VIBROACOUSTICAL DIAGNOSIS OF PLANETARY PRECESSIONAL KINEMATICAL TRANSMISSION

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1. INTRODUCTION

The paper regarding vibroacustical research on planetary precessional kinematical gear box with transmission ratio u=-72,3, see figure 1 [1,2,4,6]. Acoustical analysis on planetary precessional kinematical transmission was made regarding analysis over a frequency range, here, a special analysis (FFT – Fast Fourier Transformation). In practice the simple amplitude measurement of the

a.

b.

Figure 1. Planetary precesional kinematical gear box*: a) Satellite wheel made of plastic material type Hostaform C2091 b) Satellite wheel made of powders material type Жгр7.*

vibration speed signal is often used for evaluation of the balance condition. The vibration speed signal is a direct measure of the out-of-balance condition, since the balance quality is specified as the speed of the center of gravity of the rotor. An increase in amplitude over time may indicate increasing damage.

2. CONSTRUCTIVE AND TECHNOLOGICAL SOLUTION TO REDUCE VIBRATION AND NOISE IN KINEMATICAL PPT

In practice we can use various methods to minimize vibration and noise levels in dynamic systems. Mechanical transmissions used in various machines and installations are sources of high frequency vibration and noise. The most effective, but also the most expensive way to get quieter transmission, is the method of execution of machine parts with very high precision or method of static and dynamic balancing of moving parts. For kinematical PPT we recommend correct choice of materials for gearwheels in terms of shock and vibration damping. One of the main advantages of PPT is the multiplicity meshing (up to 100% pairs of gearing teeth). For kinematical PPT satellite block can be made of plastic materials with damping properties (absorption) of gear shock. For this purpose has been developed kinematic precessional reducer (Fig. 2), with satellite block made of plastic materials type Hostaform C9021, and satellite wheel made of powders material type Жгр7 [3,4] , see figure 2.

3. STANDARDS FOR ASSESSING THE SOUND PRESSURE LEVEL

In practice the simple amplitude measurement of the vibration speed signal is often used for evaluation of the balance condition. The vibration speed signal is a direct measure of the out-of-balance condition, since the balance quality is specified as the speed of the center of gravity of the rotor. An increase in amplitude over time may indicate increasing damage.

Experimental result was compared with limits for vibration amplitude (v_{eff} in mm/s) in general engineering in line with VDI directive 2056 [5,7]. Regarding this directive Table 1, mechanical systems were divided into four main groups K (small machines), M (medium machines), G (large machines) and T (turbo machines). Tested

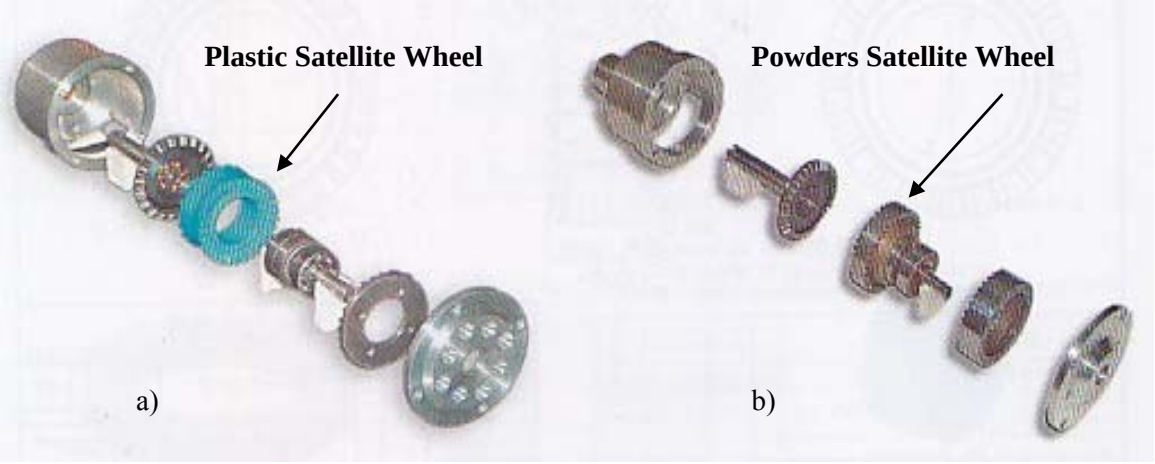

Figure 2. Planetary precesional kinematical gear box: *a) Satellite wheel made of plastic material type Hostaform C2091 b) Satellite wheel made of powders material type Жер7*

