HIGHER TECHNICAL INSTITUTE

MECHANICAL ENGINEERING DEPARTMENT

DIPLOMA PROJECT

INVESTIGATION OF ACOUSTIC EMISSION FOR THE PREDICTION OF TOOL WEAR DURING VERTICAL MILLING

M / 1036

ZAKOU MARIOS

JUNE 2007

INVESTIGATION OF ACOUSTIC EMISSION

FORT THE PREDICTION OF TOOL WEAR DURING

VERTICAL MILLING

BY

ZAKOU MARIOS

PROJECT

Submitted in partial fulfillment of the requirements for the diploma

TECHNICIAN ENGINEER

At the

HIGHER TECHNICAL INSTITUTE

NICOSIA, CYPRUS

JUNE 2007

HIGHER TECHNICAL INSTITUTE
NICOSIA – CYPRUS
MECHANICAL ENGINEERING DEPARTMENT

DIPLOMA PROJECT 2006/2007

Project Number: M/1036

Title: "Investigation of Acoustic Emission for the Prediction of Tool Wear during Vertical Milling."

Objectives:

1. Investigate on various condition monitoring techniques in monitoring tool wear during metal cutting (milling).

2. Study the applications of Acoustic Emission in tool wear monitoring and the advantages and disadvantages offered over other conventional condition monitoring techniques.

3. Study on background theory of Acoustic Emission.

4. Present a data acquisition system for Acoustic Emission signal.

5. Study on signal analysis techniques used with Acoustic Emission

6. Use the available research equipment on Acoustic emission to reproduce or prove the usefulness or not of Acoustic Emission as a tool wear monitoring technique with vertical milling.

7. Present results in an easy understandable form and derive necessary conclusion on the condition of the vertical milling cutters monitored during the cutting process.

Terms and Conditions:

1. Sources of information and references should be quoted accordingly.

2. Presentation of results should be as much as possible in the same form as in literature for easiness of comparison.

3. General report presentation should be according to HTI regulations, for final year project report presentation.

Student   :   Zakou Marios Z. (3ME)
Supervisor   :   Dr Vassilios Messaritis

VM/AEP
2006-12-20-PROJECT (M_1036) REVISED TITLE OBJECTIVES-VM-3M

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ACKNOWLEDGEMENTS

Firstly I would like to thank God for everything because without HIS valuable help and guidance, probably I wouldn't be here today.

This work has taken flesh and bones because of the support and encouragement of my supervisor Dr. Vassilios Messaritis the one's whose with out common-sense, knowledge and perceptiveness this work would surely not be the same. I am and always will be, deeply grateful to him for being a great advisor and mentor for me not only during this work but during my whole presence at HTI.

Special thanks must also go to my godparents Mr. Costas and Mrs. Eleni Constantinou for providing me the necessary moral support and guidance and the most important, for believing in me.

Finally, I am forever indebted to my mother for her understanding, endless patience and encouragement when this, was most required.

I hereby declare that the project submitted for the diploma of the technician engineer to the Cyprus Higher Technical Institute, apart from the help recognized, is my own work and has not formerly submitted to another University or Institute for a degree.
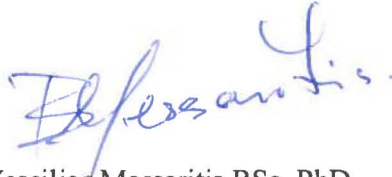
Marios Zakou

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SUPERVISOR'S STATEMENT

This is to certify that Mr. Marios Zakou has prosecuted research work under my supervision and he has fulfilled the conditions for of the Ordinances and Regulations of the final year project for the Higher Technical Institute.

21 May 2007

Vassilios Messaritis BSc, PhD.
Senior Lecturer (Mechanical)
Mechanical Engineering Department
Higher Technical Institute

SYNOPSIS

The purpose of this work was the investigation of Acoustic Emission (AE) as a method for predicting tool wear during vertical milling. This work was born near last December. To tell you the truth if someone before December came to ask the author what Acoustic Emission is all about his answer would surely be..."WHAT?" The reason for choosing to study the specific subject was the need of meeting something new and the specific work was offered for this purpose.

This work has started by first starting to know what Condition Monitoring (CM) and furthermore what Acoustic Emission (AE) is all about. After this preliminary research the next step was to get "In-Line", meaning that the next step was to start the preliminary work in order for the various tests for investigating the purpose of this work to begin. Tests could not start immediately due to the fact that some preliminary testing in order to establish the appropriate equipment which would be used during the work should be carried out. This preliminary testing turned out to be the most difficult part of the whole work due to the fact that several problems with the initial equipment and instrumentation had occurred. At the beginning problems with the oscilloscope had occurred due to the fact that the specific oscilloscope GDS-806C was not able to provide with data for future analysis but only with jpeg and bitmap images of frozen screen, so for this reason the use of the Pico digital oscilloscope has been decided for the purposes of the specific work. Another problem which has occurred of vital importance was the fact that the preamplifier AEP3 which was first used was providing no amplification to the generated AE signal, so the AEP4-1S preamplifier was adopted.

When the proper equipment has been chosen, various tests have taken place. The first part of the experiment included tests which included the variation of the cutting conditions during machining for a 60 mm face cutter and the second part had as purpose the

investigation of the variation of the AE generated during cutting with sharp and worn tools and for this purpose cutters of 14 and 18 mm of the slot drill type sharp and worn have been used.

As far as the first part of the experiment is concerned, the one with the 60 mm face cutter, tests of examining the AE generated during varying the depth of cut, feed rate, and cutting speed were conducted. In each test, two of the above said cutting conditions were kept steady while the third was varied. After capturing the AE signals generated during these tests several conclusions have been extracted and a quite detailed discussion is presented in chapter 8 for each case.

As far as the second part of the experiment is concerned, the results were quite clear from the point of view that during the examination of the signals captured, the difference in the RMS background level of the AE generated during cutting with sharp tools and the AE generated during cutting with worn tools has presented a difference which could be translated that it is due to the tool wear formation. Although in the specific tests the RMS background level was quite low this could not stop the extraction of the very useful conclusion which states that the AE generated during cutting with sharp and the AE generated during cutting with worn tools presents a difference.

A strong effort has taken place in order to present results in an easy understandable form in order to provide an easiness of comparison with results stated from other researchers. For each test, cutting conditions, RMS background levels of the AE signal generated, and also a typical signal for each case are presented. More signals could not be shown due to lack of space. As far as the conclusions and comments is concerned, for each test separately, a discussion has taken place trying to explain what was possible to be explained.

So, by concluding it must be said that a great amount of work has been done during the last months and several hours were dedicated on this work. One of the most important conclusions of this work was the fact that future work is a "must". Future work on the subject on which

this work is all about, must take place in order to get into further depth and study how the AE generated responds under a larger variety of cutting conditions, tool diameters and workpiece materials. In our belief, a lot of things have been earned from this work and as far as the subject of Acoustic Emission (AE) is concerned, it proved to be a quite interesting subject which must be and will be, further studied in the future.