"Experimental Study and Modelling of Heat Transfer in Milling of Titanium Alloys" by Belén Cámara Herrero

The current project shows the communion of experimental and theoretical heat transfer models in the cutting metal industry, in collaboration with Seco Tools AB, one of the global leaders in production and manufacturing of cutting tools.

In this project, an orthogonal milling process will be studied by means of cutting tools provided by the Swedish company Seco Tools AB. The main aim of this research is to analyse the heat transfer process behaviour in interrupted cutting of titanium alloys, with the creation of a finite element model and a validation through experimental results. To achieve this purpose, different scenarios are studied and compared; consisting all of them on dry machining slot milling.

As a summary, this project aims to answer the following questions:

Q1: What is the expected temperature behaviour in the insert for different cutting conditions in dry milling of titanium alloys?

Q2: How do PVD coatings of tools affect the temperature behaviour for different cutting conditions in dry milling of titanium alloys?

Q3: How accurate could be predicted the heat transfer using a model, simulated with standard industrial software, compared to the experimental data?

The workpieces used for this experiment consist on a selection of $\alpha - \beta$ and β titanium alloys widely used in industrial applications. Regarding the cutting tools, SNHQ commercial inserts were used in three different modalities: uncoated and PVD coated with F40 coating and 16 coating. The tool holder consists in a disc mill of diameter 125 mm, prepared for slot milling operations.

In regards to the thermal equipment, FLIR infrared camera and a trigger were necessary to take a frame every revolution.

The findings of this project will help to develop more efficient tools and contribute to a deeper understanding of milling processes and thermal behaviour in interrupted cutting. At a practical level, the implications reside in obtaining an experimental methodology available, tested and documented to measure cutting tool temperatures during milling of titanium alloys, replicated by means of a thermal model.

In addition, some complementary measurements such as Light Flash Analysis, emissivity measurements and microhardness are performed to characterize the process and the material, generating a baseline of know-how.

The impact that the improvement of efficiency when machining titanium alloys could suppose for high technology industries such aerospace and biomedicine is quite remarkable.

Finally, the project allows the author to respond the research questions contemplated at the beginning of the master thesis, with a remarkable accuracy of the simulated model, being able to predict the temperature behaviour of the tool for all the studied cases and materials with an average deviation below 15 ºC and the maximum below 26ºC.