START-UP TEST FOR SODIUM SULPHIDE TRACTION BATTERIES

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Sodium sulphide batteries are 'high temperature batteries' with high energy density (*ca.* 100 W h kg^{-1}, 100 W h l^{-1}). Their inner resistance shows no significant dependency, neither from state of charge nor from load. The start-up tests check the capacity, inner resistance, insulation resistance, and proper operation of the thermal management system.

B06-type batteries contain 224 cells in parallel chains of 56 cells. The cell matrix is surrounded by a vacuum insulation. There are 5 thermocouples in the cell matrix and one voltage probe in the middle of each chain. The battery has a direct cooling system and heater plates to maintain an even temperature profile within the cell matrix (*ca.* 310 °C).

The test facility and instrumentation for this battery type consist of a computer-controlled inverted rectifier and several data logger systems. The data to be measured are: temperature in the cell matrix, current in each cell chain, total battery current, voltage of each half chain, air flow of the cooling system, and power of the heater plates.

The first step in the start-up procedure is heating of the battery. If the operating temperature cannot be reached within a time limit, the heater plates of the vacuum insulation are defective, which must be proved by appropriate measurements.

After the operating temperature is reached, insulation resistances (>1 MΩ) and open circuit voltages (2.07 V/cell) are measured. Then the I–U characteristics for charging and discharging in the one and two phase region are recorded. Up to 150 A these characteristics must be linear, because the behavior of the inner resistance in an intact battery is ohmic.

From the measured inner resistance of the battery the lower cut-off voltage for the capacity test is calculated. To perform this test the battery is charged. The end-of-charge criterion is the attainment of a specific inner resistance. The charging characteristic (charging voltage as a function of the state of charge) gives, in combination with the measured capacity, some indication of the quality of the battery on line. This function should show three regions: a one-phase region with a linear increase in voltage, a two-phase region at constant voltage, and the end of charge with a rapid increase in voltage. The two-phase region should cover *ca.* 50 - 60% of the whole capacity.

From the voltage probe in the middle of each cell chain it is also possible to check the synchronicity of the cell groups.

Following the capacity test the battery is recharged according to the above procedure and then discharged with a constant current at a two hour rate to check that the operation is satisfactory.

Finally a cooling system load test is carried out by discharging the battery with *ca.* 80% of the max. battery current. This equals a one hour rate discharge.

CELL AND BATTERY TEST METHODS

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