Finite Element Simulation of Cryogenic Milling of Ti6Al4V

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Abstract. Although Titanium-based components are used in many advanced applications, its machinability is still an open challenge. If the cutting parameters that are typically adopted for other materials are used for machining titanium alloys, the tools are subjected to an excessive thermal load that drastically reduce their duration. In order to assure an acceptable productivity of the machining operations, a coolant (oil-water emulsion) is needed to limit the temperatures in the cutting region. However, the high costs for the coolant purchasing, for its maintenance and for its disposal, together with the associated risks for the environment and for the human health, make the manufacturing sector demanding for feasible alternatives. Cooling the process with cryogenic fluids (Liquid Nitrogen LN2) seems both an environmentally-friendly and a profitable alternative to conventional cooling although, a lack of knowledge is affecting its applicability in the shop-floors. In order to bridge this gap, three-dimensional Finite Element FE simulations of both dry and cryogenic milling of Ti6Al4V were developed in this research work. Cutting tests were carried out in order to validate the simulation models that showed a good agreement with the experimental observations for what concern the cutting forces and the chip morphology.