NEW MACHINING CONCEPT FOR SAFE AND CLEAN MANUFACTURING OF FIBRE REINFORCED PLASTICS

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ABSTRACT

CFRP and GFRP are considered difficult to cut materials due to the same characteristics that grant them with good mechanical properties: not homogeneous, anisotropic, very abrasive reinforcement fibres, etc [1-2]. Currently the main problems of the machining of composite material are the damage of the part (delamination), cracks, bad surface finish, the extreme wear of the cutting tool and the collection of the small particles of material produced during machining. All these features make composite materials far different from the machining of metals, more familiar to the traditional machining technologies and goods.

Many of the parts made of FRP (Fibre Reinforced Polymers) obtain their net shape almost completely in the transition from soft to hard material stage. This happens during the phase change or the curing of the thermoplastic matrix. In spite of this "near net shape" production technology in general, a finish machining of cured FRP will become necessary because the final requirements expected in the dimensional accuracy, surface quality or the material homogeneity may not be achieved in this previous process. One of the most typical cutting operations is trimming of moulded parts at surfaces without mechanical important functions with accuracy requirements from one tenth to one millimetre. Higher accuracy, less than one tenth of a millimetre, is demanded for the machining of surfaces. In the case of holes, the requirements for surface quality arise depending on the function of the part with functional requirements.

CFRP and GFRP are brittle materials and behave completely different from metallic materials during cutting. The materials show no plastification during the cutting process. Instead of chips, small particles and dust in the range of 0,5 μm to 20 μm appear. These residues are harmful for human beings if aspirated because of their carcinogenic potential. Variations of cutting tools and process parameters can not change the brittle material behaviour during cutting and subsequently not the kind of machining residues, also here named chips. Beside the danger for the operators, CFRP and GFRP chips pollute the machine tool, its surroundings and the workpiece, causing wear effect on moving parts due to the abrasive characteristics of the fibres. Therefore the only solution is to control chips and particles produced during the machining operations.

The proposed approach towards chip collection, which will be described in this paper, is the internal chip extraction through the cutting tool/tool holder/spindle system. This technology permits a chip extraction rate of almost the 100% out of the working area depending on the operation and the characteristics of the process. This high efficiency is supported by other technical advantages like the use of conventional automatic tool change without any obstacles and no need of designing a special machine configuration for chip extraction. The internal chip recovery permits the elimination of dangerous carbon fibre particles from the atmosphere controlling them during the whole machining process and the afterwards chip management

tasks. Furthermore, the recovered chips and dust particles will have no pollution due to the direct recovery from very moment they are produced in the cutting edge, improving the re-use and recycling of the dust.

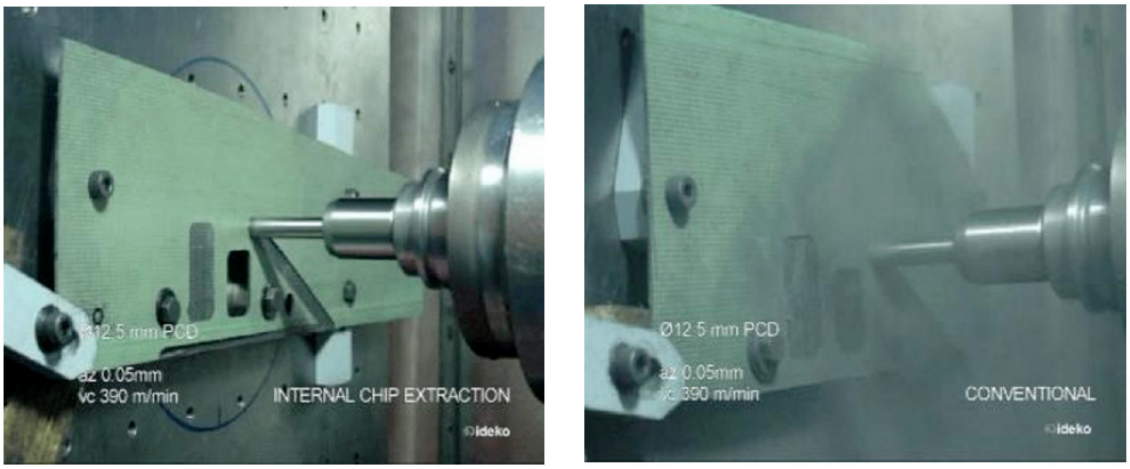

Fig. 1: Left: internal chip extraction machining of a CFRP part; Right: conventional machining of a CFRP part,

This technology offers great advantages in comparison with the conventional machining processes in terms of safety, environmental issues and cost effectiveness. The advantages and characteristics of this technology will be described in this paper. A whole description of the system set up, from the cutting edge to the chip extracting system, will be also presented, describing the characteristics of each of the components of this new machining concept for machining CFRP and GFRP parts. Critical aspects like cutting tool and cutting conditions, will the remarked as influence parameters in the quality of the machined parts.

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