EXPERIMENTAL RESEARCH ON NOISE AND VIBRATION LEVEL OF GERABOX USING WORM FACE-GEAR WITH REVERSE TAPERED PINION

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ABSTRACT

This paper presents some aspects obtained on an experimental basis, on the determination of noise and vibration level in operation of a gearbox with worm face-gear with reverse tapered pinion to a pair of steel-bronze materials, oil lubricated T90, with 1:47 transmission ratio.

Keywords: *Gearbox, Worm-Face Gear, Reverse tapered, vibration and noise levels*

1. Introduction

The gearboxes using an worm face-gear, have the advantage of having an increased carrying capacity to general-purpose worm gear which requires them to be sensitive gauge lower. Among the advantages of worm face-gears stands out: high coverage, contact line incomparably greater good lubrication conditions, higher gear ratios, increased precision and noiseless in operation, make operational gearboxes equipped with such gear have better behavior

The Worm face-gears are characterized by the fact that the angle of pressure on both sides of the screw is not symmetrical. This makes the component values that appear in the gear forces, axial component and radial component, are not identical, depending on how the worm fuctioned, the pressure flank with small or big angle.

Fig. 1 Worm face-gear with reverse tapered pinion

Radial component in particular, because the interest has tended to remove the screw from the flanks of the wheel. This explains why the recommendation of the screw bearing flank angle to be at low pressure. In practice it is recommended that flank the site will be small, so the contact line is almost perpendicular to the slip velocity vector creating the conditions for formation of a hydrodynamic lubricant film compared to engagement on the other side, there is a tendency to remove the film gear lubricant during gear operation condition ensured by appropriate choice of rotation.

The worm face-gear with reverse tapered pinion shows in Fig. 1 a front worm placement conjugated inner surface, thus significantly lowering gear gauge.

To study and establish the performances of a gear, one of the fundamental criteria is to determine the level of quiet operation of the gear.

The paper presents an experiment on determining the level of noise and vibration of a gearbox with worm face-gear with reverse tapered.

2.The operation and construction of the experimental stand

In paper [1] presents an construction and operation of an exeprimental stand. Thus at different times of loading gear front has a different behavior in terms of noise and vibration transmitted to the gearbox. The noise level was measured using a Sound Level Meter Voltcraft SL-50 type device, from a distance of 0.5 m, and the vibration was measured with a meter-10 type VIB / VIB-11, fixed to the gearbox.

The worm face-gear with reverse tapered submitted is carried out in a couple of steel-bronze material with the following characteristics:

The tapered worm is made of one quality steel alloy 41MoCr11, heat treated of nitriding in gas, so the worm-surface hardness is 960HV. The type of worm is archimedical tapered and the flank's roughness is Ra = 6,3 μm.

Fig. 2 The tapered worm

The worm-wheel with reverse tapered is made of bronze CuSn12 and has a hardness of 95HB, the flank's roughness is different resulting thrust on the flanks, respectively on the bearing flank 10^0, roughness is Ra = 6.3μm, and the support flank 30^0, roughness is Ra = 12.5μm.

Fig. 3 The worm-wheel with reverse tapered

Construction of experimental stand is shown in paper [1], as in Fig. 4 can be seen at the entrance drives is coupled to an electric motor and the output shaft is mounted an electromagnetic brake with powdered. Load time can be set differently on the gearbox output shaft. Thus have identified 10 successive loading checking for each load step noise and vibration.

3. Experimental data

For the proposed experiment identifies the main features of the geometric and functional gearbox having a worm face-gear with reverse taper pinion: 1.5 kW input power, 3196rpm input speed, output speed of 68rpm, the transmission ratio i = 1:47; distance axial A = 58mm, module m_a=2.5mm, bearing flank angle α_1 = 10°, support flank angle α_2 =30°; type screw - Archimedes, δ1 = -5 ° taper worm, worm drive wheel taper δ2 =-8°, time for each step loading-15min.

Fig. 4 The experimental stand

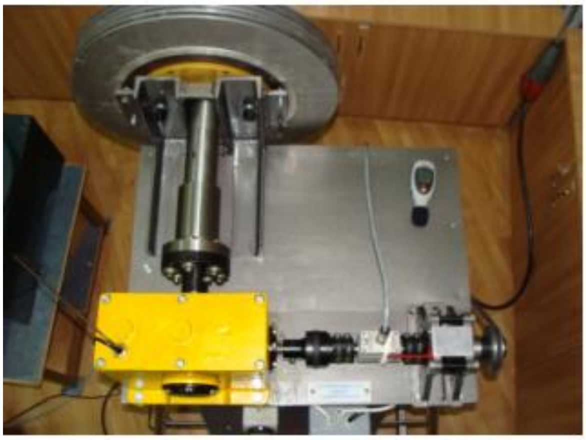

Fig. 5 Top view of experimental stand

The characteristics of measuring instruments are presented in Table 1 for sound level meter, respectively Table 2 for vibration frequency meter.

