process. Introduce the tools for milling and drilling operations to learners, as well as support configurations of common tools. The learners study the concept of spindle speed and feed rate.

Course objectives

After learning this lesson, you'll know how to:

- Know different types of common milling tools
- Know common drilling and threading tools
- Basic tools used to identify milling
- Identify the main tool materials and coatings
- Know the application of common end mill
- know how to distinguish cutting speed and feed rate
- know how to distinguish RPM and surface foot (SPM) per minute
- know how to distinguish the number of inches per minute (IPM) and every tooth inch (IPT)

Anatomy of a Milling Tool

The milling is a cylindrical milling cutter installed on a milling cutter and installed on the spindle of the machine tool.



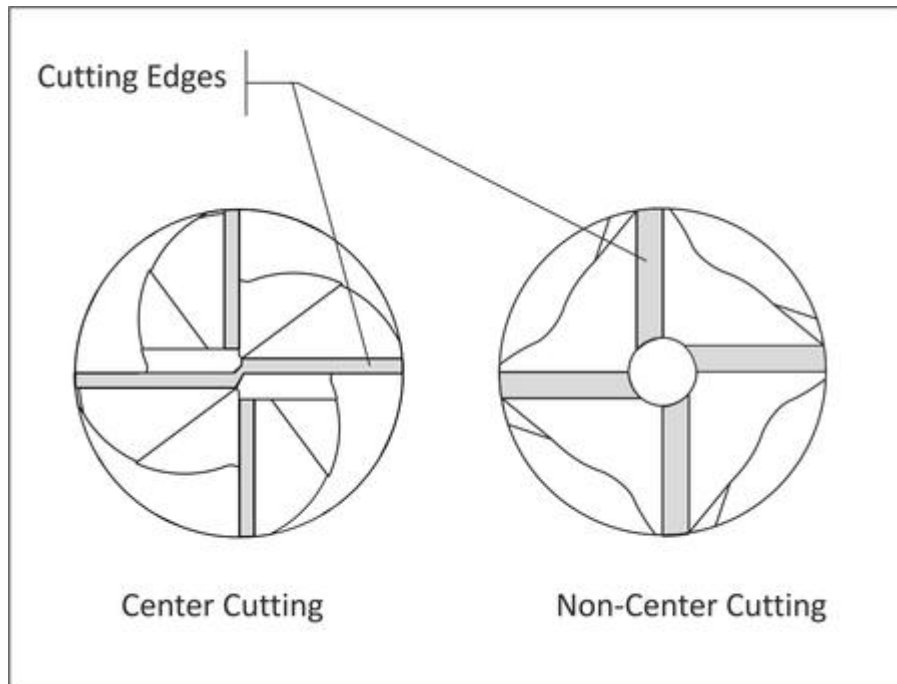
End Mills

The vertical milling cutter is the most common type of milling cutter. Vertical mills have different lengths, diameters and types.

Most general milling applications use square vertical milling cutter. It forms sharp edges in the bottom of the pocket and groove.



Vertical milling cutter can be center cutting and non - center cutting. As their name implies, the central cutting end mill has a cutting edge at the end and side of the cutter. Cutting end mills are the key to milling.



The non-central cutting end milling cutter is only used on the side cutting edge, only for side milling. These tools have a hole in the center.



Non Center Cutting

Rough mills have serrations on teeth that can quickly remove large amounts of material without causing vibrations. This sawtooth produces many small wafers and rough surfaces.



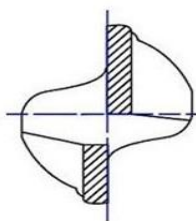
The ball end milling cutter forms a radius at the bottom of the pocket and groove. Ball end milling cutter is suitable for contour milling, shallow slot milling, contour milling and pocket application.



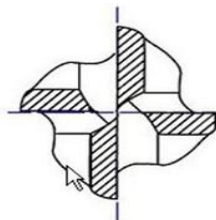
Flutes

The helical cutting edge is cut to the end of the end milling cutter, providing a channel for the chip to fall in the cut slot or pocket.

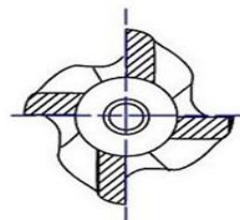
The most common choice is 2,3 or 4 blades. The more blades, the greater the cutting angle, but the narrower the evacuation path.



2 Flute
Center
Cutting



4 Flute
Center
Cutting



4 Flute
Non-Center
Cutting

An important consideration when choosing the number of edges is the "chip load".

