DEVELOPMENT OF A NUMERICAL MODEL FOR THE CRYOGENIC MACHINING SIMULATION APPLIED TO A NICKEL SUPERALLOY

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Abstract. Nickel superalloys are used in all the applications where high temperature and corrosion resistance are required, for example in aerospace, nuclear and oil&gas fields. Often defined as difficult to cut, these alloys are currently the most used materials in production of turbines of aircraft jet engines, stator parts and combustion chambers. Machining of superalloys is characterised by low productivity, poor surface quality and short tool life because of the high temperature reached during the process. So cutting fluids are used to cool and lubricate the cutting area; however, conventional fluids are often expensive for the difficult in their disposal management and represent a considerable risk for workers' health. In the last years, in order to solve environmental sustainability issues tied to these processes, the cryogenic machining with liquid nitrogen (LN2) has been developed. The cryogenic cooling effect is particularly interesting in difficult to machine materials but it presents some problems, e.g, cryogenic fluid affects material thermomechanical behavior. A small number of studies explore this aspect and moreover, the cooling approach for effectively using cryogenic machining and dispensing method shall be identified. In this sense, FE simulation can be considered a valid support tool for the process understanding. Furthermore, in this work a 3D numerical model in TWS AdvantEdge FE machining code has been developed. This model has been calibrated and validated with a comparison between simulations results, in term of cutting forces and temperatures, and experimental data.