# Method of design of heroic transmission

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**Abstract**. This document describes how to construct a heroic transmission used in the mechanization of agricultural machinery. The article discusses the basic principles, design features and advantages of heroic transmission. Various methods of designing heroic programs are also considered. Based on the information considered, a method for designing a heroic transmission was developed. Based on the calculation, sketches of the impeller of the hero gear were developed. Based on the sketch of the outer wheel and the eccentricity, the obtained data were substituted into the parametric equation of the eccentroid cycloid, the profile of which is the basis for the construction of the inner wheel of the rocking pair. Based on the sketch, a 3D model of heroic transmission was developed, which was based on mathematical modeling.

## 1 Introduction

Gerotor gears are a type of gear train that provides the transmission of the moment of force and speed of rotation between two shafts. They consist of a rotor and stator, which have a special shape called rotor and stator planes. [1]

The main feature of gerotor transmissions is that they use the movement of the rotor inside the stator to create a sealed chamber in which the moment of force is transmitted. The rotor is a toothed structure having fewer teeth than the stator. This creates an eccentric movement of the rotor as the rotor rotates within the stator. As a result of this movement, variable volume chambers are formed between the teeth of the rotor and stator.

The advantages of heroic broadcasts include [2]:

- High efficiency: Gerotor transmissions have high efficiency, which means that little energy is lost during the transmission process.
- Compact size: Gerotor transmissions have a small size and weight, which makes them ideal for use in a limited space.
- Smooth operation: Heroic transmissions ensure smooth and uniform transmission of the moment of force without jerks or jumps.

Gerotor transmissions are widely used in various fields, including the automotive industry, aerospace engineering, medical equipment and others. They are used to transmit power and control rotating mechanisms such as motors, pumps and compressors. [3]

Gerotor gear, also known as gerotor, is a type of gear gear that is widely used in the mechanization of agricultural machinery. It consists of two elements: a gerotor and a shell.

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The gerotor is an inner gear with slots, and the shell is an outer gear with protrusions. The gerotor and the shell rotate relative to each other, creating a transmission of motion. The main advantage of the heroic transmission is that it provides high torque with small dimensions and weight. It also has high reliability and durability.

Mechanization of agricultural machinery, such as tractors, combine harvesters and wood crushers, require the transmission of a large amount of torque to handle heavy loads. Heroic transmission copes with this task perfectly, ensuring effective power transmission and controllability of mechanisms.

Gerotor transmission is an important element in the mechanization of agricultural machinery, ensuring high efficiency and reliability of work. It allows agricultural machines to cope with difficult tasks and increase productivity in agriculture.

## 2 Materials and methods

There are several methods for designing hero programs, including [4]:

1. Evolute construction method: This method begins with the original concept of heroic transmission and consistently applies various operations to create an iterative process that results in an optimal construction. The designer changes the shape of the teeth, radii, profiles, and other parameters to achieve the best result.
2. Reverse Engineering Method: In this method, the designer begins with given gerotor transmission requirements such as required torque and rotational speed. The designer then performs reverse calculations to determine transmission parameters, such as the number of teeth and their profile. This method requires the use of mathematical algorithms and computer simulations.
3. Finite Element Method (FEA): The finite element method is used to analyze stresses and strains in heroic transmission. The designer creates a 3D transmission model and uses FEA to determine its strength. This allows you to determine the optimal transmission dimensions and parameters so that it can withstand the required loads and operating conditions.
4. Computer modeling and simulation: Using special software, the designer creates a computer model of heroic transmission and conducts simulations to determine its performance and effectiveness. This allows for virtual testing and optimization of the design prior to its physical implementation.

These design methods allow the creation of herotor transmissions with high efficiency, reliability and optimal design for various applications

## 3 Results and discussion

This chapter describes gear design. The MathCad program is used for the calculation.

Based on the sketch of the outer wheel and eccentricity, we obtain data for substituting an eccentroid cycloid into the parametric equation, the profile of which is the basis for building the inner wheel of the rocking pair.[5]

$$\Omega(\varphi)=\begin{cases} X(\varphi)=R_{gK}\cdot\cos\varphi+e\cdot\cos\left((z+1)\varphi\right)-r_K\cdot\cos\left[a\tan\left(\dfrac{\sin(z\varphi)}{k+\sin(2z\varphi)}\right)+\varphi\right] \\ Y(\varphi)=R_{gK}\cdot\sin\varphi+e\cdot\sin\left((z+1)\varphi\right)-r_K\cdot\sin\left[a\tan\left(\dfrac{\sin(z\varphi)}{k+\sin(2z\varphi)}\right)+\varphi\right] \end{cases} \tag{1}$$

Where $R_{gk}$ is the radius of the center of the semicircular teeth of the wheel; $e$ - eccentricity of feed pump pumping pair; $z$ - number of teeth of the inner gear of the rocking pair; $r_k$ -

radius of the semicircular tooth of the external wheel; $k$ - correction factor determined by the matching method. [6]

