ASPECTS CONCERNING THE IMPROVEMENT OF THE FUNCTIONING CENTERS OF WOOD PROCESSING FOR THE PREVENTION OF NOISE AS A PROFESSIONAL RISK

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Abstract

The paper refers to the study and the improvement of dynamic stability on high number of revolutions of the wood processing centers for the noise reduction under the accepted limits. The noise prevention as professional risk is a major problem in the wood industry, and this study makes reference to concrete actions, adopting some technical solutions applied to working shafts, systems of tool attachments, internal control systems and not in the last place of the tool.

Key words: woodworking, tools, stress zone, cutting forces.

INTRODUCTION

The target of this experiment is an elaborated and tested detection method of noise and vibration.

This experiment was making at S.C. Mobil Tileagd S.A., to a woodworker center, ROVER -346 types. The clamping tool system is HSK-F63A. This tools growth to high rotation speed between 15000 rpm and 45000 rpm. The woodwork is from oak, coniferous and beech essence. The tools type is HSK-F63-A-76,5 RH/Dx V26 with 10 cm diameter and 20 cm length and so many alternative of this. The tools are cutter with two cutting edges [1].

At the experimental verification we adopt a strategy who allow for the non-linear cutting forces modeling.

MATERIALS AND METHODS

In the effectuated experiment we consider the maximum thickness of chip of wood. The purpose of this experiment was to see the action of the Clamping Tool System (STT) and the working spindle. We take the improve version.

The simulation software was elaborated by COSMOS and MatLab™ Simulink package software. The software gives the result of relative movement and the final result of strain at failure according as frequencies [2].

The stress zone is: the rotator of working spindle and the clamping tool system.

This zone has bending stress distortion and thermal expansion.

To avoid this problem the solution is: to assembling a special angular-contact ball bearing with ceramic balls; making some special bearings box with ceramic rings; cooling and oiling the spindle with oil-mist system; using HSK system to the clamping tool. This solution degreases an unwished phenomenon that's caring to dynamic instability.

The working parameters are an answer for two requests: HSM ruggedness and the minimization of the vibration effect during the milling process.

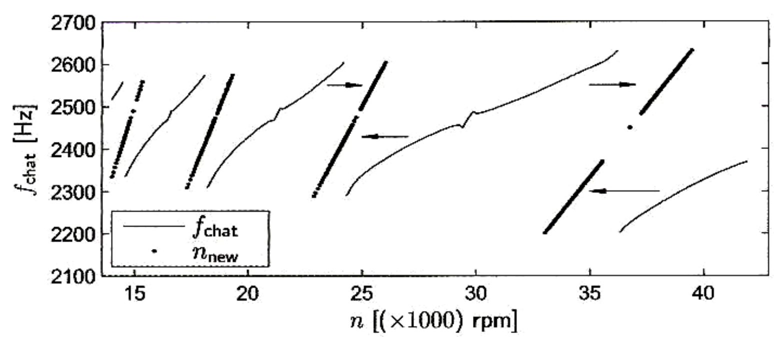

Fig.1. The working parameters for the new speed for different frequencies [3], [4].

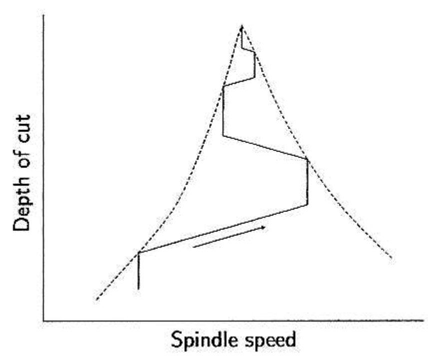

Fig.2. The establishment example of SLD diagram center using the detection and the vibration control [3], [4].

The improvement of the dynamic stability for HSM demands a new choice method of optimal speed. The estimated dominant frequencies f_{chat} is the same with the highest harmonic of the new excitation frequencies of the power feed on tooth [4], [5].

The vibration frequencies are the same with the phase difference between two consecutive waves:

$$\varepsilon + k = f_{chat}\frac{60}{zn} \text{ [Hz]} \qquad (1)$$

Where k is full number of lobes from SLD diagram, and ε is the fraction of the incomplete waves between two consecutive manufactures.

The optimum speed is calculated to be $\varepsilon = 0$. The ideal situation is when the dynamic thickness of the chip of wood is minimum ($\varepsilon = 0$). The optimum number of lobes is calculated with the next equation:

$$k_{new} = \{\frac{60 fchat}{zn}\} \quad \text{[round no.]} \qquad (2)$$

Where k_n means the approximation to the most proximate round number and n is the current speed. We calculated the new value of the speed with:

$$n_{new} = \frac{60 fchat}{Knew \cdot z} \quad \text{[rot/min]} \qquad (3)$$

The relation (3) is used for the calculus of the new speed. Using these methods the speed is directed to the center of the lobes. At the peak of the stability curve, the new value of parameters is in the proximate center of the lobes. However, the new values of parameters is in the proximate optimum position, but the peak of the stability curve can be change the speed so much to making the next curve to be erased. This problem can be prevent by an alternative definition of working parameters such the vibration was eliminated. The modification of the speed can change the new frequencies of the vibration and the working parameter is changing. We need to update these parameters long as during the milling process that produce the vibration. [3], [2], [4], [5]

