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REDLINE VERSION

INTERNATIONAL STANDARD

colour
inside

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

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INTERNATIONAL
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ELECTROLYTE AND WATER FOR VENTED LEAD ACID ACCUMULATORS –

Part 1: Requirements for electrolyte

FOREWORD

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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:

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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~~, for example~~ with dry-charged cells~~ or batteries,~~ 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

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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
~~diluted sulfuric acid (H_2SO_4) for lead-acid accumulators~~

<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 ~~and etching~~ liquid with a density ~~1,84 kg/l~~ 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 battery manufacturer or~~ 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 ~~the first~~ electrolyte filling and first use in the application

Note 1 to entry: The density ~~values~~ and the degree of purity of the operating electrolyte ~~may~~ can deviate from the values of the filling electrolyte due to ~~impurity input from replenishment by water and to elution~~ electrolysis, evaporation, introduction of impurities with the replacement water and leaching from ~~e.g.~~ separators, active material and electrode grids.

3.7
~~electrolyte density~~
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
~~density of the battery to be stated by the battery manufacturer valid at the maximum electrolyte level (see 3.10) at full state of charge of the battery at the reference temperature~~

~~Note 1 to entry: It is related to the application and design of the battery.~~

<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~~
~~reference temperature for analytical results of electrolyte impurities which is 25 °C ± 1 °C~~

~~Note 1 to entry: Density values measured at temperatures deviating from this reference temperature are adjusted accordingly.~~

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
~~**measurement of the electrolyte density**~~
~~measurement is carried out by densimeters, in which areometers (hydrometers) are used, or by electronic devices based on e.g. on ultrasonic measurements~~

~~Note 1 to entry: The accuracy of the instrument is better than ± 0,001 kg/l.~~

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/battery, where the recommended tidal movements are indicated by maximum and minimum electrolyte level marks to assist in water replenishment~~

~~Note 1 to entry: Water replenishment should take place in a fully charged state to the upper limit, to avoid over topping and electrolyte loss.~~

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
~~value specified by the battery manufacturer for the indication of properties, such as the nominal electrolyte density, the maximum electrolyte level and the nominal capacity of the battery~~

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

<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
~~**electrolyte additives**~~
~~compounds which, added to the electrolyte, improve certain properties of the accumulator~~

~~Note 1 to entry: They shall be specified by the manufacturer. Other additives, not specified or not approved by the battery manufacturer, should not be used as they may cause damage to the battery and thus endanger the functional reliability.~~

~~Note 2 to entry: Examples of electrolyte additives are alkaline metal sulfates.~~

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
~~impurities from the electrolyte in practical use may cause damage to the battery and reduce its performance~~

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

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 ~~accumulators~~ batteries

~~The electrolyte is prepared from sulfuric acid of high concentration by pouring it into purified water.~~

~~As concentrated and diluted sulfuric acid has a highly etching effect on human skin and corrosive effect on clothes and many materials, and therefore the electrolyte shall be prepared by the battery manufacturer or skilled personnel only.~~

~~NOTE The mixing of sulphuric acid of high concentrations with water releases a high amount of heat. To avoid sudden splashing of hot acid, always pour acid into water, never the opposite. Pay attention to the safety data sheets.~~

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 ~~densities~~ 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 ~~by~~ 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 ~~of density from measuring temperature to reference/specified temperature~~ 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 ~~refers to the~~ is applicable for a temperature range from 0 °C to 55 °C.

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

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 ~~at 25 °C~~

Sulphuric acid content (H_2SO_4)			
Acid electrolyte density at 25 °C kg/l	Mass ~~ratio~~ fraction H_2SO_4 % ~~w/w~~	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

Sulphuric acid content (H_2SO_4)			
Acid electrolyte density at 25 °C kg/l	**Mass ~~ratio~~ fraction** H_2SO_4 % ~~w/w~~	**Amount of** H_2SO_4 mol/l	**Concentration** H_2SO_4 g/l
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 ~~compared~~ in relation to the state of discharge

The electrolyte density decreases during discharge of a battery. ~~Therefore the specified electrolyte densities relate to a fully charged state. The permissible limit values shall be specified by the battery manufacturer for the various battery types and applications.~~ 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 ~~of higher~~ at high concentration ~~degrees~~

The purity of sulphuric acid ~~of higher~~ at high concentration ~~degrees~~ shall be such that after the ~~following~~ subsequent dilution with water to values of ~~≦~~ $d_n \leq 1{,}30$ kg/l and use as filling electrolyte, the values given in Table 3 are ~~by no means~~ not exceeded.

