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# Analysis of CO2 dry ice projection on Al 7075, applied to drilling and milling operations

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**Abstract**

Quite a long time the machining industry purchases the aim to remove traditional cutting fluids in machining processes, due to all the inconveniences that conventional refrigeration involves. Nowadays and especially in technological sector such as aeronautical, it is a trend to develop new refrigeration techniques in order to replace the based oil coolants.

The present research compare three different refrigeration process applied on Al 7075. Pressured air, cryogenic machining, using CO2 as coolant agent and dry machining, without the use of any cutting fluid. On this purpose, a series of experiments are carried out in order to analyze the impact of cutting fluid on tool wear and surface quality, for parts under roughing and finishing machining conditions.



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*Keywords:* cryogenic machining, CO2, refrigeration, tool wear and roughness.

## 1. Introduction

In the field of mechanical manufacturing and concretely attending to technologies of cutting lubrication and refrigeration, today is a trending the research in the area of cryogenic refrigeration. This technology is based on use a refrigerating agent such as liquid nitrogen, or CO2 to get negative temperatures applied directly on cutting area.

The temperature reached during machining and its distribution affects directly to cutting force and to chips removal. All of these facts give to refrigeration during machining produccion a critical priority in order to extend the service life of tools by reducing HAZ (heating affected zone) [1].

It is known that conventional cutting fluids have several inconveniences, one of the most important is their low capability to get into the area between chips and tool and this fact reduced the coolant effectiveness. This efficiency loss in heat dissipate, is increased furthermore in cases that high temperatures are reached [2].

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These cryogenics fluids also have the capability of a naturally and quickly evaporation, being in this way thrown off to the atmosphere, so keeping machined part completely free of cutting fluids impregnations and residue [3]. This kind of wastes is nowadays an important problem that affects to machine, chips and workplace and the elimination of them carry on expenses from fluids management and collateral waste [4].

In Ti-6Al-4V, used in aeronautical applications, have been found a few results so as to the increase productivity in operations with cryogenic refrigeration [5]. The main reason involves a HAZ reduction and consequently in cutting force and tool wear. In the same way has been found a lower friction between chips and tool [6]. These results pursuing a yield increases, on machining process.

M. I. Ahmed et al. analyze on their research, the process from an energy point of view. As they showed in this publication, one of the essential trouble during machining operation is heat and high temperature reached. The energy spend on machining operations is converted to heat. To remove it, the authors presented a coolant agent projection (LN2 for Ahmed) through the tool by using different geometrical configurations, increasing, the tool service live 30 times at least [7].

The present comparative is proposed as a first step into a higher research. The main objective of this mentioned research is to increase machinability conditions and improving on surface quality on aeronautical materials [8]. In this case applied to aluminum 7075, by using cryogenic refrigeration strategies, in this case a liquid CO2 projection on cutting area [9].Here introduce the paper, and put a nomenclature if necessary, in a box with the same font size as the rest of the paper. The paragraphs continue from here and are only separated by headings, subheadings, images and formulae. The section headings are arranged by numbers, bold and 10 pt. Here follows further instructions for authors.

## 2. Methodology

As has been mentioned, the experimental procedure has been done comparing two different machining operations, roughing and finishing, using different refrigeration techniques, dry, air and cryogenic machining. The dry machining doesn´t use any support fluid for the refrigeration, the cryogenic machining uses liquid CO2 at a pressure of 30bar and -90□C and the air machining uses compressed air at 8 bar, its temperature depends on the room temperature and the humidity, but in this case, it could fixed around 10□C. All this experimentation methodology is defined by two principal variables groups, the machining and the measuring ones.

Machining variables were defined as follows: refrigeration, working operation and cutting conditions. Starting for the refrigeration, as it was said previously, there are dry, air and cryogenic machining. Continuing, the working operation could be a roughing one or a finishing one. Finally, the cutting conditions depends on the tool used during the machining. In this case are used Sumitomo AXET 123508PEFR-S H1 and it was used a cutting velocity of 950mm/min in roughing and finishing operations and a feed rate of 0,3mm/teeth in roughing and 0,15mm/teeth in finishing.

The CO2 for the refrigeration is provided from a dewar and through a device specially developed for this study. It consists con a magnetic base with an articulated arm, which handle a metallic nozzle, as it can be seen on the figure 1. This device should allow the coolant, CO2, to reach the cutting area and to get a better chip removement.

Fig. 1. Nozzle device.