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INTERNATIONAL STANDARD

NORME INTERNATIONALE

Electrolyte and water for vented lead acid accumulators – Part 1: Requirements for electrolyte

Electrolyte et eau pour accumulateurs plomb-acide ouverts – Partie 1: Exigences pour l'électrolyte

IEC 62877-1:2023-09(en-fr)

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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ELECTROLYTE AND WATER FOR VENTED LEAD ACID ACCUMULATORS –

Part 1: Requirements for electrolyte

FOREWORD

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IEC 62877-1 has been prepared by IEC technical committee 21: Secondary cells and batteries. It is an International Standard.

This second edition cancels and replaces the first edition published in 2016. This edition constitutes a technical revision.

This edition includes the following significant technical changes with respect to the previous edition:

a) Addition of the concentration values of halogens in Table 4.

The text of this International Standard is based on the following documents:

Draft	Report on voting
21/1169/FDIS	21/1172/RVD

Full information on the voting for its approval can be found in the report on voting indicated in the above table.

The language used for the development of this International Standard is English.

This document was drafted in accordance with ISO/IEC Directives, Part 2, and developed in accordance with ISO/IEC Directives, Part 1 and ISO/IEC Directives, IEC Supplement, available at www.iec.ch/members_experts/refdocs. The main document types developed by IEC are described in greater detail at www.iec.ch/publications.

A list of all parts of the IEC 62877 series can be found, under the general title *Electrolyte and water for vented lead acid accumulators*, on the IEC website.

The committee has decided that the contents of this document will remain unchanged until the stability date indicated on the IEC website under webstore.iec.ch in the data related to the specific document. At this date, the document will be

- reconfirmed,
- withdrawn,
- replaced by a revised edition, or
- amended.

ELECTROLYTE AND WATER FOR VENTED LEAD ACID ACCUMULATORS –

Part 1: Requirements for electrolyte

1 Scope

This part of IEC 62877 applies to electrolytes and their components used for filling vented lead acid batteries with dry-charged cells and for electrolyte replenishment, replacement or electrolyte density adjustment of batteries in operation. This document defines the composition, purity and properties of electrolyte, for application where specific instructions from the battery manufacturer are not available.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

IEC 62877-2, *Electrolyte and water for vented lead acid accumulators – Part 2: Requirements for water*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

- IEC Electropedia: available at https://www.electropedia.org/
- ISO Online browsing platform: available at https://www.iso.org/obp

3.1
lead dioxide lead battery
lead acid battery
secondary battery with an aqueous electrolyte based on dilute sulphuric acid, a positive electrode of lead dioxide and a negative electrode of lead

[SOURCE: IEC 60050-482:2004, 482-05-01, modified – Note 1 deleted and the term "lead acid battery" added.]

3.2
electrolyte
<of a lead dioxide lead battery> dilute solution of sulphuric acid (H_2SO_4) in purified water

Note 1 to entry: The electrolyte is prepared by mixing concentrated sulphuric acid or sulphuric acid with high density of d > 1,30 kg/l and purified water to achieve the density values specified by the battery manufacturer or specified in standards related to the type and battery design in question for a defined state of charge. Its purity meets the requirements laid down in Table 3.

Note 2 to entry: Concentrated sulphuric acid is a colourless and highly corrosive liquid with a density d > 1,82 kg/l.

3.3
water
<for a lead dioxide lead battery> purified water (H_2O) used for the preparation of electrolyte for batteries and for the replacement (topping up) of water loss in the operating electrolyte due to decomposition of water by overcharge and evaporation

Note 1 to entry: The requirements for purified water are specified in IEC 62877-2.

3.4
filling electrolyte
<of a lead dioxide lead battery> diluted sulphuric acid used for the first filling of dry-charged batteries or for the replenishment, density adjustment or replacement of contaminated operating electrolyte

3.5
first filling
<of a lead dioxide lead battery> original filling of a dry-charged battery carried out by the user in accordance with the applicable manufacturer's instructions

3.6
operating electrolyte
<of a lead dioxide lead battery> electrolyte present in the battery following electrolyte filling and first use in the application

Note 1 to entry: The density and the degree of purity of the operating electrolyte can deviate from the values of the filling electrolyte due to electrolysis, evaporation, introduction of impurities with the replacement water and leaching from separators, active material and electrode grids.

