Technical Disclosure Commons

February 20, 2019

PREDICTIVE DETECTION OF COOLING WATER LOSS IN HV VEHICLES

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Technical task:
Vehicles have one or more cooling circuits. Usually with a water-glycol mixture.

Combustion vehicles have a high-temperature cooling circuit and for HV components often a separate low-temperature cooling circuit (typically 65 degrees).

In the case of combustion vehicles, the failure of the cooling system generally does not immediately lead to damage to components, as these are not as thermally sensitive as HV components.

With HV components, a failure of the cooling system (e.g. strong/sudden loss of cooling water) can lead to a total loss of one or more HV components. Here, for example, an electric machine with internal rotor cooling can be used. The sealing of the rotor cooling takes place via so-called constant ring seals or shaft sealing rings. If the cooling medium suddenly fails, the seals break and the electric machine is completely flooded and destroyed. Often the power electronics directly attached to the electric machine are then also directly flooded and destroyed.

Initial situation:
The loss of cooling water is indeed detected in the cooling water compensation tank by a mini-level sensor, but if the loss of cooling water occurs very quickly (gradient), then too much time has passed from the detection of the mini-level to the driver warning and stopping of the vehicle, so that the drive may already be damaged.

Today, the cooling water system for HV components is still designed in the same way as for combustion vehicles; this also applies to the warning strategy for cooling water loss. HV components are, however, more sensitive to loss of cooling water, so that a new and advantageous detection of loss of cooling water is required.

Solution:
This can be remedied, for example, in 3 different ways.
The basic idea is always the same: Recognition of the gradient for the loss of cooling water. And thus a predictive warning strategy for a loss of cooling water.

Path 1: Maintaining the current sensor technology with min-level detection
When driving, the cooling water sloshes in the expansion tank. The min. detection is activated again and again, but filtered out. On the basis of the raw data of the sensor and the frequency of the min. detection in the context of the vehicle status of the vehicle (e.g. by acceleration detection), the filling level or the gradient of the decrease of the filling level can be detected.

Path 2: Introduction of max-level detection in addition to min-level detection
The detection is improved in relation to path 1, because also the sloshing upwards (in direction max) is detected and thus the algorithm can be improved.

Path 3: Introduction of a linear measuring sensor
This makes it possible to permanently detect the fill level and most easily track the gradient of the cooling water drop and to adapt a corresponding warning to the driver and/or the operating mode of the vehicle (e.g. emergency operation) in good time.

Advantages:
- Detection of the filling level by means of the Min- & Max-Level detection of the sensor.
- Permanent detection of the filling level by means of a linear measuring sensor
- Triggering of a warning signal when the level is insufficient enables early adjustment of the filling level
- Early adjustment prevents damage to the actuator