METHOD TO EVALUATE THE RUNNING TIME OF PNEUMATIC TOOLS IN A CAR WORKSHOP

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1. INTRODUCTION

In Finland, there are about 2 million cars. Approximately 50,000 cars are serviced every day. Although the new European Vibration Directive (2002/44/EC) has been implemented in the Finnish legislation since 2005, the adverse effects of hand-arm vibration are poorly identified in workplaces and in occupational health care.

In car workshops, several pneumatic tools are used. The most common tools are impact wrenches, grinders and sanders.

According to Palmer at al (1998), the self-evaluation of exposure time is not a reliable method to estimate worker exposures. Even immediately after the end of a work shift, the self-evaluation results are inaccurate when using questionnaires or interviews. Several potential sources for errors can be found, including -

- time estimations – for example, rounding the results to the nearest 5 or 10 minutes, or rounding up to the next full minute, when the exposure time is less than one minute;
- repeated short exposure times;
- workers tend to estimate the length of task instead of the trigger time;
- the number of tasks using vibrating tools;
- the number of vibrating tools in use;
- variations in daily usage times; and,
- the varying names of tasks and tools.

All these errors are present in evaluations of vibration exposures in car workshops. According to Palmer et al (2001) and Åkesson (1998), the average trigger time in car workshops is 14 minutes and weighted average levels during that time is 3.55 m/s^2. These results do not correspond to the observed prevalence of Vibration White Finger (VWF) symptoms.

The purpose of the study is to develop a measuring device capable of measuring the actual trigger times of several working points simultaneously.

2. APPARATUS AND METHOD

2.1. Apparatus

The system consists of several (1-16) high precision digital pressure switches (SMS ZSE30A) capable of fast detection of pressure (Figure 1). The switches have a common power supply delivering 12 V DC. The pressure signal was directed to a A/D-converter (Agilent 3481A), and was sampled two times per second. The readings were data logged to the hard disk of a computer with software developed with Agilent VEE-Pro 6.0. The software displayed the pressure and stored the data on the disk (Figure 2).

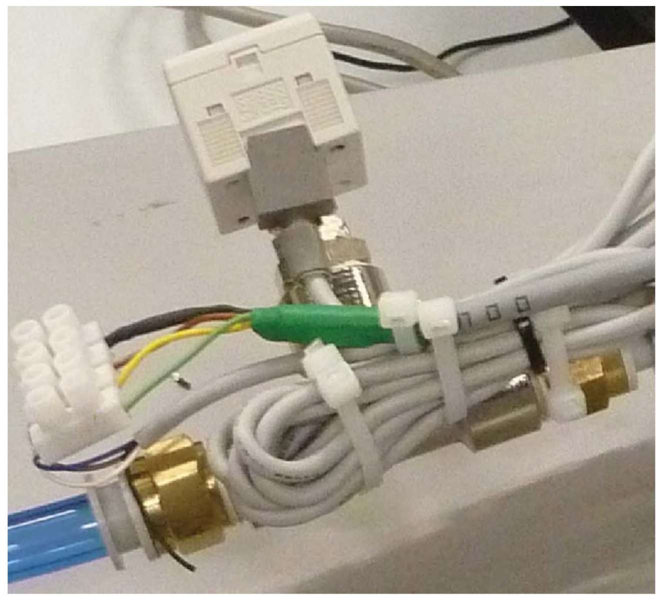


Figure 1. The pressure switch and its connection to air supply.