3.7
density
<of a battery electrolyte> value for the mass per unit volume expressed in kg/l

Note 1 to entry: The density varies with the battery's state of charge, the electrolyte volume variation due to water loss and the temperature.

Note 2 to entry: The density value is not to be confounded with that of specific gravity (SG). Specific gravity or relative density is the ratio of the density of a substance e.g., the electrolyte, to the density of a given reference material e.g., water, and is dimensionless.

3.8
specified density
<of a battery electrolyte> density of the electrolyte of the battery declared by the manufacturer when being at the maximum upper electrolyte level, at a state of full charge and at the reference temperature

Note 1 to entry: The value is related to the design and application of the battery.

3.9
reference temperature
<for analytical results> temperature of the substance for which the analysis results are applicable

Note 1 to entry: Electrolyte density values measured at temperatures deviating from the reference temperature of 25 °C, are adjusted accordingly.

3.10
density measurement
<of the electrolyte> determination of the mass per unit volume of the electrolyte with appropriate tools such as aerometers, hydrometers, diffractometers or vibration-type densitometers

Note 1 to entry: The accuracy of such instruments is typically ± 0,001 kg/l.

3.11
electrolyte level
position of the electrolyte surface in the cell during operation

Note 1 to entry: The recommended level heights are indicated by the maximum and minimum electrolyte level marks on the cell or filling plug.

Note 2 to entry: Level adjustments such as water replenishment are carried out only when the cell reaches, under charge current flow and gas evolution, a fully charged state so as to avoid spillage due to overflowing electrolyte.

3.12
reference temperature
<for specified values> temperature at which properties, such as the electrolyte density, the maximum electrolyte level and the capacity of the battery are specified by the battery manufacturer

Note 1 to entry: The value of the reference temperature for the indication of parameters can differ depending on battery type and application.

3.13
additive
<to the electrolyte> compound which, added deliberately to the electrolyte, modifies certain properties of the cell

Note 1 to entry: Additives and their level are specified by the battery manufacturer. Non-specified additives can result in damages to the cell and voiding the terms of warranty.

Note 2 to entry: Examples of electrolyte additives are alkaline metal sulphates or phosphoric acid.

3.14
impurity
constituent in the electrolyte impairing the performance and life of a cell

Note 1 to entry: The type and maximum permissible quantity of impurities are specified in Table 3 and Table 4.

4 Preparation of electrolyte for lead acid batteries

The electrolyte shall be prepared from sulphuric acid of high concentration by pouring it into purified water and not the reverse. Purified water as specified in IEC 62877-2 shall be used.

Concentrated and diluted sulphuric acid has a highly irritating and burning effect on skin and a corrosive effect on clothes and many materials. The electrolyte shall be prepared by the battery manufacturer or by skilled personnel only. Adequate personal protection equipment such as goggles, face shields, rubber gloves, aprons and similar shall be used.

The mixing of sulphuric acid of high concentrations with water releases a great amount of heat. To avoid splashing of hot acid, sulphuric acid shall be always poured into water and not the reverse. The relevant material safety data sheets (MSDS) shall be consulted.

The density measurement of the electrolyte can be carried out with appropriate tools such as aerometers, hydrometers, diffractometers or vibration-type densitometers. The obtained values shall be normalized to the specified reference temperature.

5 Physical properties of diluted sulphuric acid as electrolyte

5.1 Dependence of sulphuric acid electrolyte density on temperature

The value of sulphuric acid electrolyte density obtained at the measuring temperature shall be converted to the value of sulphuric acid electrolyte density at the reference temperature of 25 °C with the following equation:

$$d_{\mathrm{n}} = d_{\mathrm{T}} + f_{\mathrm{d}} \, (T - T_{\mathrm{n}})$$

where

d_{n} is the acid electrolyte density at 25 °C;

d_{T} is the acid electrolyte density at measuring temperature T;

f_{d} is the correction factor according to Table 1;

T is the measuring temperature;

T_{n} is the reference temperature of 25 °C.

Table 1 – Correction factor to convert the acid electrolyte density found at the measuring temperature to that at the specified reference temperature

Acid electrolyte density d_{n} kg/l	Correction factor f_{d} [a] kg/l per K
1,10	0,000 50
1,15	0,000 60
1,20	0,000 70
1,30	0,000 75

[a] The correction factor is applicable for a temperature range from 0 °C to 55 °C.