Table 1. Technical data for sound level meter - Voltcraft SL-50

The operating Voltage: 9 VDC (1602, 6F22)
Power consumption: max. 40 mA (with light in background)
Measuring range: 40 – 130 dBC (30 Hz – 4 kHz)
The evaluation time: 125 ms
Display: 0,1 dB
Accuracy: +/- 3,5 dB (pentru 1 kHz şi 94 dB)
Microfon: electrostatic microfon for ½
Operating terms: 0 – 40 °C/10 – 75 %rF (no condensation)
Operating altitude: max. 2.000 m
Weight: cca. 135 g
Dimension: (L x l x Î): 130 mm x 52 mm x 32 mm

Table 2. Technical data for vibration frequency meter -VIB-10 / VIB-11

Measuring range VIB-10B: 0.5 to 99.9 mm/s RMS,
VIB-11B: 0.01 to 3.93 in/s RMS,
10 to 1000 Hz
Resolution: 0.1 mm/s (0.01 in/s)
Accuracy 2% □0.2 mm/s (2% □0.02 in/s)
Power supply Four 1.5 V alkaline cells
(e.g. MN 1500 or UCAR E91)
Temp. range 0 to +55 □C (32 to 131 □F)
Display 3 digits, red LED
Switch-off Automatic
Protective cover Polyurethane
Dimensions 210 x 75 x 30 mm
(8.3" x 2.9" x 1.2")
Weight 410 grams (14 oz) incl. batteries
Connector type TNC

4. The experimental data evaluation

The experiment carrying out has two stages to measure the level of vibration and noise respectively for two different cases:

case I – bearing flank's on the 10^0 angle;

case II - bearing flank's on the 30^0 angle.

Table 3. Data of bearing flank's on the 10^0

		bearing flank-10
Load step	Average noise level [dBC]	Average vibration level [mm/s]
0	77,6	1,65
1	77,85	1,7
2	78,7	1,75
3	78,68	1,8
4	78,85	1,8
5	78,1	1,8
6	77,78	1,8
7	78,88	2
8	81,45	2
9	82,33	2,1

Table 4. Data of bearing flank's on the 30^0

		bearing flank-30
Load step	Average noise level [dBC]	Average vibration level [mm/s]
0	80,1	1,5
1	81	1,8
2	79,55	1,45
3	78,1	1,4
4	77,2	1,25
5	76,4	1,25
6	76,75	1,3
7	78,175	1,3
8	79,15	1,55
9	78,1	1,5

It can identify the average values for each load step, which stabilizes the numerical value of the noise and vibration levels, corresponding to load step.

Table 5. The values of the load's step

Load step	0	1	2	3	4	5	6	7	8	9
Values [Nm]	0	7,77	9,73	14,07	19,09	23,36	34,88	56,25	83,82	112,8

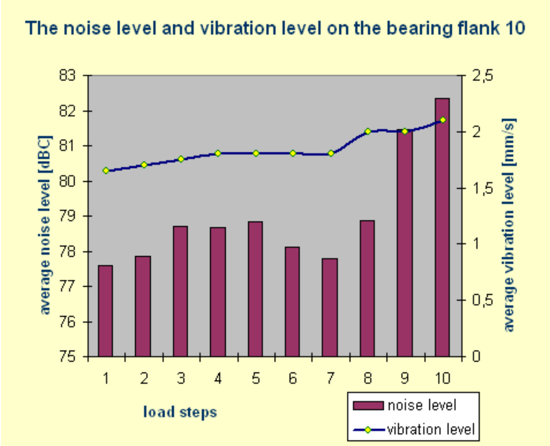

Fig. 6. The noise level and vibration level on the bearing flank 10^0

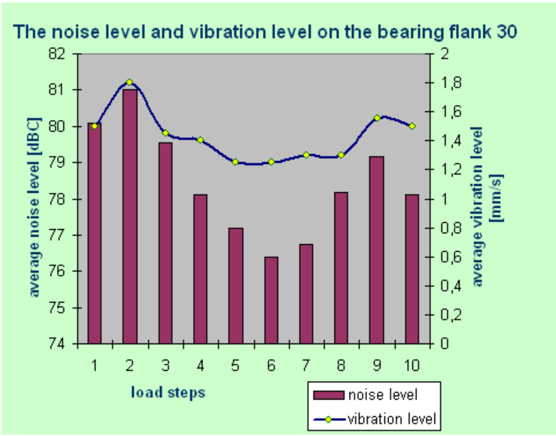

Fig. 7. The noise level and vibration level on the bearing flank 30^0

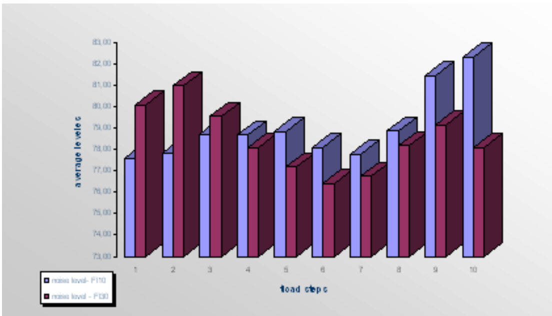
Fig. 8. Graphical comparison of noise level

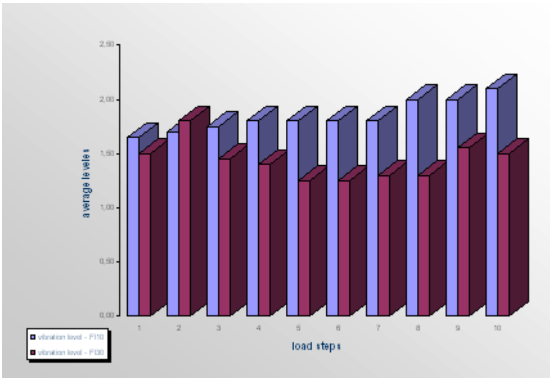
Fig. 9. Graphical comparison of vibration level

5. Conclusion

Allows the experiment can be conducted formulating the following conclusions:

- The experimental dates obtained refers only to the experimental loading period mentioned in the paper and represent average values for each load step at the beginning and the end result on stage in function;
- The operation of the gearbox can be seen that the side bearing 30^0 provides superior conditions of noise and vibration lower level to flank 10^0;
- The measurements required for other couples of materials, namely steel-gray cast iron, steel-plastic, to create a complete picture of the functioning of these types of gear.

References

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[3] *** AGMA ISO *Gear Reducers - Thermal Capacity Based on ISO/TR 14179-1*