MEASURING AND ANALYSIS OF NOISE LEVEL OF A NEW GEOMETRIC, ARCHED PROFILE CONICAL WORM GEAR DRIVE IN AXIAL SECTION

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Abstract: The ambition is global fact for noise poor construction. The importance of noise level analysis is justified by the ambition of health protection, the improvement and conservation of the productive capacity of worker. After production we have infiltrated a new geometric conical worm gear drive to a gear box and during running we have done noise analysis among working circumstances.

Keywords: conical worm, noise, sound pressure level

1. INTRODUCTION

Knowing the advantageous characteristics of the arched profile cylindrical and the line formed conical worm in axial section a new geometric gear drive, the arched profile (ellipse, circle, parable, etc.) conical worm gear drive has been carried out (Figure 1) [3].

Fig.1. CAD model of the arched profile conical worm in axial section

In technical practice, conical worm surfaces - which can be used in many different ways - are most widely applied as an active surface of conical worms. The conical worm and face gear paired spiroid drives can be used for example as jointless drives of robots and tool machines [2]. We can get jointless drives by simply shifting (setting) the worm into an axial direction (Figure 1).

Power dissipation in the power transmission can be reduced significantly with these modern drive pairs which are characterized by favorable hydrodynamic conditions, great strength and high efficiency [2, 4]. In case of power loss it is important to apply those geometrical characteristics of the cog which result in good connection terms.

2. THE EXECUTION OF THE NOISE MEASUREMENT

In the machine industry that requirement is being spread better and better to operate the installations and machines more silently from the permissible noisiness as a result the permissible high limit value is the toleration in case of noise toleration. That is why only the high limit value namely defining of the permissible highest noisiness has to be investigated in case of noise toleration. A frame does vibration in every noise source and this vibration is given to a substance, usually air so sound waves are originated which are spread as longitudinal waves. The dominion of human hearing is between 20...20000 Hz [5, 6].

Fig.2. The 8 channel SOUNDBOOK noise- and vibration analyser
The production of the gear drive (worm, face gear, hob) and gear box has been done at the DifiCAD Engineering Office Ltd., Miskolc. During running we have done noise analysis among working circumstances in case of low and high side of the worm tooth.

The 8 channel SOUNDBOOK noise- and vibration analyser, which is found in the Department of Technical Preparatory and Production Engineering, the College of Nyíregyháza, has been used for the measurement (Figure 2).

On Figure 3 the microphones are nominated with 'A' and 'B' symbols. The gear drive was run by an \( n=1440 \text{ 1/min} \) number of revolutions and \( P_m=5.5 \text{ kW} \) power electric motor. The motor and the spiroid worm are connected by a \( i=1 \) transmission ratio V-belt drive. The transmission ratio between the worm and the face gear is \( i_{cs}=41 \).

For the objective of qualification of the power transmission 5 measurements were completed. Based on the standard [1] the noise measurements were completed by the weight filters 'A' and 'C' of the sound-lever meter. This is the equivalent sound pressure level A (\( L_{Aeq} \) [dB(A)]):

\[
L_{Aeq} = 10 \cdot \lg \left( \frac{1}{T_m} \int_{t_1}^{t_2} \frac{p_0^2}{p(t)^2} \, dt \right)
\]

where:
- \( T_m \) - the measurement period (\( T_m = t_2 - t_1 \) [s]);
- \( p_0 \) - the reference sound pressure with the weighting filter A [Pa];
- \( p(t) \) - the measured high value with weighting filter A [Pa];
- \( L_{Cpeak} \) - the measured high value with weighting filter C.

The equivalent sound pressure level A \( L_{Aeq} \) and the sound pressure \( L_{Cpeak} \) (the measured high value with weighting filter C) have to be measured for the qualification of the working noise. Since 5 measurements were completed with two microphones that is why the measured values \( L_{Aeq} \) have to be averaged in case of both microphones [6]:

\[
L_{Aeq(ätlag)} = 10 \cdot \lg \left( \frac{1}{n} \sum_{i=1}^{n} 10^{0.1 \cdot L_{Aeq(i)}} \right)
\]

Knowing of the \( L_{Aeq(ätlag)} \) the level of the daily noise exposition could be defined for both microphones which is the average of the noise exposition with time weighted for eight hour workday [1]:

\[
L_{EX,8h} = 10 \cdot \lg \left( \frac{T}{T_m} \cdot 10^{0.1 \cdot L_{Aeq(ätlag)}} \right)
\]

where:
- \( T \) - the awarding period (28800 s);
- \( \tau \) - the valuation period (8 h).

