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Fluted End Mills- ME Featured February 2021

Fluted end mills are used in one of the oldest mechanized machining processes—milling—but cutting-edge software, machine tools, novel strategies, ever-improving techniques and design updates in the tools themselves set them squarely in the modern age. The machinist who masters the art of these helix-shaped metal eaters can save his shop time and money while producing superior parts.

“Dynamic milling is defined as a method that is done with large axial depth of cut and small radial depth of cut to reduce the engagement time of the cutting edge of an end mill, which reduces the force load on the tool and spindle and the generation of cutting heat, while increasing the amount of material removed,” said Tyler Hashizume, Product Engineer II, OSG USA Inc. (St. Charles, IL.)

Dynamic milling refers to the realization of efficient machining, he said. It relies on the ability of CAD/CAM software to create the trochoidal milling program, which is the basic concept, and the ability of the machine to read complicated trochoidal milling programs at high speed, and also the ability of the machine to move the spindle and table at high speed.

“But once these conditions are met, it is possible that not only high efficiency is achieved as a result, but also the tool life and the life of the machine spindle are greatly extended,” said Hashizume. “In such an environment, it is less important to consider chip evacuation by enlarging the chip pocket of the end mill, but rather it is important how to increase the number of flutes to increase the tool rigidity and feed rate to achieve high efficiency.”

In contrast to a completely linear radial tool path in conventional machining, trochoidal milling takes advantage of a spiral (or “D”-shaped) tool path with a low radial depth of cut to reduce load and wear on the tool. Since trochoidal milling uses a tool to machine a slot wider than its cutting diameter, the same tool can be used to create slots of varying sizes, rather than just one size. This can free up space in the tool carousel and save time on tool change outs, depending on the requirements of the part.

These strategies change the way a machinist can tackle a job, and it’s becoming more possible and popular for machinists to use four, five, six, and seven-flute end mills to do both roughing and finishing, eliminating the need to fill up the tool carousel a full array of fluted end mills. These modern strategies mitigate the need to bury the tool into a part and any worries about getting chips clogged up in the flute gullets which can lead to a broken end mill and the failure of the part in progress.

By eliminating the need to change out one mill for another and employing more cutting-edge techniques today’s machinists can go faster, which leads to increased productivity.

The question is how can a machinist seemingly defy the laws of physics and use the speed of a higher flute tool without clogging it with chips and causing it to break? The most meaningful technological advancement that makes that happen is in new programming strategies. Specifically, different CAD/CAM software, with sophisticated tool path generation built in allows programmers and machinists to generate more efficient tool paths that allow speed but prevent the tool from getting into danger zone areas. The software’s approach is very specific so that the mill is never over-engaged with the part. Users can tell CAM software, “I don’t want to exceed this amount of tool engagement,” and the application will create the toolpath necessary to ensure the tool never gets engaged beyond the point he defined.

Chips Limit Number of Flutes

Is there a limit on the number of flutes for one end mill?

The main method of manufacturing end mills is grinding using automatic numerically controlled grinding machines, said OSG's Hashizume. As long as they are manufactured using such processing machines, the capabilities of CAD/CAM applications and the processing machines themselves impose limitations on the number of flutes possible, especially the size of the grinding wheel.

"The larger the outer diameter of the end mill manufactured, the bigger the space that can be used for one cutting edge, and the more cutting edges that can be manufactured," said Hashizume.

Information provided by OSG USA, Inc.