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COMPARISON BETWEEN THE CLASSICAL HARMONIC DRIVE AND THE HERMETIZED HARMONIC DRIVE

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Abstract

This paper refers to the need of the HHD appearance in the context of HD development, to be used in closed spaces.

The closed spaces from various domains, such as chemical industry, petroleum industry or biological laboratory etc., must be separated from other workspaces by using different types of hermetized gears. Those hermetized gears work in dangerous spaces and isolate the two spaces.

In this paper is the HHD and HD comparison is presented, according to the elements which are characteristic to both gear drive.

1. INTRODUCTION

The harmonic drive was invented by CW Musser in 1955 and in the year that followed it was developed, being now used in different types of top industries such as the space industry, naval industry, robotics etc.

These transmissions assure a precise and silence functioning, offering great mechanical efficiency at higher gear ratio, higher gear ratio on one gear, lower jigs and weight, simplicity in construction etc.

From the view point of the construction elements a harmonic drive is made up of three main parts as specified next: flexible gear wheel, rigid gear wheel, wave generator.

The figure below (figure 1) presents these characteristic parts as they look on a harmonic drive with flexible gear wheel with cup shape.

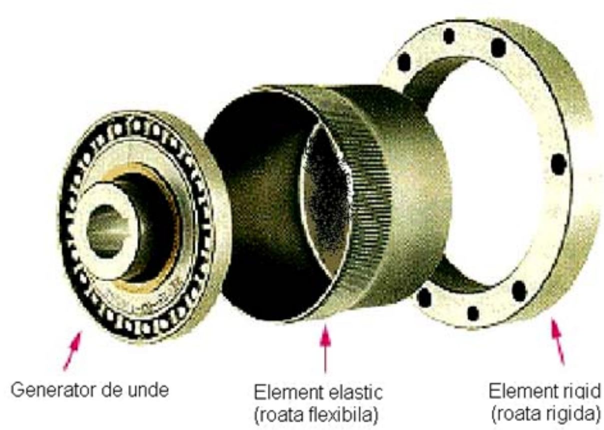


Fig. 1 Harmonic drive parts

Functioning of this transmission is shown in figure 2.

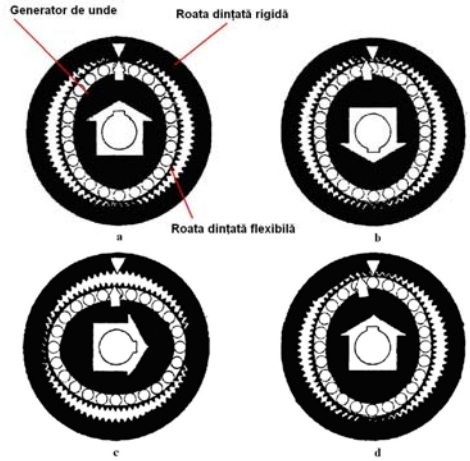


Fig. 2 Harmonic drive meshing exemplification

The wave generator could be in different construction type like mechanical, hydraulics, pneumatics or electromagnetic, with one, two, three or four deforming arms, named deforming waves. The wave generator deforms the flexible gear wheel forcing this wheel to mesh with rigid gear wheel, the movement to the exit shaft being like a harmonic wave. That's why these transmissions were named Harmonic Drives.

2. HERMETIZED HARMONIC DRIVE

Hermetized harmonic drive appeared because of the necessity of some transmissions to work in hermetized spaces. The role of these transmissions is to work between those two spaces separated without any leaks. Examples of hermetized workspaces are in chemical industry where it is necessary to manipulate toxic substances, or in biological laboratories where the activities are with very dangerous materials and also in the petroleum industry with pollutant and explosive materials. That's why the heremetized harmonic drive is absolutely necessary.

The elements of this transmission are not different from the classical harmonic drive, so we have the flexible gear wheel, rigid gear wheel and wave generator.

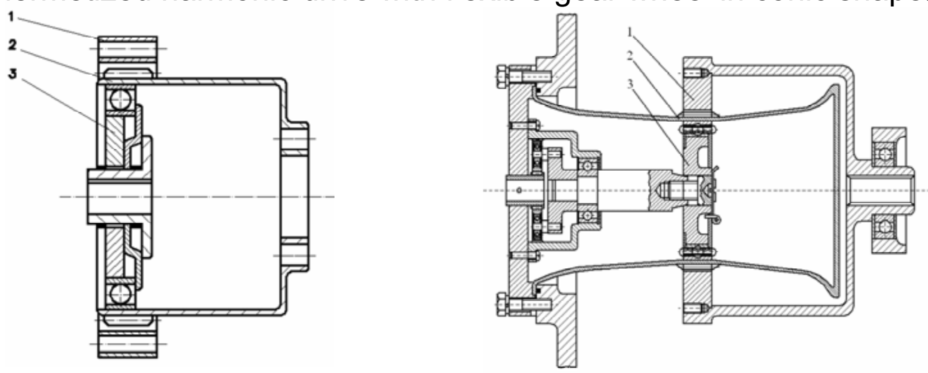
The sealing element of the hermetized harmonic is represented by the flexible gear wheels which represent the difference between the classical harmonic drive and hermetized harmonic drive.

