



DESEMPENHO DE CORTE NA PRODUÇÃO DE MOLDURAS DE *PINUS RADIATA*. AVALIAÇÃO DA VIDA ÚTIL DA FERRAMENTA

¹Alfredo Aguilera (aguilera@uach.cl), ²Pierre-Jean Méausoone (pierre-jean.meausoone@univ-lorraine.fr), ³Víctor Solís (victorsolisbrevis@gmail.com)

¹Associate Professor, Forest Sciences and Natural Resources Faculty, Universidad Austral de Chile, Valdivia, Chile

²Professor, École Nationale Supérieure des Technologies et Industries du Bois, Lorraine University, Épinal, France

³Master Mechanical Engineering student, Engineering Faculty, Universidad Austral de Chile, Valdivia, Chile

RESUMO: Hoje em dia, um importante setor exportador da indústria madeireira do Chile produz produtos com qualidade visual. Um exemplo deste tipo de produto são as molduras sólidas de *Pinus radiata*. Mas, na linha de produção, a qualidade da superfície, associada ao controle do corte e a vida útil da ferramenta, não é avaliada ou controlada por uma grandeza quantitativa. O objetivo desta pesquisa é estabelecer o efeito do desgaste da ferramenta sobre a qualidade da superfície de molduras sólidas. Adicionalmente, estabelecer o efeito das forças dinâmica-energia do corte sobre diferentes configurações de corte utilizadas para fabricar molduras planas de *Pinus radiata*. Amostras de madeira de *Pinus radiata* sólida foram processadas numa máquina fuso, gerandose uma superfície plana sobre a superfície maquinada. Os parâmetros de corte avaliados foram; três níveis para a velocidade de corte 44, 50 e 56 m/s, velocidade de alimentação até 38 m/min. e dois níveis para o ângulo de saída; 15 e 25°. Durante o processo de corte foram registradas as forças dinâmica-energia do corte. As superfícies das molduras foram analisadas em termos da sua rugosidade. Os resultados indicam uma relação entre forças dinâmica-energia do corte com o aumento da distância do corte. Ademais, o ângulo de inclinação e a velocidade de corte interatuam com as forças e energia do corte. Adicionalmente, a espessura do chip é um parâmetro que pode relacionar-se com o processo de corte, sendo que alterações na qualidade da superfície da moldura limitam a vida útil da ferramenta.

Palavras Chave: usinagem de madeira, forças de corte, corrente elétrica, *Pinus radiata*

CUTTING PERFORMANCE IN MOLDING PRODUCTION OF *PINUS RADIATA*. A TOOL LIFE ASSESSMENT

ABSTRACT: Actually an important exporting sub-sector of Chilean wood industry produces appearance grade products such as *Pinus radiata* solid moldings, however at the production line the control of cutting performance in terms of surface quality and consequently the tool life remains not accurate restricted by a quantitative parameter. The aim of this research is to establish the effect of tool wear on the surface quality and dynamic forces - power when different cutting configurations are tested for radiata pine flat moldings. Solid wood samples of radiata pine were processed on a spindle machine, developing a flat profile on the machined surface. The cutting parameters to evaluate were the cutting speed at three levels: 44, 50 and 56 m/s, the feed speed at up to 38 m/min, and rake angle at 15 and 25°. During cutting process cutting forces and the cutting power were recorded, and, on the machined surface it was measured the surface roughness.

The findings permit to conclude an interesting behavior of cutting forces and cutting power with the increase of the cutting distance. The change of the rake angle and the cutting speed reacts with cutting forces and power, being also the chip thickness a linked parameter that permits to well understand the cutting process, so the changes on the surface quality aiding to limit the tool life as well.

Keywords: wood machining, cutting forces, electrical current, *Pinus radiata*

1. INTRODUCTION

Wood added value products such as appearance grade molding involve several processing variables, being the most important the surface quality which has critical importance as response variable in this kind of products. At the cutting process, the most important parameter is the chip-forming mechanism, i.e., machining kinematics, knife sharpness; geometry and material of the cutting edge are basic components of the resulting quality.

The surface quality of these wood products influence the coating or the adhesion between the surfaces, where the evolution of tool wear will affect in some extent these properties. In this sense, when the cutting distance is regularly increased with the production, various response parameters becoming evident mainly showing a gradual increase of cutting forces and power and with a progressive deterioration of the surface quality, due to tool wear effect.

The cutting edge recession due by interaction between tool and the workpiece has a gradual increase when both the time and the distance of the processed material increase. In addition, the magnitude of this cutting edge recession and for consequence the performance of the tool is affected by others factors such as the rake angle and the cutting material (type of steel). Furthermore, the cutting conditions is expressed essentially as chip thickness or bite, and then as chip marks per inch, determining the final quality, both related to cutting energy and surface quality.

At the cutting process, a quality trait is the resulting surface roughness, where poor quality may be associated to a non-adequate selection of cutting parameters, in particular the chip thickness, the cutting geometry and the tool wear.

Changes in surface roughness, at different machining conditions have been reported by DAVIM et al. (2008, 2009), HIZIROGLU and KOSONKORN (2006), DIPPON et al. (2000), AGUILERA et al. (2000), LIN et al. (2006), AKBULUT and AYRILMIS (2006) and ENGIN et al. (2000). Surface quality problems had been linked to cutting conditions and raw material parameters. Machining conditions as the increase of spindle speed and the decrease of the feed rate provide smoother surfaces, i.e., the relationship between the chip thickness and surface roughness is directly proportional (AGUILERA et al. 1999) where a smooth surface is obtained with a small chip thickness, but with a decrease of tool life.

Different methods may be applied to monitor the cutting performance of the tools and to detect at early stages when changes occurs at the process line. MURATA et al. (1993) and ISKRA and TANAKA (2006) evaluated the power consumption of the motor-spindle system, but the authors conclude that due to inert masses of the motor-spindle system the output signal is low-pass filter type, so the results are not accurate enough. Another method particularly useful to monitor the tool wear process is the cutting forces measurement studied by KO et al. (1999), SCHOLZ and HOFFMANN (1999) and ISKRA and TANAKA (2006). However, this method requires the use of dynamometers, mounted between the spindle and the feed table, having a negative effect on the dynamic stiffness of the tool-workpiece system, and the fact that they need to be placed closely to the cutting zone and in direct contact with the workpiece, makes them not effective enough as on-line monitoring system. Interesting relationship between cutting forces and electrical current makes these methods promising to assess the cutting performances of wood material (AGUILERA et al. 2013).

It is important to monitor the wood machining process, because an efficient survey of it allows to activate an early alert to the operator in order to shut-off the machine before critical conditions may reached about cutting kinematics (cutting speed or feed). Therefore, the measure of cutting forces and electrical current, make these response parameters as interesting tools to control surface quality and tool wear. Consequently, the use of some means to monitor the cutting process seeks to improve performance by decreasing delays at production line, maintaining the quality standards at the wood machining operations.

The main objective of this research is to study the machining performance when appearance grade products are produced, assessing the relationship between the surface