

Cryogenic lubricoolant machining on difficult-to-cut alloys

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Abstract (300 word limit)

Nowadays, environmental consciousness is taking relevance in the society. This situation involves some consequences in the manufacturing processes with the aim of improving this philosophy. In the particular case of machining operations, the target is reducing the use of cutting fluids to assist the process. It has to be taken into account that these cutting fluids are based on mineral oils and consequently, its use is environmentally inefficient. Besides, according to several authors, its use represents between 17% and 30% of the total manufacturing costs. Therefore, looking for other lubricooling alternatives is a big challenge to be faced. Among these alternatives, CryoMQL, which combines CO2 cryogenic cooling and MQL, is presented as a full solution reaching a balance between environmental and economic issues. In Figure 1 is shown several performances of its use.

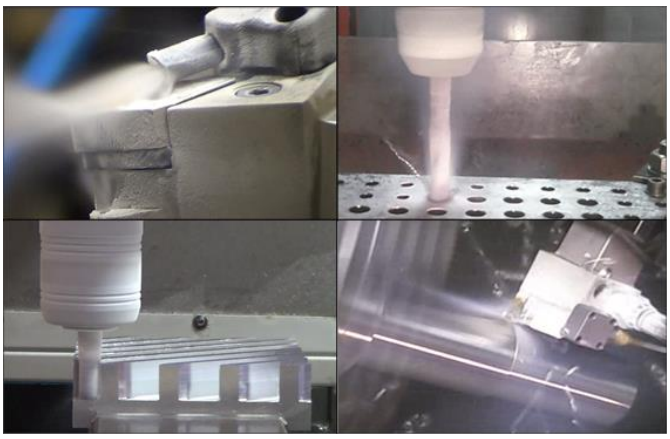


Figure 1. Cryogenic machining performances

Furthermore, this lubricooling technique takes relevance during the machining processes of heat-resistant superalloys. The use of these alloys, known also as difficult-to-cut materials, is growing worldwide in aeronautical industry related to turbomachinery components. In particular, Inconel 718 superalloy is one of the most used material in this sector to manufacture turbofan critical components due to its high hardness combined with a good tensile strength at high temperatures. However, this material presents some challenges during machining processes leading to high cutting forces, low material removal rates, and other problems that may cause premature tool breakage which needs to be avoided.

Therefore, in order to improve milling processes in Inconel 718, in this paper is presented a new lubricooling technique of applying CryoMQL in which CO2 is used as internal tool coolant with the aim of reducing its consumption. The results show that its use improves the current process, not only from an environmental point of view, but also from economic and technical point of view, reaching a technology known as “ECO2 milling performance” (economy + ecology).

Key words: Cryogenic machining, CO2 machining, CryoMQL milling, Inconel 718 milling, difficult-to-cut alloys, ECO2-performance

Recent Publications (minimum 5)

1. González H, Calleja A, Pereira O, Ortega N, López de Lacalle LN, Barton M (2018) Super abrasive machining of integral rotary components using grinding flank tools. Metals 8:24
2. Pereira O, Martín-Alfonso J.E., Rodríguez A, Calleja A, Fernández-Valdivielso A, López de Lacalle LN (2017) Sustainability analysis of lubricant oils for minimum quantity lubrication based on their tribo-rheological performance. J. of Cleaner Production 164:1419-1429.
3. Pereira O, Rodríguez A, Barreiro J, Fernández-Abia AI, López de Lacalle LN (2017) Nozzle design for combined use of MQL and cryogenic gas in machining. Int. J. of Precision Eng. and Manufacturing-Green Technology 4:87-95.
4. Pereira O, Rodríguez A, Fernández-Abia AI, Barreiro J, López de Lacalle LN (2016) Cryogenic and minimum quantity lubrication for an ecoefficiency turning of AISI 304. J. of Cleaner Production 139:440-449.
5. Pereira O, Rodríguez A, Fernández-Valdivielso A, Barreiro J, Fernández-Abia AI, López de Lacalle LN (2015) Cryogenic hardturning of ASP23 steel using carbon dioxide. Procedia Engineering 132:486-491.

Biography

University Professor of the Department of Mechanical Engineering at the University of the Basque Country (UPV/EHU) and director of the Aeronautics Advanced Manufacturing Center (CFAA). He is also head of the high-performance manufacturing line. He manages international I+D+i projects with several companies and research centers. Ph.D. for more than 20 years, nowadays his research lines are focused in machining processes for difficult-to-cut materials and green manufacturing. He has 3 books, more than 115 JCR international articles, 60 international conference papers and 5 patents among others. He has H-index of 42.

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