

Parametric Design on Internal Gear of Cycloid Gear Pump with NX10.0

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Abstract. The parametric equation of the theoretical contour curve of cycloid gear was established in this paper. Using the NX10.0 software, parametric design of cycloidal gear profile curve was carried out, and the radius of curvature with the contour curve of cycloid gear was analyzed. The consistency between the simulation results and the theoretical design results was verified by assembly analysis, and the parametric drive of the cycloidal gear was verified simultaneously.

1. Introduction

The cycloidal gear pump is an internal gear pump. Its outer rotor tooth-form is a circular arc, and the inner rotor tooth-form is an equidistant curve of curtate epicycloid, so it is also called as internal meshing cycloidal gear pump. The two tooth lines are a pair of conjugate curves. The tooth-form of cycloid gear is composed of a cycloid curve. The so-called cycloid, that is, a rolling circle, along the basic circle outside rolling, the trajectory of a point on the rolling circle is called the outer cycloid, while the trajectory of a point that rolling along the basic circle inside is called the hypocycloid. Cycloidal gear pump has the advantages of compact structure, small size, light weight, less parts, speed up to 10000r/min, smooth movement, low noise, high volumetric efficiency, small force on the shaft and so on. While its disadvantages are large flow pulsation, complex rotor manufacturing process and etc. It is widely used in the hydraulic systems such as aviation, spaceflight, automobile, ship, chemical machinery and so on. For example, the cycloidal pumps are widely used in the fuel system and lubricating system of engines as oil supply pump and oil return pump[1].

It is difficult to design the inner rotor in designing the cycloidal gear pump. That is because the inner rotor tooth profile is continuous closed equidistant curve of curtate epicycloid, which is complex and involves many geometric parameters. Meanwhile, the related geometry parameter values also change along with different cycloidal gear pump models. The profile curve of the inner rotor tooth-form of the cycloidal gear pump should be redesigned every time the gear is updated in traditional design method, which will take a lot of time and effort. So it is necessary to introduce parametric modeling in the design of the inner rotor[2]. With the rapid development of computer aided design and analysis technology, the CAD method of the contour curve of cycloidal gear is gradually enriched, and more and more manufacturing information software can realize the design of cycloidal gear contour curve and the motion simulation of internal gear pump. At present, many researchers[3-6] use UG, PRO/E and SolidWorks to do parametric design. This paper uses NX10.0 for design and simulation. NX10.0 is a powerful 3D parametric software which integrates CAD/CAE/CAM as a whole, and its function covers the whole life cycle of the product. This paper introduced the parametric design method of cycloidal gear profile curve on the platform of NX10.0, analyzed the radius of curvature with the contour curve of cycloid gear, proved the consistency between the simulation results and the theoretical design results by assembly analysis, and verified the parametric drive of the cycloidal gear



simultaneously. The internal and external gears of the gear pump involved in this paper are shown in figure 1.



Figure 1. Trochoid Pump

2. Parameter Determination

The profile curve of the inner rotor of the cycloidal gear pump is related to the base circle that forms the curtate epicycloid, spheronization radius r_2 , number of inner rotor teeth Z_1 , number of external rotor teeth Z_2 ($Z_2 = Z_1 + 1$), center distance e , formation coefficient K and the radius factor H of the tooth circle. Once these parameters are determined, other geometries relevant to the tooth profile can be computed. The key parameters of the internal and external rotors of the gear pump are shown in figure 2.

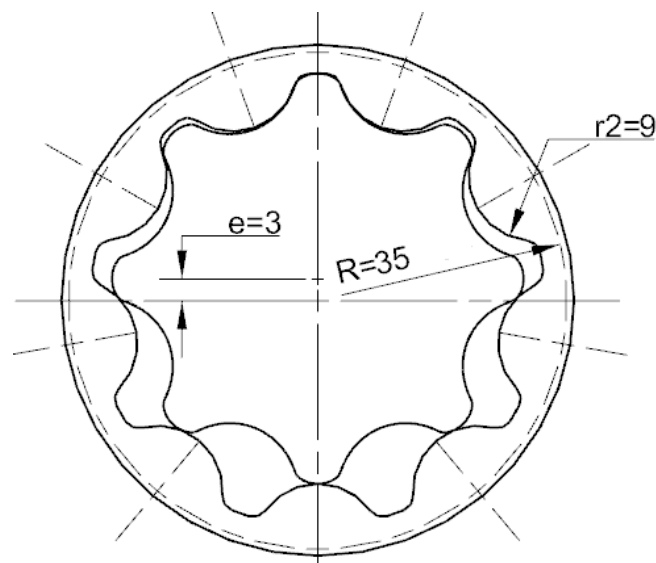


Figure 2. Internal and external rotor parameters of cycloidal gear pump

3. Build Models Using NX10.0

The key of Internal Gear of Cycloid Gear Pump design lies in the design of its contour, but the parametric design of the contour depends on "expression" and "law curve" of NX10.0 modeling module. Expressions created in NX10.0 are shown as follows. The contour curve of the cycloid gear generated with the "law curve" is shown in figure 3. After changing the number of teeth, a new gear contour is generated, as shown in Figure 4, which indicates that parameterized driver is valid. Figure 5 shows the analysis about the radius of curvature of the original gear profile. Since the outer rotor is an

arc gear, use sketch to draw the contour curve, and then stretch to create the internal and external rotors separately. After that, using the assembly module of NX10.0 to assemble and perform interference analysis about the inner and outer rotors. If there is no interference, the rationality of the design is preliminarily proved, and then motion simulation can be used to further verify the rationality of the motion state. No more narrative here. The assembly model is shown in Figure 6.

