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INCREASE THE POWER LOSS OF THE ELECTRIC MACHINE TO HEAT THE HV-BATTERY

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Technical task:
The technical innovation describes a concept for increasing the power loss of an electric machine and the heat which is given to the cooling system in this connection, which contributes to the heating of the HV battery.

Initial situation:
Today's E-machine control provides the most efficient possible torque generation. The goal is to keep the MTPA (maximum torque via amb) maximum. The current regulation consists of a torque-forming current (q component) and a loss component (d component). The latter is kept as small as possible for reasons of efficiency.

The resulting loss power is dissipated to the environment via the low-temperature circuit and the low-temperature cooler in a liquid-cooled system (electric machine and power electronics).

There is a system which allows to use the waste heat of the E components to „heat" the indoor space by switching the system (consisting of NT & tNT circuit) so that the E-machine, the power electronics and The HV battery is flowed through the „chiller" in series in the same cooling system. The „waste heat" is transferred to the refrigeration circuit via the „chiller" and delivered to the heating circuit.

A further application is the so-called „HV battery heating". In this case, excess waste heat from the E components is used to heat the HV battery and to increase its performance and service life.

Today's applications for the use of E-component waste heat:

1. Heating Interior:

The power loss of the electric machine and the power electronics in the driving mode is used via the refrigeration circuit of the motor vehicle to heat the interior (glycol heat pump)

2. HV battery heating

The energy emitted by the E-machine and the power electronics during normal control is not sufficient to achieve the following goal:
- to bring the HV battery to a comfortable temperature in an appropriate time
- Observe the intake state EKK (electric refrigerant circuit compressor) in the target range „5K superheat before compressor"
- Cold cut-off limit Total system PHEV <-10 ° C

Today's concepts provide for various improvements:
- Use of an IWWT concept for HV battery conditioning
- Hybrid batch in driving mode
- Overheating control over compressor

Solution:
The technical innovation lies in the artificial increase of the loss proportion of the electric machine to the following objectives:

System heat pump:
- Improvement of the heating output in the overall system
- Extension of the cold run-off limit to <-10 ° C

System HV battery:
- Conditioning the HV battery without additional components (eg IWWT)

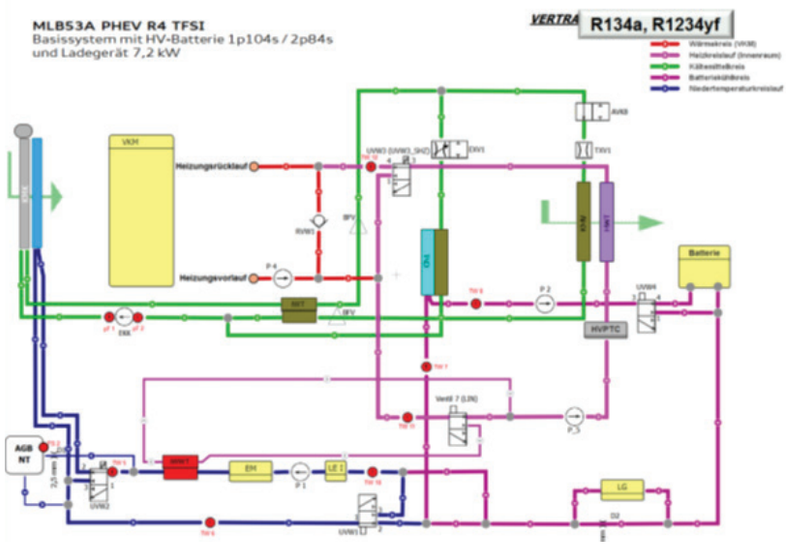
The loss of the E components in the coolant can be achieved by „additional energization" of the copper windings (ohmic resistance) in a synchronous and asynchronous machine. This is achieved, for example, by artificially increasing the „d-part" (loss component), which is normally regulated to „zero", in the E-machine control.

Advantages:
- Die Erwärmung der HV-Batterie in ihren Wohlfühlbereich und die Erweiterung des Einsatzbereichs der Wärmepumpe kann ohne Einsatz weiterer Bauteile mit dem bestehenden System bewerkstelligt werden.

Possible application:
- Electric drive machines.