6.2 Impurities ~~of~~ limits of sulphuric acid electrolyte for first filling ~~acid~~

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 ~~included~~ present in the ~~acid~~ 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 ~~of~~ in diluted sulphuric acid in the density range $d_n \leq 1,30$ kg/l when used as filling electrolyte for lead acid batteries ~~in the density range ≦ 1,30 kg/l~~

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	~~annealing~~ 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.

6.3 Impurities ~~of operating~~ limits for sulphuric acid electrolyte in operation

~~The sulfuric acid used for filling lead-acid batteries should be clear and colorless.~~

The impurities present in the operating electrolyte shall not exceed any value in Table 4.

Table 4 – Maximum allowed ~~impurity of diluted acid as operating electrolyte for lead-acid batteries in the density range ≦ 1,30 kg/l~~ impurities in diluted sulphuric acid in the density range d_n ≤ 1,30 kg/l when this acid is acting as the operating electrolyte in lead acid batteries

Item	Impurities	mg/l [b] max.
1	Palladium (Pd), Platinum (Pt), Rhenium (Re) Copper (Cu)	n.m. [a]
2	Tellurium (Te) and Selenium (Se) individually	1,0
3	Arsenic (As), Bismuth (Bi) , Cadmium (Cd), Tin (Sn) – individually – total (all together)	 3 6
4	Antimony (Sb) – stationary cells with Planté or flat plates – stationary cells with tubular plates and traction cells	 3 10
5	Manganese (Mn), Chromium (Cr), Titanium (Ti), Nickel (Ni) – Individually	 0,2
6	Iron (Fe)	100
7	Cobalt (Co), Zinc (Zn) – individually – total (all together)	 1,0 2,0
8	Halogens calculated as chloride: – stationary cells with Planté plates – other stationary cells – traction cells and vented starter batteries	 30 100 200
9	Nitrogen in the form of nitrate	10
10	Nitrogen in other form e.g., as ammonia	50
11	Volatile organic acids calculated as acetic acid	30
12	Oxidable organic substances calculated as $KMnO_4$ consumption	50

Key

n.m. = not measurable

[a] These metals remain deposited virtually completely on the negative ~~electrode~~ plate. ~~These harmful substances effect a high self-discharge.~~ The elements cause an elevated self-discharge, i.e., capacity loss on stand in open circuit of the cells.

[b] It is not possible to specify valid limit values for metals in general. The levels of impurities which are harmful to the batteries depend strongly on other parameters such as type, age and operating conditions of the cell.

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.

7 Storage of electrolyte

The electrolyte ~~which is to be stored shall be placed in vessels which are~~ shall be stored in closable vessels, appropriately marked and resistant to chemical corrosion (e.g., polyethylene, polypropylene or similar plastic materials).

8 Remedy in the event of damage due to the electrolyte

When parts of skin, eyes or mucous membranes have been exposed to the harmful effect of the sulphuric acid electrolyte, immediate measures shall be taken in all these cases by carefully rinsing ~~out~~ the affected parts with plenty of water. In addition, medical ~~care~~ attention is ~~required~~ to be sought.

Appliances, installations and clothes ~~may~~ can be cleaned by using neutralization agents and by rinsing them out with water.

Sodium carbonate or bicarbonate solutions in water with a concentration of 5 % in weight or solid soda ($NaCO_3$) can be used as neutralizing agents in order to reduce the effect of electrolyte on appliances, the human body and clothes.

Commercial acid neutralizing and absorbent powders with incorporated coloured pH indicators are available in numerous formulations.

Diatomaceous earth is ~~especially~~ also suited ~~absorbing~~ to absorb spilled electrolyte.

Bibliography

IEC 62485-2, *Safety requirements for secondary batteries and battery installations – Part 2: Stationary batteries*

IEC 62485-3, *Safety requirements for secondary batteries and battery installations – Part 3: Traction batteries*

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INTERNATIONAL STANDARD

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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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Part 1: Requirements for electrolyte

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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 $d_n \leq 1{,}30$ 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 $d_n \leq 1{,}30$ 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.		

6.3 Impurities limits for sulphuric acid electrolyte in operation

The impurities present in the operating electrolyte shall not exceed any value in Table 4.

Table 4 – Maximum allowed impurities in diluted sulphuric acid in the density range $d_n \leq 1{,}30$ kg/l when this acid is acting as the operating electrolyte in lead acid batteries

