Design of torque converter

Huimin Sun [a], Nannan Liu [b]

School of Science and Technology, Shandong University, Qingdao 266590, China.
[a]1281808102@qq.com, [b]763093193@qq.com

Abstract

Hydraulic torque converter is a hydraulic transmission device used in vehicles. In the process of energy transfer of liquid components, mechanical energy is first converted into liquid energy, and then from liquid energy to mechanical energy. In the working chamber composed of two or more impellers, the liquid is used as the working medium, and the change of the working fluid momentum is mainly relied on to transfer or realize the change of energy. According to the requirements of different vehicles, hydraulic torque converters with various performance and structure requirements are designed and manufactured. The circular diameter ranges from 244 to 350, and the transmission power ranges from 30KW to 160KW. They are applied to 1.5 ton hydraulic forklift trucks and loaders ZL30 and ZL50. The products have high reliability and convenient maintenance.

Keywords

Hydraulic torque converter, Impeller, Hydraulic energy.

1. Introduction

The pump wheel in the torque converter is connected with the torque converter housing. The inner radial part of the pump wheel is provided with many twisted blades, and the inner edge of the blade is provided with a guide ring for the transmission oil to flow smoothly. The torque converter housing is connected to the driving disc at the rear end of the crankshaft. Like pump wheels, turbines also have many blades[1]. However, the distortion direction of turbine blades is opposite to that of the impeller blades. The turbine hub has a spline hole connected to the transmission input shaft. The impeller and the turbine blades are relatively positioned, with a clearance of 3 to 4mm in the center. The guide wheel is located between the pump wheel and the turbine, and is mounted on the guide axle connected with the oil pump through a unidirectional clutch, and the oil pump is mounted on the transmission housing[2].

The torque converter consists of a pump wheel, a turbine, a guide wheel, a rotating cover and a diversion surface. The working process is: power input cover drive pump wheel rotation liquid energy (torque) into the turbine liquid energy (torque) so that the turbine rotation drive the working machine (output) work liquid flow into the guide wheel (guide wheel does not move), change the torque (outside resistance torque input) liquid into the pump wheel, and then Continued circulation.

2. Design and calculation of torque converter

2.1 Main parameter.

Hydraulic torque converter mainly relies on its pump wheels to absorb the power or torque transmitted from the engine or input shaft. According to the references[3]: density $\rho = 900kg/m^3$, speed $n_B = 2200r/\min$, pump wheel torque $T_{Bg} = 71N \cdot m$, therefore

$$\lambda_B = \frac{T_B}{\rho g n_B^2 D^5} = \frac{71}{900 \times 10 \times 2200^2 \times 0.315^5} = 5.5 \times 10^{-6}$$

$$\lambda_T = \frac{T_T}{\rho g n_T^2 D^5} = \frac{325.57}{900 \times 10 \times 2200^2 \times 0.315^5} = 25 \times 10^{-6}$$

Therefore, variable torque ratio and efficiency can be obtained,

$$K = -\frac{T_T}{T_B} = -\frac{\lambda_T}{\lambda_B} = -\frac{25}{5.5} = -4.5$$

$$\eta = Ki = -\frac{\lambda_T}{\lambda_B i} = 91\%$$

2.2 Blade design.

As the converter models are known, the impeller design method is introduced here. The design of the torque converter impeller is to design the impeller and draw the shape of the blade after calculating the design and selecting the parameters of the working wheel according to the experience, and finally draw the wooden pattern to facilitate the casting or machining of the working wheel.

(1) The shape of the inlet and outlet edges of the impeller of the torque converter is various on the axial graph, most of which are straight lines and a few of them are curves. But no matter what shape, it is determined by the designer in the impeller design process. The inlet can be placed on the same axial plane or on the same straight line according to conformal transformation. Because of the influence of the inlet edge shape, the blade skeleton is drawn on the conformal mesh according to the inlet angle of the blade on the streamline of the front and rear covers and the average streamline, so that the blade shape can be drawn and determined. In general, the gap between the two working wheels should be kept between 2-3mm ports.

(2) Drawing average streamline and auxiliary streamline for hydraulic torque converter, because the circle size is not very large, only need three streamlines, namely inner, outer and average streamline.

(3) The conformal method for blade design is called conformal transformation if two infinitesimal figures have the same angle and the characteristic lines are in the same proportion. In the hydraulic torque converter working wheel, the average flow surface is a space trumpet-shaped surface revolving around the central axis. The average streamline is on this surface. This spatial surface can not be expanded into planar graphics. But by using conformal transformation method, the surface can be transformed into a cylindrical surface which can be expanded into a plane, and then the cylindrical surface can be expanded into a plane figure. The streamline in the inner and outer rings can also be expanded into plane figures by this method.

3. Various properties and their evaluation

1) Torque performance:

Torque performance refers to the ability of a hydraulic torque converter to steplessly change the torque from the pump shaft to the turbine shaft in a certain range according to certain laws. There are two kinds of indexes used to evaluate the performance: one is the torque ratio K0 when I = 0, usually called the failure torque ratio; the other is the torque ratio I when the torque ratio K = 1, expressed as iM, usually called the speed ratio of the operating point of the coupling, which represents the operating range of torque increment of the hydraulic torque converter.

2) Economic performance

Economic performance refers to the efficiency of hydraulic torque converters in the process of transmitting energy. It can be represented by dimensionless efficiency.

3) Load characteristics:

Load characteristics refer to its performance of loading the engine with certain rules. The load performance of the torque converter applied to the engine is entirely determined by the torque variation characteristics of the pump wheel.

4) Penetration performance

Penetration performance refers to the ability to change the speed and torque on the corresponding pump shaft when the speed and torque on the turbine shaft of the hydraulic torque converter change.

References

[1] Bu Yan. Mechanical design transmission manual [M]. Beijing: Machinery Industry Press, 1998.12.
[2] Xu Hao. Mechanical design manual (volume fifth) [M]. Beijing: China Machine Press, 1991.
[3] Zhu Jingchang. Design and calculation of hydraulic torque converter [M]. Beijing: National Defense Industry Press, 1991.