Sliding performance of toroidal type CVT transmissions

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Toroidal CVTs are mechanisms where torque is transferred through traction forces on the contact points between disc and rollers. Torque is transferred by heavily loaded lubricated elliptical contacts, therefore, the traction performance of this kind of mechanism is related with the Elastohydrodynamic lubrication performance. Therefore, sliding motion happens which influences the efficiency of this kind of transmission mechanisms.

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1. Introduction

Toroidal Continuously Variable Transmissions (T-CVT) are mechanisms where torque is transferred through traction forces over heavily loaded lubricated elliptical contacts [1]. Lubricated traction is governed by the shear stresses of the lubricating film, which is directly related with the sliding (SRR) motion between disc and rollers. Therefore, it may be assumed that sliding is essential for the torque transmission. However, sliding is a power loss source, which means that a balance has to be found between traction and power loss as a function of sliding. Moreover, an additional power loss source appears in this kind of transmission at low sliding values known as spinning, which increases sliding on the contact area. The sliding motion control is carried out by means of clamping mechanisms in order to adapt the normal load as a function of the working conditions [2].
In this work, the sliding performance of a T-CVT is studied as a function of different variables such as torque and clamping force.

2. Method

A T-CVT prototype has been developed considering the possibility to externally apply different clamping forces at each working condition, for that purpose, the clamping mechanism consist on hydraulic cylinders. Santotrac 50 lubricant has been used in the transmission due to the high traction that could be obtained with it.
The tests were carried out in a transmission test bench that consist on two electric motors placed one against the other. Moreover, built-in wireless torque and speed sensors have been developed in order to measure the performance of the transmission. The tested conditions are shown in table 1.

Figure 1: (left) Designed CVT placed on the test bench; (right) rollers of the CVT

Table 1: Test conditions

ω_{in}	T_{out}	F_c	F_N
2000 RPM	0 – 40 Nm	5 - 10 kN	1.5 – 3.3 kN

3. Results and discussion

The obtained experimental results are shown in figure 2. There, the influence of torque and clamping in sliding is shown and then the variation of efficiency as a function of sliding is represented.

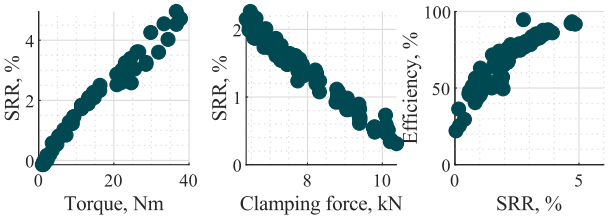

Figure 2: Sliding results as a function of torque and clamping; and efficiency as a function of sliding

As expected, higher torque increases sliding motion at constant clamping conditions, which happens because the needed traction coefficient appears at higher sliding values. Conversely, increasing clamping forces reduces the sliding because the transmission needs less traction.
Combining the influence of torque and clamping the efficiency as a function of sliding is obtained and the following trends have been identified:

- High sliding motion decreases the efficiency of the transmission as a result of sliding motion
- Low sliding conditions decreases the efficiency as a result of the friction losses created by spinning motion.
- The optimum efficiency condition appears at SRR ~ 5%, which happens when the spin-pole leaves the contact interface in the designed components.

4. References

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