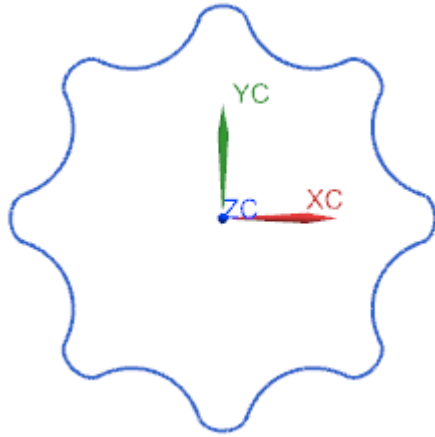


Figure 3. contour curve of cycloidal gear

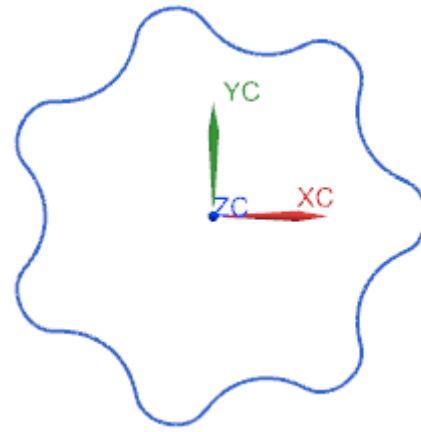


Figure 4. updated contour curve of cycloidal

gear

The formula formats under NX software are as follows:

$$R=35$$

$$a=360*t*z2$$

$$b=\sqrt{e^2+R^2*(1-i)^2+2*R*e*(1-i)*\cos(i*a)}$$

$$e=3$$

$$h=r2/(e*z2)$$

$$i=z1/z2$$

$$k=R/(e*z2)$$

$$r2=9$$

$$t=1$$

$$x1=R*\cos((1-i)*a)+e*\cos(a)$$

$$x2=r2*(R*(1-i)*\cos((1-i)*a)+e*\cos(a))/b$$

$$xt=x1-x2$$

$$y1=R*\sin((1-i)*a)+e*\sin(a)$$

$$y2=r2*(R*(1-i)*\sin((1-i)*a)+e*\sin(a))/b$$

$$yt=y1-y2$$

$$z1=8$$

$$z2=z1+1$$

$$zt=0$$

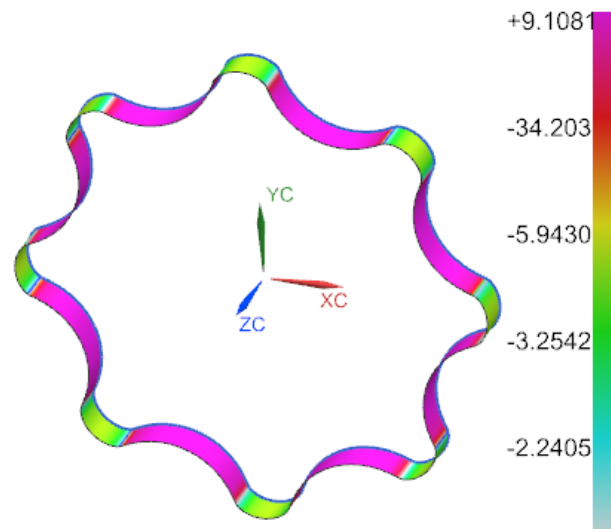


Figure 5. the minimum radius of the curtate epicycloid

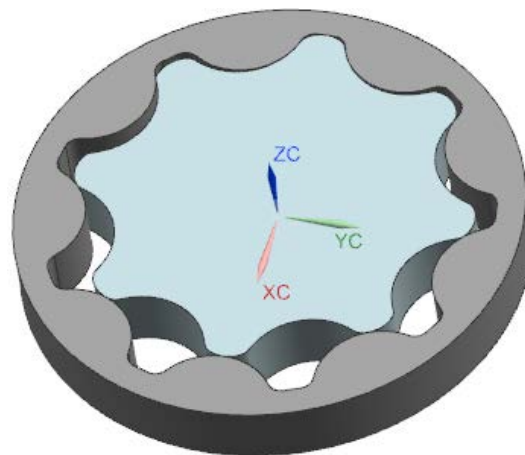


Figure 6.the assembly impression drawing of the internal and external rotors

4. Conclusions

From the above examples, it can be seen that parametric design of Cycloid Gear based on NX 10.0 can fully ensure the design accuracy. The parameterization of the key variables greatly improves designers' speed in modifying models, shortens the design cycle, and increases the reusability of models. Besides, The assembly module of NX10.0 can provide interference analysis and ensure the rationality of the design

5. References

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