Effects of Milling Method and Cutting Speed on Machinability in High-Speed Face Milling of Inconel-718 Under Emulsion Flood Cooling Using Shell Mill Inserts

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ABSTRACT
Machinability of difficult-to-cut metals like Inconel-718 used in aerospace and nuclear industries has gained a lot of interest over the years due to the need to reduce machining cost and improve machinability. This paper presents the results on experimental investigation of the effects of face-milling methods and cutting speed on high speed machining of Inconel-718 under conventional emulsion (7% concentration of semi-synthetic oil) cooling strategy, using shell mill with coated carbide inserts. Cutting force components and burr formation were the machinability response parameters investigated under 0.1 mm constant chip load (feed per tooth) and cutting speeds of 30, 40 and 50 m/min. The results showed that, increasing the cutting speed from 30 m/min to 40 m/min drastically reduced the resultant cutting force but further increase from 40 m/min drastically increased the cutting force for up- and down milling. Thus cutting speed of 40 m/min is the optimum cutting speed for milling Inconel-718 that generates the lowest resultant cutting force and longer machining passes (longer tool life). Down milling generates lower cutting force components and resultant cutting force, and longer tool life (longer machining passes) than up-milling. The combination of down milling and cutting speed of 40 m/min generates the lowest cutting force and longer tool life (longer machining passes (14)), followed by down-milling at 30 m/min. Up—milling at all three-cutting speed of 30, 40, 50 m/min is not good for machining Inconel-718 as it generates the highest cutting force components and resultant cutting force and shortest tool life (shortest machining passes). Up milling at 50 m/min generates the highest cutting force and the shortest tool life (lasts for only two passes), followed by up-milling at 30 m/min (4 passes), and up-milling at 40 m/min (5 passes). The cutting forces and vibration were more stable and controlled under down milling than up-milling in face milling using coated carbide inserts on shell mill. In face milling, down-milling using optimum machining parameters: cutting speed of 40 m/min axial depth of cut of 2 mm, radial depth of cut of 6.25 mm, and chip load of 0.1 mm under 7% concentration of semi-synthetic emulsion cooling strategy is recommended when face milling Inconel-718 with coated carbide inserts.