Performance and Wear Behaviour of Coated and Uncoated Cemented Carbide Tools during Milling of Titanium Alloys

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Metal cutting is a process in which an excess of material is removed from a metal block in the form of chips by using a cutting tool, and it comprises a group of complex processes. Within all the metal cutting theories there is one common agent that plays a really important role, regardless of the process, and is the material science. While material science advances providing materials with better properties, metal cutting must also advance, developing new tools and techniques that would cope with these materials, for the sake of progress and sustainable manufacturing.

One of these difficult-to-machine materials, since it was industrially and commercially used for the first time in the 1950's, is titanium and its alloys. Titanium alloys show a great strength-to-weight ratio (also high strength in absolute values), good corrosion resistance, high strength at high temperatures and low thermal expansion and conductivity.

The purpose of this project is to study the performance of uncoated versus coated cemented carbide tools when performing milling operations in heat treated titanium alloys, with the goal of establishing a base line of knowledge and methodology linked to these difficult-to-machine materials relevant for the metal cutting industry.

The work that is carried out in this project comprise both literature review, that is presented as the state of the art as the necessary theoretical background to understand what is done; and experiments, that were designed and executed at Seco Tools in Fagersta in order to achieve the primary goal, testing and comparing different scenarios where cutting parameters played a key role.

The main challenge faced during the execution of the aforementioned experiments was machining time. Not all the experiments that were planned were finally executed due to this issue, so that future work should focus on continuing these experiments to extract more information out of these materials.

The findings of this project have been broad; clear differences in performance in some cases between coated and uncoated indexable tools have been seen, but also not significant differences in some other cases with some uncoated tools behaving even better than their coated counterparts; wear mechanisms indicators such as adhesion or diffusion were seen in most of the footage analysed, from initial stages of wear to 100% of wear criteria; and other relevant findings were achieved linked to coating performance and its morphology in the initial phases of contact between tool and workpiece.

The findings that have been made in this master thesis will contribute to understand better how the wear mechanisms act over the tools when machining titanium alloys, in order to be able to hopefully find a better cutting solution that would enhance tool life in milling processes, creating more efficient and sustainable indexable cutting tools.