EXPERIMENTAL RESEARCH ON THE USE OF NODULAR GRAPHITE CAST IRON IN MAKING SPIROID WORM GEARS

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Abstract:

The paper presents the recommendations made in technical writing for the execution of spiroid worm gears. Then, the results of a personal study are highlighted on the behavior of a spiroid worm gear with the worm made of alloyed steel 41 Mo Cr11 hardened by ionic nitration and the worm gear made of nodular graphite cast iron.

Keywords: worm gear, spiroid, try-outs, thermal resistance limit, graphite nodular cast iron

1. Introduction

By their geometrical specificity spiroid worm gears permit the accomplishing of more diverse material combinations than with common worm gears. The following material combinations are possible [1]: hardened steel/hardened steel, hardened steel/bronze, hardened steel/graphite nodular cast iron, hardened steel/cast iron, hardened steel/syntherized material, hardened steel /plastic material, steel/aluminum, brass/aluminum and others.

Gears that are destined to work with heavy charges must be executed in the following combinations: hardened steel/hardened steel, hardened steel/bronze and hardened steel/nodular graphite cast iron. [1,4].

2. Tried Experiments

In order to establish the behavior of a spiroid worm gear whose gear is made of nodular graphite cast iron and its worm out of hard steel a designed gear was used in the structure of a hobbing machine [3]. The method presented in [1] was used as a design method.

The main geometrical features are as follows: i = 47, the axial distance A = 56mm, the axial modulus $m_a = 2.5$ mm, the worm flank angles 10^0 and 30^0 , arhimedic worm.

The materials used in making the tested gears were:

- Cylindrical spiroid worm: alloyed steel 41 MoCr 11 STAS 791-80, improved and nitrated at 810 HV5;
- Spiroid worm gear: nodular graphite cast iron, brand Fgn 600-2 STAS 6071-75 with a part hardness of 255 HB.

Table1

	Chemical Composition %				
	C	Mn	Si	Cr	Mo
Worm	0.42	0.63	0.27	1.08	0.10

Table 2

	Chemical Composition %					Test piece mechanical characteristics		
	C	Si	Mn	Mg	S	R-N/mm	A 5%	HB
Worm Gear	2.96	3.07	0.68	0.063	0.015	700	4.9	200

Table 1 presents the chemical composition of the material used for putting together the worm and Table 2 shows the chemical composition of the test pieces cast together with the worm gears out of nodular graphite cast iron.

The cylindrical spiroid worm gear that was accomplished and tested is shown in figure 1.

Fig. 1

Analyzing the obtained microstructures by using the metallographic microscope the following can be demonstrated.

The structure of the spiroid worm made of ionic-nitrated steel, fig. 2 highlights (zooming 500 times) a uniform, compact, combination layer with no pores and a thickness of 8 μm. In the diffusion zone area there are no precipitate nitrate segregates. The base material has a ferrite structure with insulated carbide formations corresponding to a preliminary recovery treatment.

Figure 3, which shows the structure of the worm gear made of Fgn-600-2 (zooming 173 times), there is a structure of a pearlitic base mass (P 70), ferrite separations around the graphite nods. (GNd 4, GNf 1, GN 10).

Fig. 2

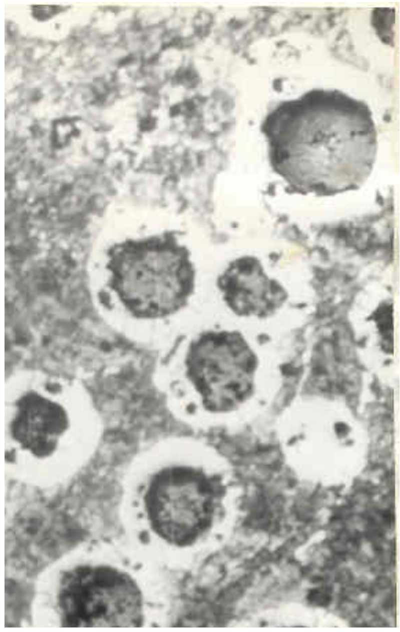

Fig. 3

Turning the left and right flanks separately has made the execution of the teeth of the worms. The work piece was in a normalized state. To obtain an arhimedic worm the knife was placed with its profile on the axial plane of the worm. After turning the flanks, the ionic nitration was applied protecting the filleted area. For a layer depth of 0.4 mm a hardness of 810 HV5 was obtained. The roughness of the flanks had a value of R_a=3.7μm.

Nodular graphite cast iron worm gears had a hardness of 255 HB. The teething was done on the FD 500 type U.M. Cugir machine. Tangential advance milling was used once with the advance being S_t=0.133 mm/rot and a cutting velocity of 21m/min. The resulted roughness on the 10^0 flank was R_a=1.12 μm and on the 30^0 flank R_a= 0.675 μm.

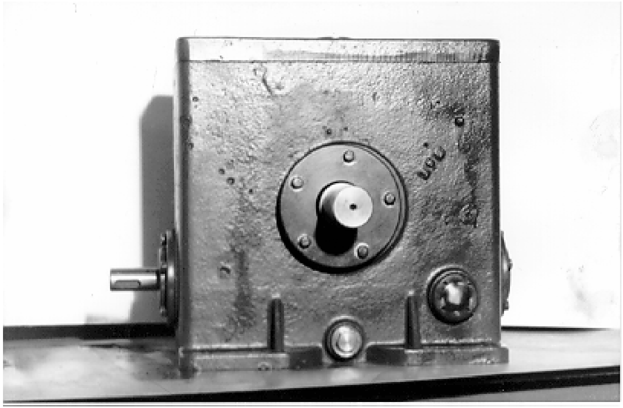

Fig. 4

The gear made in the above-mentioned technical conditions was included in the structure of a propeller reduction gear lubricated with T90 EP2 oil. The reduction gear (fig.4) was tested for charges on a specialized stand [2] making the specific verification known as thermal resistance limit.

A thermal limit of 20 daNm was obtained (for a temperature of 90^0 Celsius).

The efficiency corresponding to the thermal limit was 0.73, approximately equal on the two working flanks.

3. Conclusions:

- Using spiroid worm gears made of nodular graphite cast iron creates good functioning conditions from the point of view of thermal limit.
- Highlighting the wear behavior for a long functioning period presupposes performing of specific experiments.

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