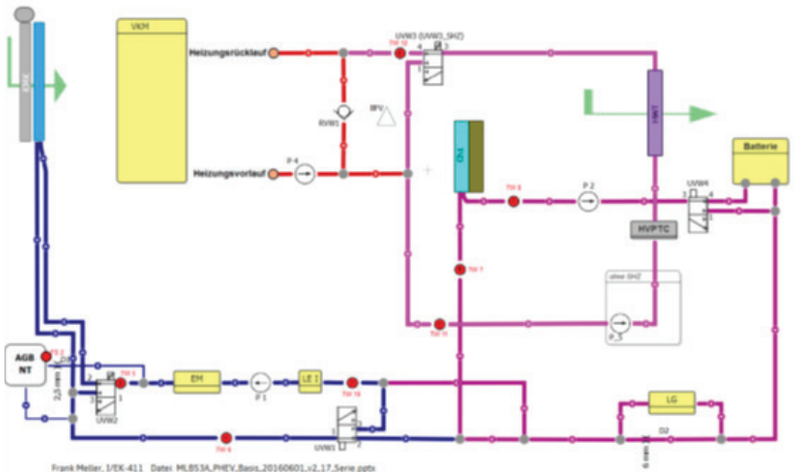
Technical innovation

IWWT-Concept for heating the HV battery



Technical innovation

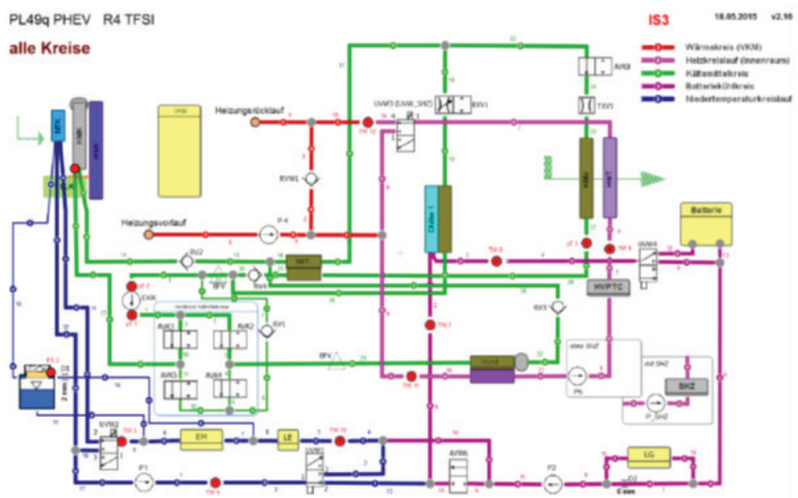
System without IWWT with increased power dissipation NT- circuit components (LE & EM)



heat pump system

Increasing the power loss of the electric machine at cold ambient temperatures increases the proportion of electric driving without the use of additional components. The additional power dissipation of the electric machine and the power electronics by means of „D-current heating“ is delivered to the cooling system in the form of heat and can be adjusted by appropriately interconnecting the circuit to heat the HV battery or to raise the „source“ for the heat pump in PHEVs.

Schematic diagram is the circuit diagram of a PHEV with heat pump system and permanent magnet synchronous synchronous machine.



Technical innovation

In the case of a permanent-magnet-excited synchronous machine, it is possible to regulate the torque [T] by means of control-technical intervention in the rotating state of the machine and nevertheless to set the current-pointer length ma-ximal (by Id = max).

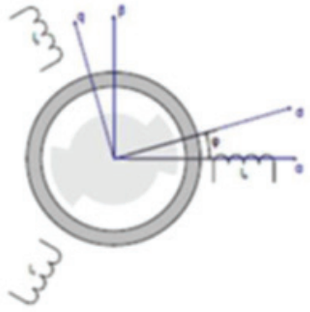
Permanent magnet synchronous machine

•Transformation in rotorfestes Koordinatensystem (dq)

$$U_d = R_s I_d + L_d \frac{dI_d}{dt} - \omega_r L_q I_q$$

$$U_q = R_s I_q + L_q \frac{dI_q}{dt} + \omega_r L_d I_d + \omega_r \Psi_{pm}$$

$$T = \frac{3}{2} \cdot p \cdot \left[\Psi_{pm} I_q + (L_d - L_q) \cdot I_q I_d \right]$$



•Quasistationärer Zustand $\frac{dI_d}{dt} = \frac{dI_q}{dt} = 0$

•Keine Reluktanzeinflüsse $L_d = L_q$

This results in additional losses in the machine which are delivered in the form of heat to a cooling system (eg NT circuit) and heat the HV battery, which is connected via the same cooling system. Depending on the internal resistance of the windings (internal resistance, copper windings) of the synchronous machine, a power dissipation occurs according to the following formula:

Pv = [√Id2 + Iq2)2 * Rs

[Pv] power loss
[Id] d- electricity
[Iq] q-Strom (forming torque)
[Rs] Internal resistance copper winding

Furthermore, this approach results in further losses in the field of power electronics,
So-called switching losses, which also contribute to the heating of the HV battery.

Legend:
EM = E-machine (electric drive machine)
LE = power electronics
Batterie = High-voltage battery
LG = charger
IWWT = Integrated water heat exchanger