Figure 3 shows, in comparative mode, an example of a flexible gear wheel from a classical harmonic drive and a hermetized harmonic drive also.

a b

Fig. 3 Flexible gear wheel
a. at classical harmonic drives; b. at hermetized harmonic drives

Figure 4 a, presents a harmonic drive with flexible gear wheel with L=D whereas figure 4 b presents a hermetized harmonic drive with flexible gear wheel in conic shape.



a ***b***

Fig. 4 a. Harmonic drive; b. Hermetized harmonic drive

3. HARMONIC DRIVE FINITE ELEMENT ANALYSIS

The solid 3D model of the two types of flexible gear wheels was realised using the soft "Catia".

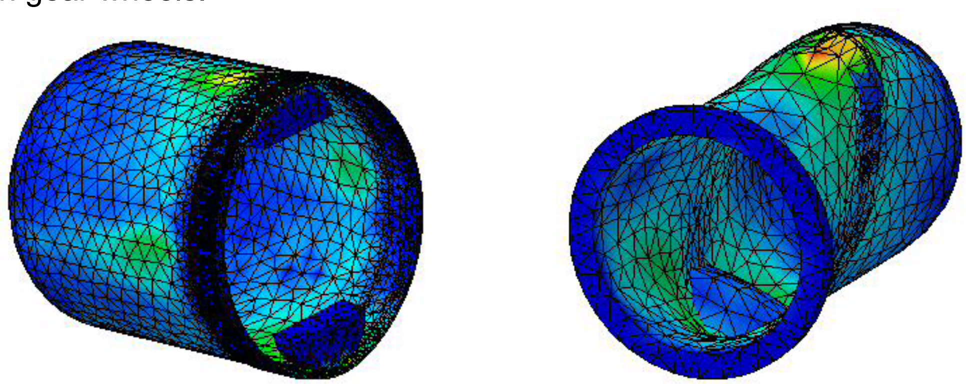
By the analysis it was observed those two flexible gear wheels when they are deformed by a two arms wave generator.

Both gear wheels had the same diameter, Φ60 mm, the same number of teeth, respectively 120. The flexible hermetized gear wheel had the length equal with two times of diameter, respectively L=2D, which means that L=120 mm and the other flexible gear wheel has the length equal with the diameter, respectively L=D which means that L=60 mm.

The wave generator had built only its extremities because there it is in contact with flexible gear wheel and, because of design reasons, it is easier to accomplish for the finite element analysis.

A force of 5000 N was constantly and equaly applied to both gear wheels, the results being observed.

The flexible gear wheel under deformation is presented in figure 5, a, with L=D length whereas in figure 5, b, the flexible hermetized gear wheel with L=2D length under the same deformation like the L=D gear wheel is presented, for the finite element analysis. It is noted: 1 – flexible gear wheel, 2 – wave generator represented. The notes of the components are the same for both gear wheels.



a *b*

Fig. 4 Flexible gear wheel
a. L=D; b. L=2D

In figure 6 the strains are shown which appear in the flexible gear wheels under stress at the teeth area.

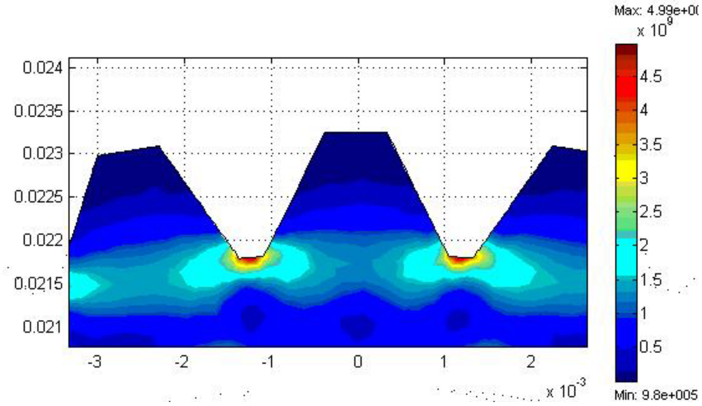


Fig. 6 Strains on flexible gear wheel at the teeth area

The measures made using the soft “Catia” reveal that between those two types of wheels there are a plenty of similarities.

4. CONCLUSIONS

After the finite element analysis it could be said that hermetized harmonic drive has a lot of similarities with the classical harmonic drive regarding the strains and deformations especially at the base of the teeth.

The differences which appear are determinated by the constructive shape of the flexible gear wheel and by it’s functionality.

The length of the flexible hermetized gear wheel, L=2D, influenced the strains distribution on the flexible gear wheel and the shape of the gear wheel has an important part in a long functionality of the hermetized harmonic drive.

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