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Relevant test procedures on component level used for friction performance, wear behavior and lifetime prediction in wet clutches of transfer cases

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The tribological behavior of wet clutches used in automotive driveline systems is influenced by many interacting parameters. As commonly known, suitable test procedures and strategies are necessary to ensure a fail-proof clutch operation during lifetime on the one hand and to meet the requirement for low development costs and time on the other hand. The report provides insights in test procedures, which were specially developed on component level related to system specific issues on friction performance, plate wear and oil damage of a friction system.

Keywords: wet clutch, component tester, oil damage, test procedures, test strategy

1. Introduction

The main torque transmitting component of a transfer case is the wet clutch, which supplies the required torque to front and rear axle in an automotive powertrain. It is commonly known that the impact of clutch plate properties, operating and environment conditions as well as the interaction between these influencing parameters have effects on clutch operation, which can be tribologically explained as a momentary change in friction performance and wear behavior. Further, the actuation concept in transfer cases requires a prediction of the transmitted torque during service life, meaning that changes of friction performance and wear behavior must be known also with reference to the parameter "time" to enable a compensation of occurred changes during the entire clutch lifetime. It is a big challenge to consider each impact and interaction during the service life of a clutch while meeting the requirement for low development costs and time. That is why a well-thought-out test strategy and well-defined test procedures are indispensable. The impacts of some parameters on wet clutch operation were already published in the past, e.g. [1, 2]. The present contribution reports additional test procedures on component level to show critical influencing factors on wet clutch operation.

2. Tribosystem parameters and component tests

Figure 1 illustrates the tribosystem "friction plate – lubricant – steel plate" as a main part of clutch packs used as torque transmitting components in wet clutches. Further a rough classification of most influencing parameters on the tribosystem's friction performance and wear behavior is shown.

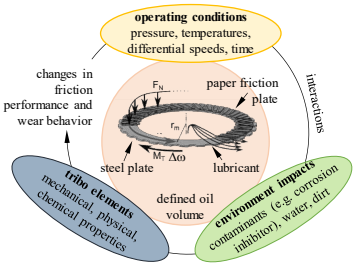

Figure 1: Influencing factors on clutch friction performance and wear behavior

The interactions of those influencing factors are a substantial part of test procedures and test strategies.
Testing of wet clutch tribosystems consist of unit and vehicle tests partly complemented with component tests, which allow the investigation of several original steel and paper friction plates in one test set-up and in a wide range of operating and environment conditions. The currently used component tester realizes rotational frequencies up to 400 min^{-1} and the torques up to 750 Nm. The lubricant is pumped in a circuit, oil temperature can be varied between 0 °C and 150 °C. The flexible test program allows the variation of rotation frequency, load/frictional torque and temperature over a wide range to simulate realistic conditions.

3. Results and discussion

This paper can be understood as a conclusion of some relevant testing procedures on component level, which are helpful during the development process or for the damage analysis of wet clutches. Especially, results are shown considering e.g. the following questions in short- and long-term tests:

- Which quantitative changes in friction performance and wear behavior can be detected in dependence of test duration, varying operating and environmental conditions as well as different tribo-element properties?
- Which tribological element is damaged most after various load conditions?

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5. References

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