Table 1. Limit values for assessment of mechanical vibration in line with VDI 2056 [5,7]

Sound pressure [dB]	Vibration amplitude v_{eff} [mm/s]	**Group *K* Small machines (< 15 kW)**	Group *M* Medium machines (15kW–75kW)	Group *G* Large machines (> 75 kW)	Group *T* Turbo machines (> 75 kW)
133	45,0	**Unacceptable**	Unacceptable	Unacceptable	Unacceptable
125	18,0				Acceptable
121	11,2			Acceptable	
117	7,1		Acceptable		Usable
113	4,5	**Acceptable**		Usable	
109	2,8		Usable		Good
105	1,8	**Usable**		Good	
101	1,12		Good		
97	0,71	**Good**			

kinematical PPT see figure 1 and figure 2 regarding VDI directive 2056 belong to group K for small machines like individual propulsion components of engines and machines whose operating condition is linked to that of the entire machine, in particular series manufactured electric motors up to around 15 kW [7].

4. RESEARCH ON EXPERIMENTAL STAND

Experiments were carried out in a closed laboratory room with rigid floor on the GUNT laboratory trolley type PT500.01 provided with a T-shaped channel. In these channels, we fix all components (figure 3): drive unit with three phase motor (P=0,36 kW), kinematical PPT gear box with satellite block from plastic materials and GUNT brake/ load unit type PT500.05. Precise axial alignment of the shafts was achieved using claw couplings. Figure 4 represent typical measurements of noise level. In figure 5 is shown Bruel & Kjaer Sound level meter Type 2250 which was used for measuring noise levels, that have everything needed to perform high-precision, Class 1 measurement tasks in environmental, occupational and industrial application areas.

Sound level meter Type-2250 is a highly versatile, cloud enabled modular platform with many optional application modules such as frequency analysis, FFT, advanced logging (profiling) and sound recording [8].

5. DATA MEASUREMENTS AND RESULTS

In Table 2 is showed noise analysis at various work speeds, with and without load: the noise level is within the range 32-58 dB for the satellite executed from plastic (figure 2,a) and 38 dB - 64 dB when the