5.2 Relationship of acid electrolyte density at 25 °C with the content of sulphuric acid

Table 2 presents the relationship between the density and the content of sulphuric acid in the electrolyte.

Table 2 – Acid electrolyte density at 25 °C versus percentage of sulphuric acid

Sulphuric acid content (H_2SO_4)			
Acid electrolyte density at 25 °C kg/l	**Mass fraction** H_2SO_4 %	**Amount of** H_2SO_4 mol/l	**Concentration** H_2SO_4 g/l
1,100	15,18	1,704	166,98
1,110	16,45	1,863	182,60
1,120	17,80	2,034	199,36
1,130	19,15	2,208	216,40
1,140	20,47	2,381	233,36
1,150	21,81	2,558	250,70
1,160	23,11	2,735	268,07
1,170	24,39	2,911	285,36
1,180	25,63	3,086	302,43
1,190	26,90	3,266	320,11
1,200	28,12	3,443	337,44
1,210	29,34	3,622	355,01
1,220	30,55	3,803	372,71
1,230	31,78	3,989	390,89
1,240	32,98	4,173	408,95
1,250	34,18	4,360	427,25
1,260	35,40	4,551	446,04
1,270	36,60	4,743	464,82
1,280	37,81	4,938	483,97
1,290	38,93	5,124	502,20
1,300	40,10	5,319	521,30
Similar tabulations of concentration vs. density values can be found in: H. Bode, Lead-Acid Batteries, Translated by R.J. Brodd, K. Kordesch, The Electrochemical Society Series, John Wiley & Sons, New York, 1977, p. 42. D. Berndt, Maintenance-Free Batteries, 3rd Edition, Research Studies Press Ltd., Baldock, England, 2003, p.109			

When additives are present in the sulphuric acid electrolyte, the density measurement value will not reveal the true content of sulphuric acid (H_2SO_4) therein.

5.3 Electrolyte density in relation to the state of discharge

The electrolyte density decreases during discharge of a battery. Therefore, the specified density of the electrolyte relates to that in a fully charged battery.

The permissible limit values of the densities in operation are specified by the battery manufacturer for each of the various battery types, applications and specific reference temperatures.

6 Requirements for sulphuric acid used as electrolyte

6.1 Impurities of sulphuric acid at high concentration

The purity of sulphuric acid at high concentration shall be such that after the subsequent dilution with water to values of d_n ≤ 1,30 kg/l and use as filling electrolyte, the values given in Table 3 are not exceeded.

6.2 Impurities limits of sulphuric acid electrolyte for first filling

The sulphuric acid used for filling lead acid batteries shall be clear and colourless.

The appropriate electrolyte filling levels shall be observed in order to avoid electrolyte spillage and associated corrosion damages and hazards.

The impurities present in the filling electrolyte shall not exceed any value in Table 3.

This level of purity is required also for acid used for an electrolyte with density higher than 1,30 kg/l, e.g., for adjustment of the electrolyte density in batteries where an electrolyte loss has occurred.

Table 3 – Maximum allowed impurities in diluted sulphuric acid in the density range d_n ≤ 1,30 kg/l when used as filling electrolyte for lead acid batteries

Item	Impurities	mg/l max.
1	Palladium (Pd), Platinum (Pt), Rhenium (Re)	0,05
2	Copper (Cu)	0,5
3	Arsenic (As), Antimony (Sb), Bismuth (Bi), Tin (Sn), Selenium (Se), Tellurium (Te), Cadmium (Cd), Mercury (Hg), – each individually – total (all together)	 1,0 2,0
4	Manganese (Mn), Chromium (Cr), Titanium (Ti), Nickel (Ni), – each individually	 0,2
5	Iron (Fe)	30
6	Cobalt (Co), Zinc (Zn) – each individually – a total (all together)	 1,0 2,0
7	Halogens calculated as chloride	5
8	Nitrogen in the form of nitrate	10
9	Nitrogen in other form, e.g., as ammonia	50
10	Volatile organic acids calculated as acetic acid	20
11	Oxidable organic substances calculated as $KMnO_4$ consumption	30
12	Dry residue after heating	250
The limit values are applicable if no equivalent manufacturer specifications are available. The analysis results pertain to an electrolyte at the reference temperature of 25 °C.		