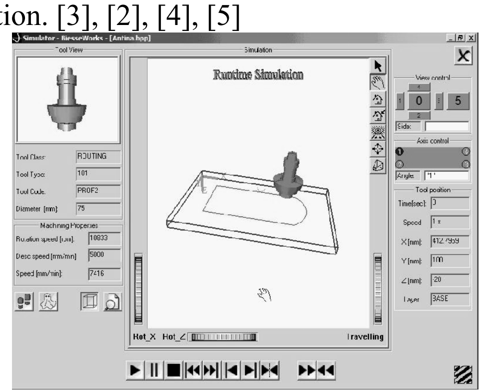

Fig.3. The BiessWorks simulator module of vibration control system for the exterior and interior milling operation. [5]

The purpose of the experiment is to test the vibration detection method. [4],[7]

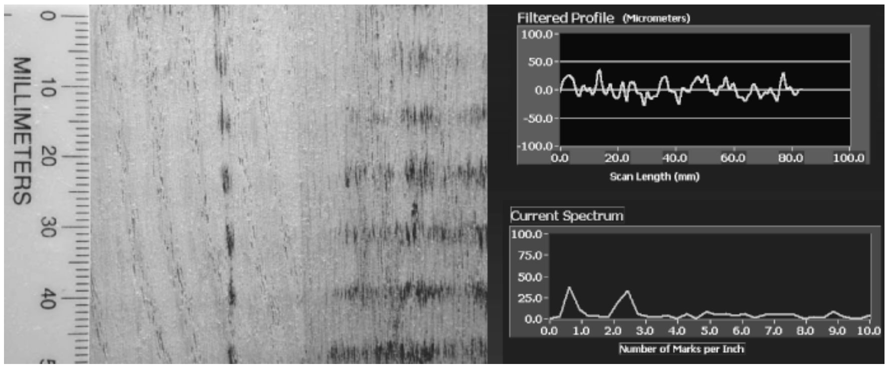

Fig.4 The mark of the regenerative vibration on manufactures surface in case when the vibration appears. [4]

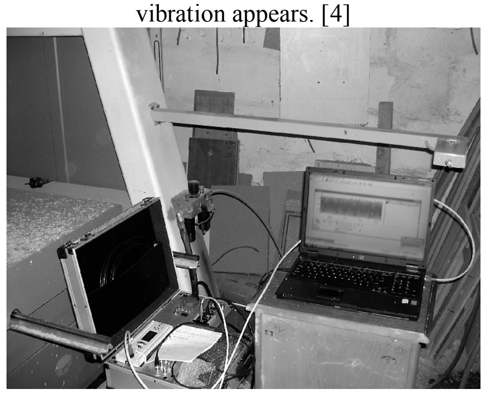

Fig.5 Stand

The instrumentation is Delphin-Hard-Delhin AMDM V2.0 type and the software is SOFT-mhouse Software V 3.6.6. The sensor is an accelerometer Bruel&Kjaer.[4],[7].

In practice can't be establish which harmonic gives the better information about the HSM dynamic. The choosing frequency was making on several tests. In first working phase we can't see the vibration because is a low value of the detected signal.

When the vibration appear (about t = 0,6 s) the vibration frequency amplitude grows and the values of the detected signal grows faster. On the establish zone of the cutting process the noise has the lowest level. If the stability level is choosing near the maximum value of the first part signal of the cutting process, the vibration was detected with 0,005 s earlier, before signalize the acceleration sensor. The maximum value of the movement depends on the thickness of the chip of wood in stable condition. [4]

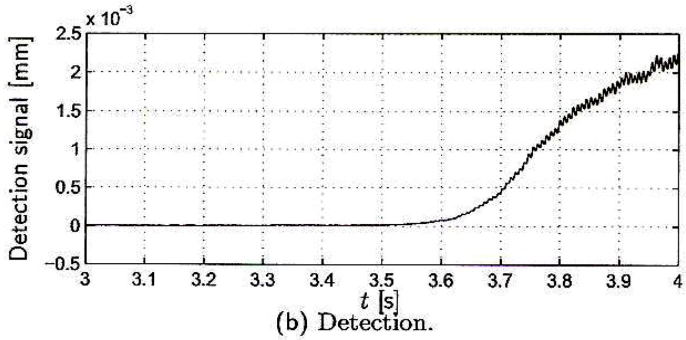

Fig. 6 The vibration detection grows with the depth of cut.[4]

For the detection in real time when the vibration appears we use an accelerometer mounted near of the ball bearing that is in fore part of the spindle.

