CNC Machining Capability Study Using Full Carbide Tooling

Timothy Moye
Western Kentucky University

Background

Computer Numerical Control (CNC) machining is the long established norm in advanced manufacturing. Many of the cutting tools available for these machines use replaceable carbide insert cutting tips. The cutting speeds and feeds for these tools are well known. However, many smaller shops which do not run the same parts over and over often use full carbide tools ground from a solid piece of ceramic. They are more expensive than replaceable inserts, but are cheaper since they can be purchased for a specialized single task that the replaceable inserts might not be optimized to handle. In addition, they do not have to buy the holder for the inserts.

Purpose

The focus of this work is to generate a protocol for the selection of appropriate speeds and feeds for solid carbide tools in a vertical CNC milling machine. The desire is to replace generic tables of cutting speeds and chip loads with a procedure that accommodates the entire system: material, machine, tool, cutter, and workholding.

Design/Method

A standardized cutting profile was established for each test. The machine was run at the maximum material removal rate that resulted in a chatter-free cut, with tool chip load and cutting depth held constant. Once the maximum spindle speed was found, the depth of cut and radial width of cut were varied to find stable points of operation.

Results

Cutting speeds, feeds, and chip loads were found that generally exceeded the stated table values. The procedure was found to be simple to use, but the work required to include the different motions (roughing, finishing, slotting, etc.) proved to be extensive if a wide range of tools were included in the tool library.

Conclusions

The methodology of setting the feeds and speeds to maximum material removal rate without chatter was proven to be effective. In general, solid carbide endmills were limited by chatter conditions rather than erosion, wear, or breakage. Limiting the machine to stable chatter-free operation proved to be the best operating point. However, changes to toolpath during the CAM development could result in chatter conditions at conditions which should have been stable. Many of these were found to be actually above the material removal rate predicted, implying the tool is overloaded. In addition, poor workholding and thin material sections can rapidly change the tool to a chatter condition when least expected. As long as the tool selection was repeatable over time, the results were found to be consistent. If different tools with different coatings were used, the tests would periodically need repeating.