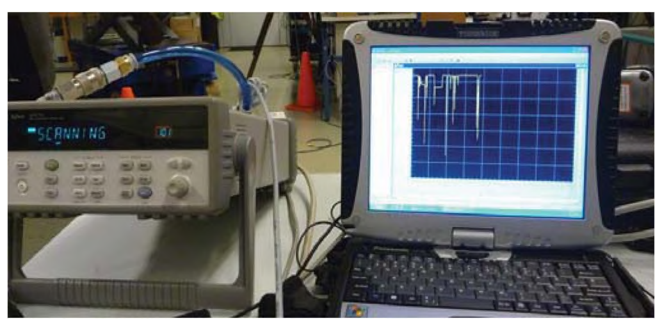
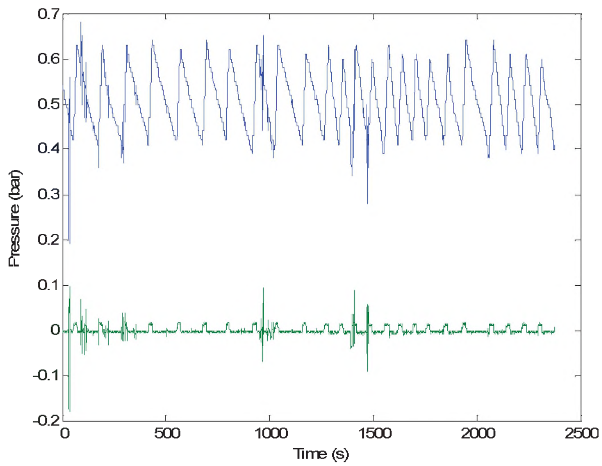


Figure 2. Data logger and display with one channel logging.

3. RESULTS

A typical measurement result is shown in Figure 3 – the upper curve. The pressure curve shows pressure changes caused by the use of tools and the slow variation caused by the relay control of the air compressor.

Figure 3. Typical pressure reading from one channel. Upper curve is the measurement curve. (The curve is brought down by 3 bar for better resolution.) Lower curve is the high-pass filtered upper curve.



By using a simple high pass filter -

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y(i)=a*y(i-1)+b*(x(i)-x(i-1))/(a+b)
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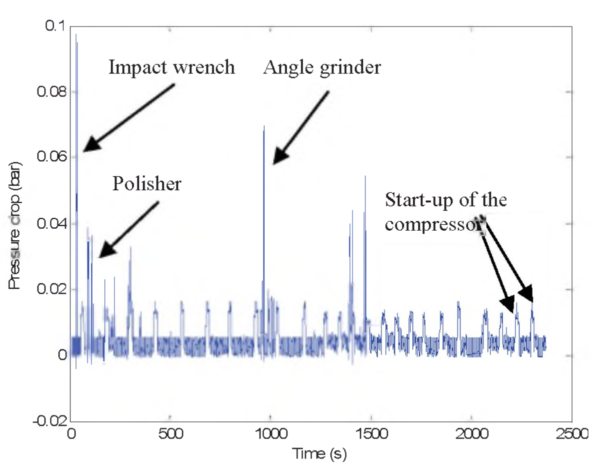
where y is (i) the filtered curve at point I, and x is the measured curve at point (i), the lower curve is created presenting only the tool use. Pressure drops at measuring point are tool dependent (Figure 4).

Simple mathematics can be used to recognize the running time. In Figure 4, the absolute value of high-pass filtered signal has been smoothed using the Savitsky-Golay smoothing. The height of the peak gives the air consumption and the width gives the trigger time. As the power consumption varies, different tools may be identified from the signal. In Figure 4, the start-up of the compressor is also visible as short peaks, which is easy to detect.

Figure 4. Running time of tools recognized by squaring and smoothing the data



4. DISCUSSION

With this equipment, it is easy to monitor up to 16 working points simultaneously. The system is easy to mount in any car workshop, simply by changing the plugs. Of course, installing the cables in such way that they do not disturb the work takes some time.

The system has been tested in one car shop where a pressure regulator did not exist, as well as in a laboratory workshop where a pressure regulator was in all outputs. The results were similar. The equipment does not recognize the tool in use, but tools can often be identified by the height of peak.

Of course, if several tools are in use, the accuracy of the recognition decreases. In the car workshops, 70-80 % of exposure is due to the use of one or two tools. This is reasonable accuracy.

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