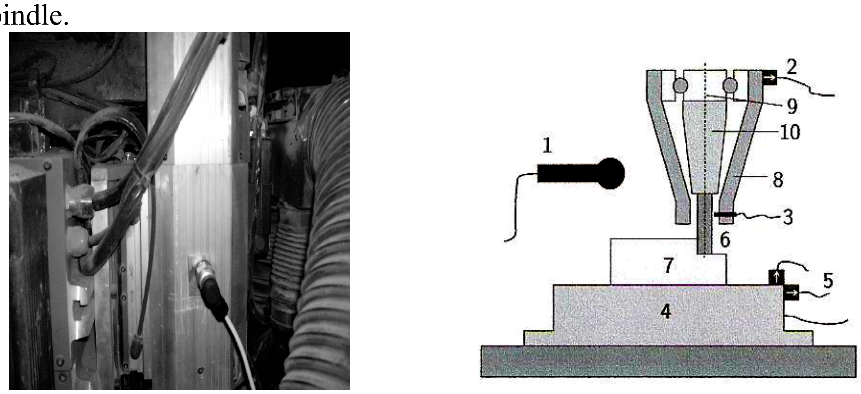

Fig. 7 The assembling of the stand.

a.) Photo (S.C. MOBIL S.A. Tileagd) b.) Schematic representation
1 – microphone; 2 – accelerometer; 3 – current sensor;
4 – working table; 5 – accelerometer, 6 – tool; 7 – piece; 8 – case; 9 – working spindle; 10 – system STT; 11 – ball bearing.

Initial accession of variation $\hat{y}_{ch}(t)$ at the admittance milling cuter in material has two causes. In first place the reported acceleration amplitude to spindle vibration frequencies grows up suddenly because at the entrance in material the forces are stronger. In the second place, because this forces the speed go down a little. This speed is measured with HSM control system. Using the demodulation signal method the measuring error speed has insignificant consequences on vibration detection operation. A certain estimation of the vibration frequencies is useful for control system with the purpose to calculate and set the new speed. The setting of the speed is a low relative process in comparison with the running detection algorithm process, in virtue of spindle inertia. [6], [4].

In the next diagrams are presented the acceleration signal that was adapted by „Mhouse Software V. 3.6.6” software for different wooden species: oak, coniferous and beech.

We can observe the initial growing of the amplitude at the entrance of the milling cutter in piece at the different time steps, at 0,4 s for oak and 1 s for coniferous. The vibration amplitude doesn’t go beyond the stability limit. [4]

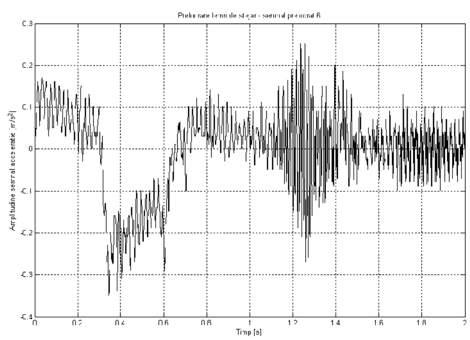

Fig. 8 The acceleration signal for oak woodworking at speed n = 15000 rpm [4]

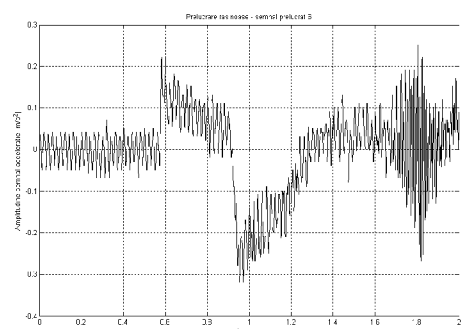

Fig. 9 The acceleration signal for coniferous woodworking at speed n = 15000 rpm [4]

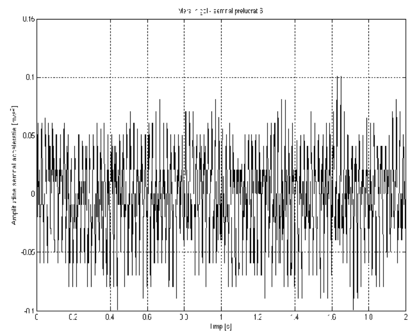

Fig. 10 The acceleration signal for beech woodworking at speed
n = 15000 rpm [4]

The control and setting internal system of the speed and the feed rate is adjusting to these working parameters.

CONCLUSION

We elaborated a new experimental method whose follow the tool action at the slowly grows of the deep of milling process for a better detection of the vibration.

We obtained experimentally a very short time step from the beginning of the vibration pending the detection and setting the speed in control loop.

The research indicated that the noise excess level indicated the apparition of growing vibration under the normal limit.

We exposed the necessary modeling and simulated methods to avoid the instability level of vibration. We indicated the optimal stability level practical and theoretical.

In the stability level limits the dynamic phenomena was not influenced by wooden species, which's in normal limits.

The theoretical and experimental research brings us to concept a working interface between men and machine, it's very practical. This allows the rapidly setting of the machine and simulating the dynamic phenomena.

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