Batteries Division

ZVEI Die Elektroindustrie

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Ventilation of battery charging rooms for lead traction batteries

1. Foreword

In order to avoid explosion hazards sufficient ventilation of charging rooms for traction batteries based on lead battery technology is mandatory.

This ZVEI information leaflet is a guide to the application of the DIN EN 62485-3 *Safety requirements for secondary batteries and battery installations – Part 3: Traction batteries*. It contains example calculations and notes for application.

2. General

During the charging of lead batteries an explosive gas mixture escapes from the battery cells through the plug openings. This gas mixture results from electrolysis of water, the main compound of the electrolyte, and consists of hydrogen and oxygen (volume ratio 2:1 = oxyhydrogen gas.

The evolution of gasses during charging rises with the battery's state of charge. In the final charging phase of the battery almost the entire charging current leads to the generation of oxyhydrogen gas.

Towards the end of the charging process, the electrolysis of water generates 0.450 liter hydrogen and 0.225 liter oxygen within one hour and a final charging current of 1 ampere (reference temperature 25°C).

The ventilation of battery charging rooms must safely ensure that the hydrogen concentration does not exceed the lower explosion limit of 4% by volume. Battery charging rooms should therefore be designed so that natural ventilation is sufficient. If this is not ensured under all operating conditions appropriate technical ventilation must be used. Details on natural and technical ventilation are described in chapter 4.

Safety note: Even though sufficient ventilation is ensured, the dilution of hydrogen cannot always be guaranteed in the near field of the battery. Therefore according to DIN EN 62485-3 the safety distance of 0.5 meters air gap (thread dimension) must be maintained from a possible ignition source, starting from a cell opening (plug or valve). Within this safety distance no open flames, sparks, arcs or glowing objects may occur (maximum surface temperature 300°C).

3. Dimensioning of the ventilation

Sufficient air exchange is necessary to dilute the potentially explosive gas.

The air volume flow Q required for this is calculated according to DIN EN 62485-3 for the reference temperature of 25 °C, as follows:

$$Q = 0.055 \mathrm{m^3/Ah} \times n \times I_{gas}$$

Q air volume flow in m^3/h

0.055 m^3/Ah
combines gas evolution rate, the necessary dilution factor of hydrogen and a general safety factor

n number of cells (e.g. 40 for an 80 volt or 12 for an 24 volt battery)

I_{gas} hydrogen-generating electric current in A

Note: Due to the safety factor this formula can also be used for the entire permissible operating temperature range of a battery. The battery related I_{gas} values shall be obtained from the charger manufacturer. Particular characteristics, e.g. pulse-, multi-voltage- or fast-charging functions, must be taken into account.

If I_{gas} is not known or cannot get to know, at least 40% of the maximum charging current (see charger's name plate) must be used for I_{gas}.

In case of several batteries are charged simultaneously in the same room, the required air flow

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rate must be calculated for each battery. For safety reasons the calculation must be based on the assumption that all batteries under charge generate hydrogen at maximum gassing rate. If this cannot be excluded by technical measures the air volume flow required for a charging station is therefore calculated from the sum of the air volume flow of all batteries being charged in the same room.

Example calculation for air volume flow:

Scenario: Mixed operation of PzS and PzV batteries, charged with the allocated chargers.

Ten PzS batteries 80 V 420Ah C_5, charging characteristic W0Wa with an I_{gas} (corresponds to the final charging current) of 21A (exemplary value stated by a charger manufacturer).

Calculation of the air volume flow for one PzS battery:

Q_{PzS} = 0.055 m³/Ah x 40 x 21A

= 46.2 m³/h

Calculation of the air volume flow for the ten PzS batteries:

Q_{PzS} = 10 x 46.2 m³/h

= 462.0 m³/h

Six PzV batteries 48 V 300Ah C_5, charging characteristic IUIa with an I_{gas} (corresponds to the final charging current) of 3.6A (exemplary value stated by a charger manufacturer).

Calculation of the air volume flow for one PzV battery:

Q_{PzV} = 0.055 m³/Ah x 24 x 3.6A

= 4.8 m³/h

Calculation of the air volume flow for the six PzV batteries:

Q_{PzV} = 6 x 4.8 m³/h

= 28.8 m³/h

The total required air volume flow for all batteries is calculated from the sum of the individual air volume flows of the PzS and PzV batteries.

Q_{ges} = Q_{PzS} + Q_{PzV}

= 462.0 m³/h + 28.8 m³/h

= 490.8 m³/h

4. Design of charging rooms

In order to ensure adequate ventilation there are basically two technical solutions:

Natural ventilation

The basic requirements for natural ventilation are a free room volume (total volume of the room minus the volume of objects in the room) of 2.5 times the hourly air volume flow Q [m³/h] to be renewed and at least an air speed of 0.1 m/s in all inlets and outlets.

The corresponding air in- and outlets shall each have at least a cross-section area which is to be calculating using the following formula:

$$A = 28 cm^2 h/m^3 \times Q$$

A Cross-section for air in- and outlet [cm²]

28 cm² h/m³ Necessary factor for conversion of units

Q Air volume flow [m³/h]

The air flow must ensure a continuous aeration of the entire battery charging room / area e.g. the inlets should be located near the floor and the airflow should be directed over the batteries and escape at outlets high as possible. This ensures optimum cross ventilation.

If the air in- and outlet openings are positioned at the same wall the minimum distance between the openings must be 2 meters.

Doors and windows are only considered to be appropriate air inlet and outlet opening if it is ensured that are constantly open during the charging process and the necessary cross-section area is provided in this state.

Example calculation required cross-section of the air inlet and outlet openings:

Using the exemplary air flow rate calculated in chapter 3 the required opening cross-section air in- and outlet are to be determined as follows:

A = 28 cm²h/m³ x Q_{ges}

= 28 cm²h/m³ x 490.8 m³/h

= 13,742 cm²

In this example this corresponds to a square opening with an edge length of approx. 117cm.

Forced ventilation

If the conditions for natural ventilation are not met forced ventilation must be installed to ensure the necessary air flow Q_{ges}.

Batteries shall only be charged if the forced ventilation is effective.

The function and effectiveness of the forced ventilation must be demonstrated at commissioning and at regular intervals.

Important boundary condition for natural and forced ventilation

The air supply must be free of gases harmful to lead batteries, such as chlorine and ammonia.

Ducts and system components of the ventilation system located in the exhaust air flow must be designed to be acid resistant.

Both, the natural and forced ventilation must be designed in such a way that the exhaust air is emitted into the open air. When positioning the exhaust air outlet the proximity to air intake openings of air condition system must be avoided. The exhaust air must not be led into active chimneys

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