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Economical Comparison of Cryogenic Vs. Traditional Turning of Ti-6Al-4V: a Case Study

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Sommario/abstract

As demonstrated by previous works by the authors, an improvement of productivity for Titanium alloys can be obtained by adopting cryogenic cooling during the machining operations. The present work shows the features of a toolholder specifically designed for cryogenic adduction in turning operations. The paper compares tool life results between traditional and cryogenic rough turning by adopting Grade 5 titanium as the working material. Rough turning is economically more relevant to the machining industry, especially in the aerospace field where generally a large quantity of rough material has to be removed due to the very high buy-to-fly ratio of aerospace components. A full factorial experimental plan was performed basing on typical rough turning parameters. Taylor's law for cryogenic and traditional cases was calculated and an hypothetical production scenario for Ti6Al4V parts was analysed. An analytical model to calculate production costs and time was built for both cooling methods. The results show that the benefits in terms of tool life offered by liquid nitrogen cooling allows to improve productivity by adopting higher optimal cutting parameters. This improvement, coupled to an increase of tool life, is very significant and allows not only to reduce time of production but also to cover the major costs of liquid nitrogen and have a slight reduction of machining total costs.

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