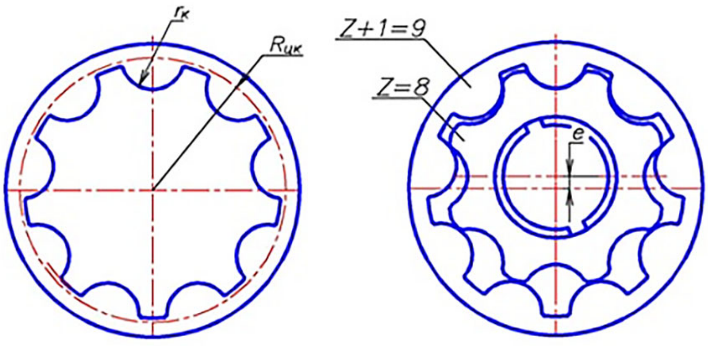


**Fig. 1.** Gear sketch.

$$X2(\varphi) = R2 \cdot \cos(\varphi) + e \cdot \cos((z+1)\varphi) - r_K \cdot \cos\left[ a\tan\left( \frac{\sin(z2 \cdot \varphi)}{k + \sin(2z \cdot \varphi)} \right) + \varphi \right] \tag{2}$$

$$Y2(\varphi) = R2\sin(\varphi) + e \cdot \sin((z+1)\varphi) - r \cdot \sin\left[ a\tan\left( \frac{\sin(z2 \cdot \varphi)}{k + \cos(2z \cdot \varphi)} \right) + \varphi \right] \tag{3}$$

Where x, y are the coordinates of the wheel profile.

$$R1 = R2 - e \tag{4}$$

Where R1, R2 is the radius of the generating circles.

$$z1 = z - 1 \tag{5}$$

$$xa(\varphi) = R2 \cdot \cos(\varphi) \tag{6}$$

$$ya(\varphi) = R2 \cdot \sin(\varphi) \tag{7}$$

$$x1(\varphi) = R1 \cdot \cos(\varphi) + e \cdot \cos(z2 \cdot \varphi) - r \cdot \cos\left[ a\tan\left( \frac{\sin(z1 \cdot \varphi)}{k + \cos(z1 \cdot \varphi)} \right) + \varphi \right] + e \tag{8}$$

$$y1(\varphi) = R1 \cdot \sin(\varphi) + e \cdot \sin(z2 \cdot \varphi) - r \cdot \sin\left[ a\tan\left( \frac{\sin(z1 \cdot \varphi)}{k + \cos(z1 \cdot \varphi)} \right) + \varphi \right] \tag{9}$$

Find the radius of the profile at the angle of the φ [7]:

$$R1(\varphi) = \sqrt{x1(\varphi)^2 + y1(\varphi)^2} \tag{10}$$

$$R2(\varphi) = \sqrt{x2(\varphi)^2 + y2(\varphi)^2} \tag{11}$$

Find the diameter of the tooth head:

$$Da_2 = 2 \cdot (R2 - r - e) \tag{12}$$

Find the diameter of the tooth cavity:

$$Df_2 = 2 \cdot (R2 - r + e) \tag{13}$$

$$Df_2 x(\varphi) = \frac{Df2}{2} \cdot \cos(\varphi) \tag{14}$$

$$Df_2 y(\varphi) = \frac{Df2}{2} \cdot \sin(\varphi) \tag{15}$$

$$Da_2 x(\varphi) = \frac{Da2}{2} \cdot \cos(\varphi) \tag{16}$$

$$Da_2 y(\varphi) = \frac{Da_2}{2} \cdot \sin(\varphi) \tag{17}$$

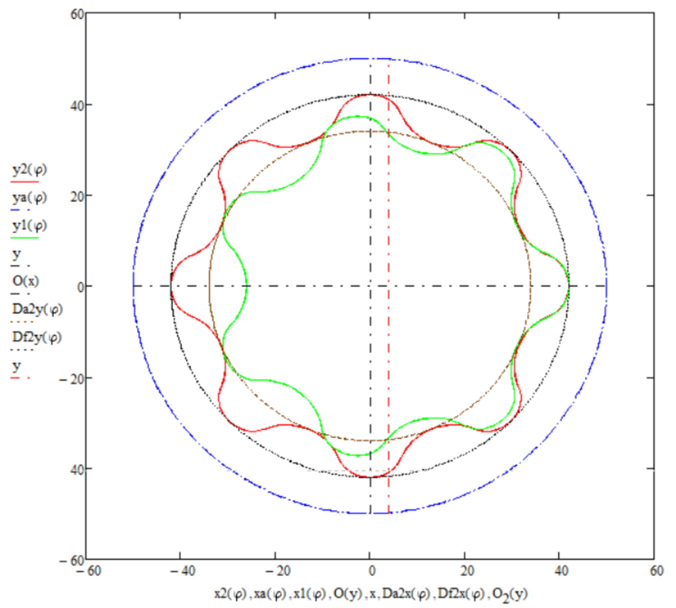


**Fig. 2.** Impeller Sketch.

We will find the area of the sector limited by the engagement profile, the integration limits - the angles of coverage of the working camera at the maximum volume [8]:

$$S1 = \int_{3{,}534}^{4{,}32} x1(\varphi) \cdot \left( \frac{d}{d\varphi} y1(\varphi) \right) \cdot d\varphi \tag{18}$$

$$S1 = \int_{3{,}534}^{4{,}32} x2(\varphi) \cdot \left( \frac{d}{d\varphi} y2(\varphi) \right) \cdot d\varphi \tag{19}$$

$$S11 = \frac{1}{2} \cdot \int_{3{,}534}^{4{,}32} R_1(\varphi)^2 \cdot d\varphi \tag{20}$$

$$S22 = \frac{1}{2} \cdot \int_{3{,}534}^{4{,}32} R_2(\varphi)^2 \cdot d\varphi \tag{21}$$

$$S22 = \frac{1}{2} \cdot \int_{3{,}534}^{4{,}32} R_2(\varphi)^2 \cdot d\varphi \tag{22}$$

