Evaluation and Damping of High-Frequency Vibrations on a Tightening Tool

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Presentation Outlines

- Introduction
- Background
- Measurement set-up and procedure
- Test results
- Post-paper studies
- Conclusion
A Few Applications with Atlas Copco Tools

- Grinding
- Scaling
- Drilling
- Tightening
- Chipping
Background

- Pulsating tightening tools are common in most industries for their high torque-to-reaction-force ratio
- The pulse mechanism may generate harmful vibration levels
- Choosing an oil dampened pulsating tools over an impact tool will reduce vibration levels
- A tool with a shut-off mechanism that stops when the correct torque is reached will reduce vibration exposure time
- Tightening tool with pulse unit and shut-off => Atlas Copco ErgoPulse PTI-range
- EP7 PTI55 provided a useful test case with potential for field tests
- Low vibration emissions according to ISO 28927-2
- Potential for high frequency vibrations due to pulse unit
- Experimental study for evaluation and damping of high frequency vibrations
Measurement Procedure

• Vibration levels were measured by using a triaxial accelerometers located on the handle of the EP7 Tool run in the C.2 Brake device described in ISO 28927-2 Annex C.

• The measurements were conducted according to the guidelines given in ISO 28927-2. However, the procedure was simplified by using only one machine run by two operators that each performed five runs of 10 s.

• An initial series of measurements was conducted with a factory new tool, which was retrofitted with dampening material underneath the regular handle’s rubber cover.

• The time signals were acquired with a sampling frequency of 65.536 Hz and in addition to a digital low-pass filter at 10 kHz.

• The time signals were evaluated for Vibration Peak Magnitude according to: $VPM = \sqrt{\frac{\sum a^{2+2k}}{\sum a^{2k}}}$ with $k = 2$
Experimental Set-Up

Added vibration dampening foam

Re-Covered with new original rubber cover
# Test Results

## VPM and $a_{h,w}$ Results

<table>
<thead>
<tr>
<th>Tool</th>
<th>Regular handle</th>
<th>Damped handle</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>VPM (Std. deviation) [m/s²]</td>
<td>$a_{h,w}$ (Std. deviation) [m/s²]</td>
</tr>
<tr>
<td>X:</td>
<td>415.1 (77.0)</td>
<td>1.8 (0.1)</td>
</tr>
<tr>
<td>Y:</td>
<td>458.6 (46.8)</td>
<td>2.0 (0.3)</td>
</tr>
<tr>
<td>Z:</td>
<td>618.9 (170.0)</td>
<td>1.7 (0.4)</td>
</tr>
<tr>
<td>Norm (X, Y, Z):</td>
<td>888.6 (113.9)</td>
<td>3.1 (0.4)</td>
</tr>
</tbody>
</table>
Lab Test Summary

- Slight decrease for the declared vibration emission value from 3.1 m/s\(^2\) to 2.5 m/s\(^2\) cannot be fully attributed to the added damping. Official declaration value for the EP7 PTI55 is 3.3 m/s\(^2\) with an uncertainty \(K = 0.9\) m/s\(^2\).
- VPM was reduced from 888.6 to 500.3 m/s\(^2\) with the most significant reduction in the Z-axis (normal to the handle surface).
- VPM is indicated to be a reliable value for high frequency vibrations.
Continuation: post-paper field test

Four tools were field tested for one month at a customer comparing 2 different dampening materials.

- One material type lost its dampening property before the month was over, which the operators could feel.
- The other material had a small dampening reduction but not statistical significant.
- Each tool was positioned at a work station in a production line with the same amount of joints per day to ensure equal test conditions.
- Operator feedback was very positive.
Continuation post-paper: Tool for higher torques, EP19PTX450

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<tbody>
<tr>
<td></td>
<td>VPM (Std. deviation)</td>
<td>a_h (Std. deviation)</td>
</tr>
<tr>
<td>Norm (X, Y, Z):</td>
<td>1671.4 (431.8)</td>
<td>5.8 (0.4)</td>
</tr>
</tbody>
</table>
Conclusions

- **VPM** is a suitable parameter for evaluation of high frequency vibrations
- There is clearly a high frequency content above 1 kHz for pulsating nutrunners which VPM captures
- More field tests are required, especially for durability of dampening materials.
- Material selection should be made specifically for each tool