Measurement of CV Joint Efficiency

Nowadays the effort to reach the saving of resources, the reduction of emissions and the increase of safety are important criteria in the development of new vehicles. Especially the clear reduction of fuel consumption plays an decisive role.

Following a concentration on the engine and transmission over the past few years, a further increase of efficiency in these fields can only be reached with an extraordinary expenditure. For this reason, attention has now turned to apparently less important components such as cv-joints that were beyond interest by now.

A new method has thus been developed at ika/fka, which enables a very accurate recording of the efficiency of drive joints that are in the focus of efficiency improvement.

The measuring procedure is based on the principle of power loss determination. A CV-joint which is operated at a constant bending angle and with a constant torque represents a mechanical system, in which power losses (P_L) occur. If one now assumes that this power loss is dissipated completely as a thermal output, the joint could be regarded as a predominantly metal, uninsulated heat accumulator. A constant thermal output is introduced under constant operating conditions (torque, speed and bending angle), see Fig. 1.

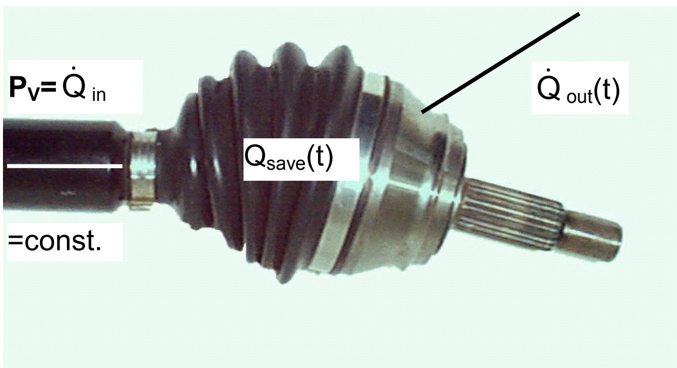

Fig. 1: Universal joint as uninsulated heat accumulator with a heat supply

In the same way that heat is introduced into the accumulator, this constantly dissipates heat to its surroundings due to the lack of insulation. On one hand, this heat dissipation depends on the filling condition of the accumulator. On the other hand, it depends on the heat supply. If the supply of heat remains constant, the supplied and dissipated thermal output reaches an equilibrium state after a certain time. The accumulator is no longer filled and the following applies:

$$P_V = \dot{Q}_{zu} = \dot{Q}_{ab}$$

The differential temperature curve for the heat accumulator (Θ_{acc}) and its environment (Θ_{env}) hereby provides information on the filling condition.

Fig. 2 shows a basic heating-up curve for an uninsulated joint heat accumulator with a constant supply of heat. It can be seen quite clearly that the differential temperature assumes a stationary value $\Delta\theta_{stat}$ with an increasing time and that thus the accumulator capacity is exhausted.

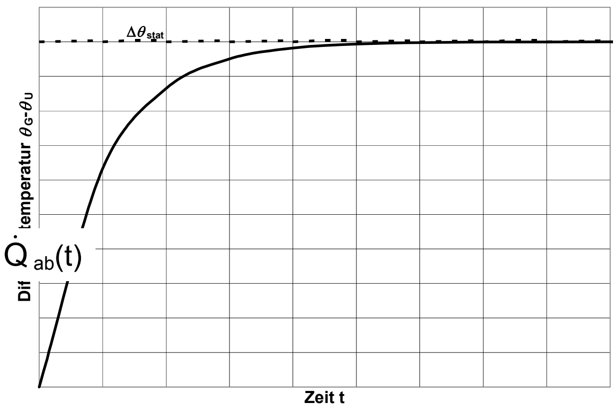

Fig. 2: Basic heating-up curve

The difference in temperature between the heat accumulator and its environment is a measure of the heat flow from the joint to the environment. In order to be able to determine the thermal output, which is equal to the input heat when the stationary differential temperature is

reached, the heat transmission between accumulator and environment must be known. The system Fig. 1 is modified as follows in order to determine this value. A heat accumulator is heated up to the stationary differential temperature and the heat supply is then switched off. The condition reached is shown in
Fig. 3.

Since heat can now only escape from the heat accumulator, this starts to cool down, as can be seen in Fig. 4.

The dissipated thermal output can be calculated on the basis of the heat transmission and stationary temperature of the heat accumulator "CV-joint". In a stationary case this corresponds to the input heat, in other words the joint's power loss. The efficiency can then be calculated from the power loss and mechanical driving power, given by the speed and torque at the operating point.

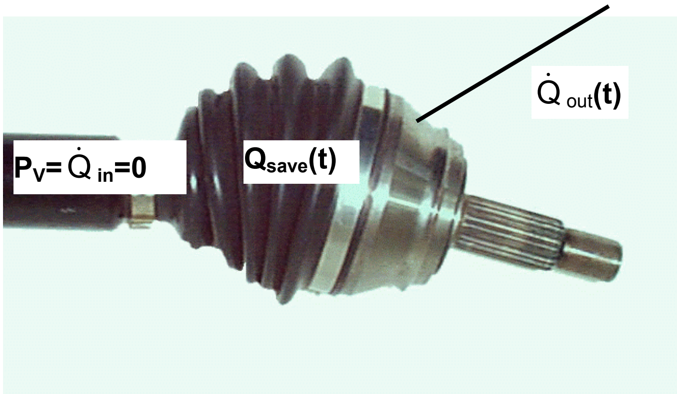

Fig. 3: Universal joint filled, uninsulated heat accumulator without heat supply

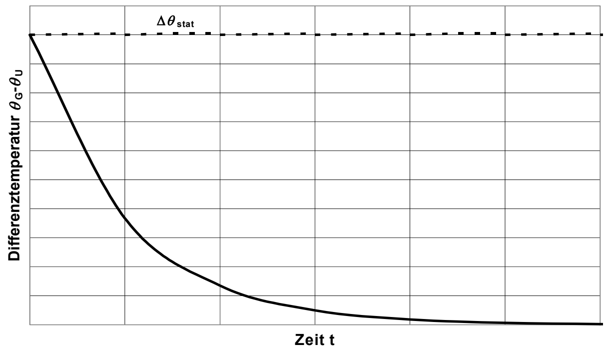

Fig. 4: Basic cooling curve

The following applies:

$$\eta = \frac{P_{An} - P_V}{P_{An}}$$

The method based on the principle described above has been checked for consistency in extensive tests. The [illegible]nation of the efficiency of the same joint under $\dot{Q}_{ab}(t)$ [illegible]l operating conditions on different days on produced a maximum deviation of ± 0.01 percentage points. This was also confirmed by error calculation, with a maximum deviation of ±0.03 percentage points. It can thus be assumed that this method offers sufficient accuracy for joint tests.