For defining of the highest sound pressure level \( L_{max} \), the highest value \( L_{Cpeak} \) has to be chosen which was measured with microphones 'A' and 'B' [1]:

\[
L_{max} = \max \{ L_{Cpeak(A)}, L_{Cpeak(B)} \}
\]

### Table 1. The results of noise measurement low side

#### ‘A’ microphone

<table>
<thead>
<tr>
<th>M. n.</th>
<th>( L_{Aeq} ) [dB(A)]</th>
<th>( L_{Cpeak} ) [dB(C)]</th>
<th>( L_{Aeq} ) [dB(A)] average</th>
<th>( L_{EX,8h} ) [dB(A)]</th>
<th>( L_{max} ) [dB(C)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>68,7</td>
<td>82,8</td>
<td></td>
<td>69</td>
<td>94</td>
</tr>
<tr>
<td>2</td>
<td>69,1</td>
<td>82,8</td>
<td></td>
<td>69</td>
<td>94</td>
</tr>
<tr>
<td>3</td>
<td>69,4</td>
<td>94,1</td>
<td></td>
<td>69</td>
<td>94</td>
</tr>
<tr>
<td>4</td>
<td>69</td>
<td>82,2</td>
<td></td>
<td>69</td>
<td>94</td>
</tr>
<tr>
<td>5</td>
<td>69,6</td>
<td>90,7</td>
<td></td>
<td>69</td>
<td>94</td>
</tr>
</tbody>
</table>

#### ‘B’ microphone

<table>
<thead>
<tr>
<th>M. n.</th>
<th>( L_{Aeq} ) [dB(A)]</th>
<th>( L_{Cpeak} ) [dB(C)]</th>
<th>( L_{Aeq} ) [dB(A)] average</th>
<th>( L_{EX,8h} ) [dB(A)]</th>
<th>( L_{max} ) [dB(C)]</th>
</tr>
</thead>
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<tr>
<td>1</td>
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<td>82,5</td>
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<td>70</td>
<td>93</td>
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<tr>
<td>2</td>
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<td>82,8</td>
<td>70</td>
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<td>93</td>
</tr>
<tr>
<td>3</td>
<td>69,9</td>
<td>89,6</td>
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<td>4</td>
<td>69,4</td>
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</tr>
<tr>
<td>5</td>
<td>70,5</td>
<td>92,5</td>
<td>70</td>
<td>70</td>
<td>93</td>
</tr>
</tbody>
</table>
Using the standard [1] knowing of limit values of the noise exposition is regarded to the daily noise exposition level and the highest sound pressure level it could be determined:

- **Low side:**
  - In case of ‘A’ microphone: \( L_{ex,8h} = 69dB(A) < 87dB(A) \)
  - In case of ‘B’ microphone: \( L_{ex,8h} = 70dB(A) < 87dB(A) \)
  - \( L_{max} = 94dB(C) < 140dB(C) \)
  - \( L_{max} = 93dB(C) < 140dB(C) \)

- **High side:**
  - In case of ‘A’ microphone: \( L_{ex,8h} = 68dB(A) < 87dB(A) \)
  - In case of ‘B’ microphone: \( L_{ex,8h} = 68dB(A) < 87dB(A) \)
  - \( L_{max} = 88dB(C) < 140dB(C) \)
  - \( L_{max} = 89dB(C) < 140dB(C) \)

According to the standard [1] if the highest sound pressure level \( L_{ex,8h} \) and/or \( L_{max} \) is less than the requirements at least with 3 dB then the noise demand is appropriate. According to noise it is diagnosable the arched profile conical worm power transmission is appropriate based on the standard [1].

Experimented noise number is given by the ISO recommendation for the permissible noise levels which are related with the audibility, the speech intelligibility and the noise demand which is caused in human constitution namely what time the exhaustion and the audition reduction.
The received 5-5 measurement data $L_{Aeq}$ (Figure 4) have been recounted from tierce level to octave level (Figure 5) and the results of the five measurements have been averaged in case of both microphones (Table 1 and 2). On Figure 5 the basic noise and the octave level equivalent sound pressure level $A$ could be seen in the function of the octave level medium frequency in addition these values are under the limit curve of the hearing impairment $N80$.

According to noise it is diagnosable the arched profile conical worm power transmission is appropriate based on the reference [5].

4. CONCLUSION

During the running of the new geometric, arched profile conical worm gear drive we have done noise level analysis. According to the standard [1] and the reference [5] the measurement and the evaluation of the received measured results have been occurred.

The sound pressure level values are less than the permissible values that is why according to noise the power transmission is appropriate.

The arched profile conical worm gear drive has more advantageous efficiency, connection and sound level characteristics than the geometric equal with this linear profile conical worm gear drive.

ACKNOWLEDGEMENT

The production of the conical worm gear drive, the infiltration of this to the gear box and the sound level measuring of this have been occurred at the DifiCAD Engineering Office Ltd. (5-7, Szentpéteri Gate, Miskolc). Director: Dr. Illés Dudás.

REFERENCES