Find the geometric volume of the hydraulic machine:

$$Vg = 10^{-3} \cdot 2 \cdot \pi \cdot b \cdot e \cdot Da_2 \frac{z2}{z1} \tag{23}$$

Based on the calculations, we build a sketch of the impeller.

$$x1(\varphi) = R11 \cdot z2 \cdot \cos(\varphi) - \lambda \cdot R11 \cdot \cos(z2 \cdot \varphi) - r11 \cdot \frac{\cos(\varphi) - \lambda \cdot \cos(z2 \cdot \varphi)}{\sqrt{1 + \lambda^2 - 2 \cdot \lambda \cdot \cos(z1 \cdot \varphi)}} + (-e) \tag{24}$$

$$y1(\varphi) = R11 \cdot z2 \cdot \sin(\varphi) - \lambda \cdot R11 \cdot \sin(z2 \cdot \varphi) - r11 \cdot \frac{\sin(\varphi) - \lambda \cdot \sin(z2 \cdot \varphi)}{\sqrt{1+\lambda^2 - 2 \cdot \lambda \cdot \cos(z1 \cdot \varphi)}} \quad (25)$$

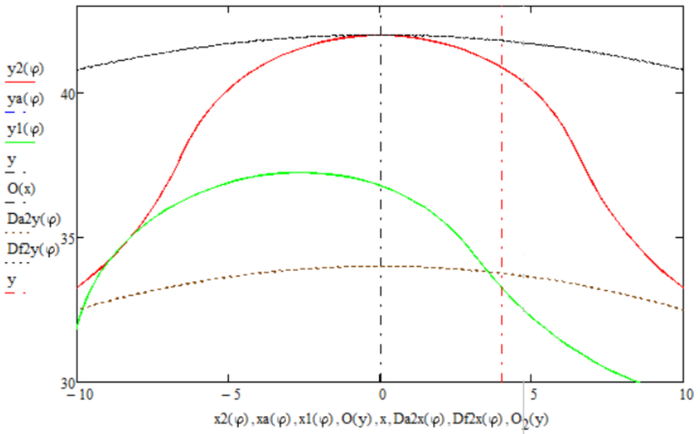


**Fig. 3.** Impeller Sketch.

Using the COMPASS 3D application, we will create a 3D model of the gear being designed.

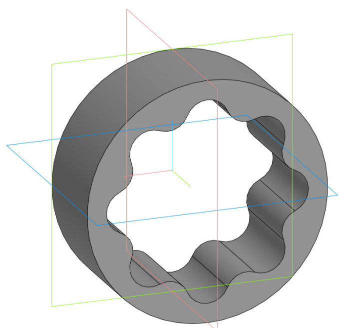

**Fig. 4.** Sketch of external gear.

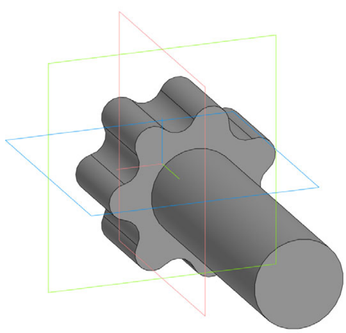

**Fig. 5.** Sketch of inner gear

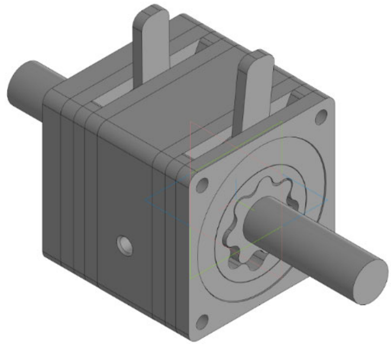

**Fig. 6.** Heroic transmission.

## 4 Conclusion

The design of heroic programs requires the use of various methods and tools. They include evolute construction methods, reverse engineering, finite element method, and computer modeling.

These methods make it possible to optimize the design of gerotor transmissions in order to achieve high efficiency and reliability. They help determine optimal transmission parameters, such as tooth shape, radii and profiles, and analyze its strength and deformations.

Computer simulations and simulations allow virtual transmission tests, reducing the risks and costs of physical prototyping. This allows designers to develop transmissions faster and more efficiently.

The optimal design of heroic transmission depends on the requirements and conditions of a particular application. Designers must consider factors such as required torque, rotational speed, loads and operating conditions to create a gear that will perform its functions optimally.

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