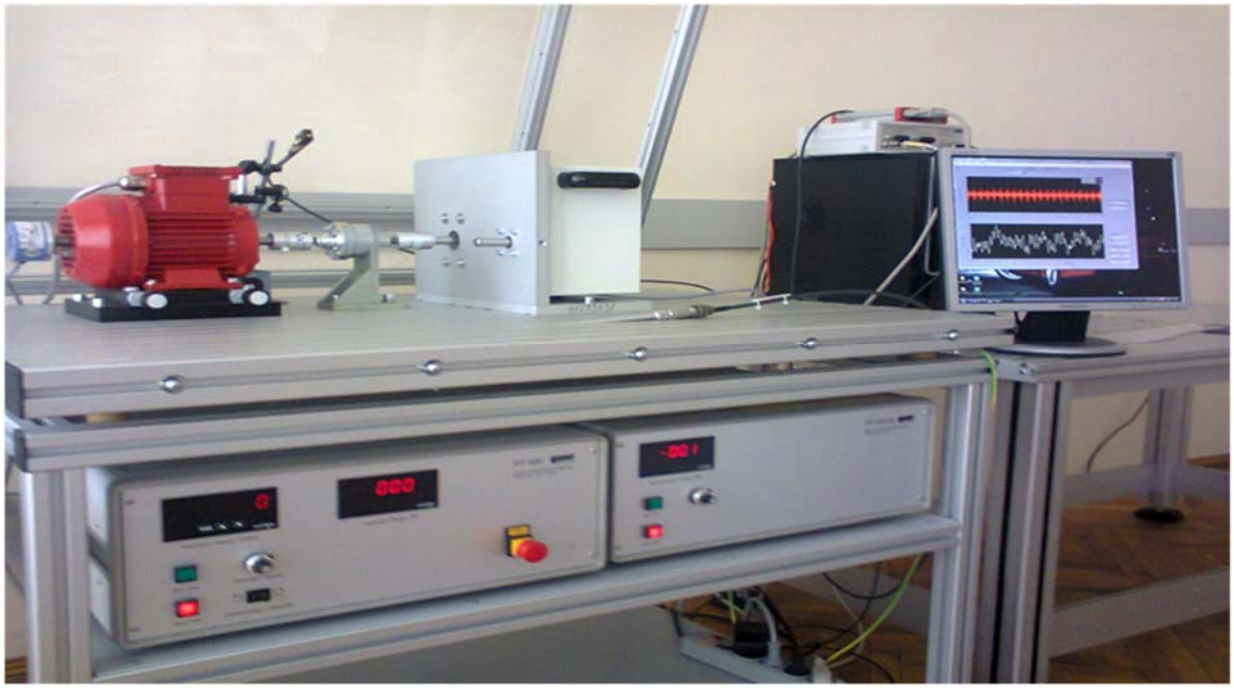

Figure 3. Research on the test bench [2].

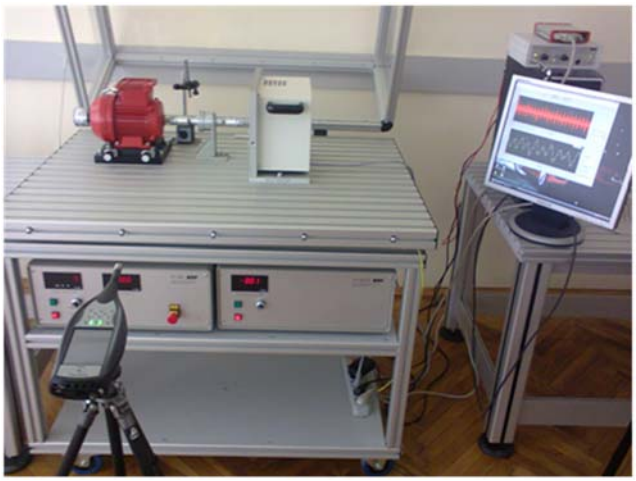

Figure 4. Measurements of noise level.

Figure 5. Sound Level Meter – Type 2250

Table 2. Measured noise level for kinematical precessional transmission

Speed / Load	**600** min^{-1}		**1200** min^{-1}		**1800** min^{-1}		**2400** min^{-1}		**3000** min^{-1}	
	Plastic satellite	**Powder satellite**	**Plastic satellite**	**Powder satellite**	**Plastic satellite**	**Powder satellite**	**Plastic satellite**	**Powder satellite**	**Plastic satellite**	**Powder satellite**
Without load	35 dB	41 dB	46 dB	49 dB	48 dB	53 dB	53 dB	58 dB	58 dB	64 dB
0,5 load	33 dB	39 dB	40 dB	48 dB	47 dB	50 dB	50 dB	56 dB	55 dB	63 dB
Full load	32 dB	38 dB	44 dB	46 dB	46 dB	49 dB	51 dB	55 dB	56 dB	62 dB

satellite wheel is made by powder metal (figure 2,b) [2].

Relatively low levels of noise can be explained by the multiplicity meshing of teeth (up to 100%) and the second factor which led to decrease noise level is represent by use of the plastic wheel (satellite) that have a greater capacity to damping shocks and vibrations and emitted noise level

CONCLUSIONS

In conclusion we can mention that assessment of measured values (Table 2) in line with VDI directive 2056 (Table 1) demonstrated good acoustical behavior of kinematical PPT gear box [1,2].

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