"Chip load" refers to the thickness of the material taken from each cutting edge during the cutting process.



The number of edges you select depends mostly on the material you want to cut and the ability of your machine.

Materials like aluminum produce a lot of debris more than other materials. For this reason, the four-edged vertical milling cutter is rarely used on aluminum because the edge of the blade will get stuck or break the knife.

For tougher material, you need to use more blades. Having more blades can reduce the load on the chip and improve surface finish.

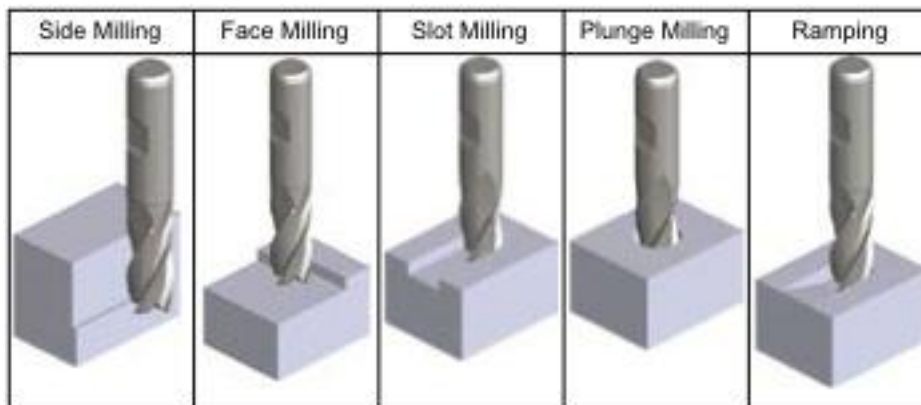
Although the number, direction and type of cutting tools vary widely, the most commonly used milling cutters have two threaded slots and upward spiral grooves for

cutting.

- The two edges have the largest blade space, making more chip carrying capacity on soft material. It is mainly used in cutting and bagging processing of non-ferrous metal materials such as aluminum.
- Three-flute: allow for better parts using harder materials. These three blades provide greater power and grooves and slots, black and black material.
- Four-flute/multi-flute: suitable for milling. The extra blade allows faster feed speed to be

The most common numbers of the blade in the milling operation are two (better chip space) and four (better surface finish).

Applications for End Mills



End Mill Materials

The vertical milling cutter is made from a cobalt alloy (called a high-speed steel or high speed steel) or a cobalt lattice of tungsten carbide.

- High speed steel (HSS) : good wear resistance, lower cost than cobalt or carbide end milling cutter. HSS is a universal milling for black and non-ferrous metal materials. HSS does not provide the cutters or speed advantage of cobalt and hard alloy end mills, although they are usually cheap.
- Cobalt: cobalt is the M42 tool steel with 8 % cobalt. Cobalt is more expensive than HSS (M7) but has better wear resistance and toughness. Since the tool is running at 10 percent faster than high speed steel, the removal rate and precision of the metal are superior to that of high speed steel.
- Solid carbide: carbon is harder, harder, and more durable than HSS. However, carbon is brittle and fragile and not easily worn. Hard alloy is mainly used in coating applications. Hard alloy cutting tool is suitable for new type milling machine or machine tool, and the spindle wear least. Rigidity is the key to using cemented carbide tools. The carbide end milling cutter may require a higher price than the cobalt end milling cutter, but they can also work at a speed of 2.5 times faster than the HSS end milling cutter.

The selection of tool materials depends on the cutting of the material and the maximum spindle speed of the machine. The smaller milling machine may not be able to achieve the recommended spindle speed of carbide end milling cutter.

End mill paint

The use of the coating increases the surface hardness of the tool. This will allow longer tool life and faster cutting speed.

The standard coatings include titanium nitride (TiN), titanium carbide (TiCN) and aluminum nitride (AlTiN).

Long life tin (titanium nitride) coating is suitable for alloy steel, aluminum, and plastics. The color is gold.



Titanium nitride coating has better wear resistance than TiN coating and is an ideal material for ductile iron, stainless steel, aluminum, plastic and other ductile iron materials. The colors are blue and grey.

End Mill Materials

Super life AlTiN (aluminum nitride) coating is the best high feed speed and high temperature application. Used for cast iron, stainless steel, nickel base alloy and titanium. Not applicable to aluminum. The color is blue.



Choosing to use the coated vertical milling cutter is a cost and benefit choice. If you have enough high quality paint to get extra performance, buy end mills and coatings.