Item	Impurities	mg/l [b] max.
1	Palladium (Pd), Platinum (Pt), Rhenium (Re) Copper (Cu)	n.m. [a]
2	Tellurium (Te) and Selenium (Se) individually	1,0
3	Arsenic (As), Bismuth (Bi) , Cadmium (Cd), Tin (Sn) – individually – total (all together)	 3 6
4	Antimony (Sb) – stationary cells with Planté or flat plates – stationary cells with tubular plates and traction cells	 3 10
5	Manganese (Mn), Chromium (Cr), Titanium (Ti), Nickel (Ni) – Individually	 0,2
6	Iron (Fe)	100
7	Cobalt (Co), Zinc (Zn) – individually – total (all together)	 1,0 2,0
8	Halogens calculated as chloride: – stationary cells with Planté plates – other stationary cells – traction cells and vented starter batteries	 30 100 200
9	Nitrogen in the form of nitrate	10
10	Nitrogen in other form e.g., as ammonia	50
11	Volatile organic acids calculated as acetic acid	30
12	Oxidable organic substances calculated as $KMnO_4$ consumption	50

Key

n.m. = not measurable

[a] These metals remain deposited virtually completely on the negative plate. The elements cause an elevated self-discharge, i.e., capacity loss on stand in open circuit of the cells.

[b] It is not possible to specify valid limit values for metals in general. The levels of impurities which are harmful to the batteries depend strongly on other parameters such as type, age and operating conditions of the cell.

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.

7 Storage of electrolyte

The electrolyte shall be stored in closable vessels, appropriately marked and resistant to chemical corrosion (e.g., polyethylene, polypropylene or similar plastic materials).

8 Remedy in the event of damage due to the electrolyte

When parts of skin, eyes or mucous membranes have been exposed to the harmful effect of the sulphuric acid electrolyte, immediate measures shall be taken in all these cases by carefully rinsing the affected parts with plenty of water. In addition, medical attention is to be sought.

Appliances, installations and clothes can be cleaned by using neutralization agents and by rinsing them out with water.

Sodium carbonate or bicarbonate solutions in water with a concentration of 5 % in weight or solid soda ($NaCO_3$) can be used as neutralizing agents in order to reduce the effect of electrolyte on appliances, the human body and clothes.

Commercial acid neutralizing and absorbent powders with incorporated coloured pH indicators are available in numerous formulations.

Diatomaceous earth is also suited to absorb spilled electrolyte.

Bibliography

IEC 62485-2, *Safety requirements for secondary batteries and battery installations – Part 2: Stationary batteries*

IEC 62485-3, *Safety requirements for secondary batteries and battery installations – Part 3: Traction batteries*

SOMMAIRE

COMMISSION ÉLECTROTECHNIQUE INTERNATIONALE

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ÉLECTROLYTE ET EAU POUR ACCUMULATEURS PLOMB-ACIDE OUVERTS –

Partie 1: Exigences pour l'électrolyte

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L'IEC 62877-1 a été établie par le comité d'études 21 de l'IEC: Accumulateurs. Il s'agit d'une Norme internationale.

Cette deuxième édition annule et remplace la première édition parue en 2016. Cette édition constitue une révision technique.

Cette édition inclut les modifications techniques majeures suivantes par rapport à l'édition précédente:

a) Ajout des valeurs de concentration des halogènes dans le Tableau 4.

Le texte de cette Norme internationale est issu des documents suivants:

Projet	Rapport de vote
21/1169/FDIS	21/1172/RVD

Le rapport de vote indiqué dans le tableau ci-dessus donne toute information sur le vote ayant abouti à son approbation.

La langue employée pour l'élaboration de cette Norme internationale est l'anglais.

Ce document a été rédigé selon les Directives ISO/IEC, Partie 2, il a été développé selon les Directives ISO/IEC, Partie 1 et les Directives ISO/IEC, Supplément IEC, disponibles sous www.iec.ch/members_experts/refdocs. Les principaux types de documents développés par l'IEC sont décrits plus en détail sous www.iec.ch/publications.

Une liste de toutes les parties de la série IEC 62877, publiées sous le titre général *Électrolyte et eau pour accumulateurs plomb-acide ouverts*, se trouve sur le site web de l'IEC.

Le comité a décidé que le contenu de cette publication ne sera pas modifié avant la date de stabilité indiquée sur le site web de l'IEC sous webstore.iec.ch dans les données relatives à la publication recherchée. À cette date, la publication sera

- reconduite,
- supprimée,
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- amendée.

ÉLECTROLYTE ET EAU POUR ACCUMULATEURS PLOMB-ACIDE OUVERTS –

Partie 1: Exigences pour l'électrolyte

1 Domaine d’application

La présente partie de l'IEC 62877 s'applique aux électrolytes et à leurs composants utilisés pour le remplissage des batteries plomb-acide ouvertes avec éléments chargés secs et pour le réapprovisionnement, le remplacement de l'électrolyte ou le réglage de la densité de l'électrolyte des batteries en fonctionnement. Le présent document définit la composition, la pureté et les propriétés de l'électrolyte pour application en l'absence d'instructions spécifiques du fabricant de batteries.

2 Références normatives

Les documents suivants sont cités dans le texte de sorte qu'ils constituent, pour tout ou partie de leur contenu, des exigences du présent document. Pour les références datées, seule l’édition citée s’applique. Pour les références non datées, la dernière édition du document de référence s'applique (y compris les éventuels amendements).

IEC 62877-2, *Électrolyte et eau pour accumulateurs plomb-acide ouverts – Partie 2: Exigences pour l'eau*

3 Termes et définitions

Pour les besoins du présent document, les termes et définitions suivants s'appliquent.

L'ISO et l'IEC tiennent à jour des bases de données terminologiques destinées à être utilisées en normalisation, consultables aux adresses suivantes:

- IEC Electropedia: disponible à l'adresse https://www.electropedia.org/
- ISO Online browsing platform: disponible à l'adresse https://www.iso.org/obp

3.1
batterie au plomb-bioxyde de plomb
batterie au plomb
batterie d'accumulateurs comprenant un électrolyte aqueux à base d’acide sulfurique dilué, une électrode positive en bioxyde de plomb et une électrode négative en plomb

[SOURCE: IEC 60050-482:2004, 482-05-01, modifié – La Note 1 a été supprimée et le terme "batterie au plomb" a été ajouté.]

3.2
électrolyte
<pour une batterie au plomb-bioxyde de plomb> solution d'acide sulfurique (H_2SO_4) diluée dans de l'eau purifiée

Note 1 à l'article: L’électrolyte est préparé en mélangeant de l'acide sulfurique concentré ou de l'acide sulfurique à haute densité à savoir d > 1,30 kg/l avec de l'eau purifiée afin d'obtenir les valeurs de densité spécifiées par le fabricant de batteries ou dans les normes applicables au type et à la conception de batterie concernés pour un état de charge défini. Sa pureté satisfait aux exigences données dans le Tableau 3.

Note 2 à l'article: L'acide sulfuriquye concentré est un liquide incolore et très corrosif, de densité d > 1,82 kg/l.

3.3
eau
<pour une batterie au plomb-bioxyde de plomb> eau purifiée (H_2O) utilisée pour la préparation de l'électrolyte pour les batteries et pour le remplacement (remplissage de complément) des pertes en eau dans l'électrolyte de fonctionnement dues à la décomposition de l'eau par surcharge et évaporation

Note 1 à l'article: Les exigences pour l'eau purifiée sont spécifiées dans l'IEC 62877-2.

3.4
électrolyte de remplissage
<pour une batterie au plomb-bioxyde de plomb> acide sulfurique dilué utilisé pour le premier remplissage des batteries chargées sèches ou pour le réapprovisionnement, l'ajustement de la densité ou le remplacement d'un électrolyte de fonctionnement contaminé

3.5
premier remplissage
<pour une batterie au plomb-bioxyde de plomb> remplissage d'origine d'une batterie chargée sèche réalisé par l'utilisateur conformément aux instructions applicables du fabricant

3.6
électrolyte de fonctionnement
<pour une batterie au plomb-bioxyde de plomb> électrolyte présent à l'intérieur de la batterie à la suite du remplissage d'électrolyte et de la première utilisation dans l'application

Note 1 à l'article: La densité et le degré de pureté de l'électrolyte de fonctionnement peuvent s'écarter des valeurs de l'électrolyte de remplissage en raison de l'électrolyse, de l'évaporation, des impuretés apportées lors du réapprovisionnement en eau et de lixiviation des séparateurs, matières actives et grilles des électrodes.

3.7
densité
<de l'électrolyte d'une batterie> valeur de la masse par unité de volume exprimée en kg/l

Note 1 à l'article: La densité varie avec l'état de charge de la batterie, la variation du volume de l'électrolyte due à la perte en eau et la température.

Note 2 à l'article: La valeur de la densité ne doit pas être confondue avec celle de la gravité spécifique (SG). La gravité spécifique ou densité relative est le rapport de la densité d'une substance, par exemple l'électrolyte, à la densité d'un matériau de référence donné, par exemple l'eau, et elle est sans dimension.

3.8
densité spécifiée
<de l'électrolyte d'une batterie> densité de l'électrolyte de la batterie déclarée par le fabricant lorsqu'il est au niveau supérieur maximal d'électrolyte, dans un état de pleine charge et à la température de référence

Note 1 à l'article: La valeur est liée à la conception et à l'application de la batterie.

3.9
température de référence
<pour des résultats analytiques> température de la substance à laquelle s'appliquent les résultats d'analyse

Note 1 à l'article: Les valeurs de densité de l'électrolyte mesurées à des températures différentes de la température de référence de 25 °C sont réglées en conséquence.

3.10
mesure de la densité
<de l'électrolyte> détermination de la masse par unité de volume de l'électrolyte au moyen d'outils appropriés tels que des aéromètres, des hydromètres, des diffractomètres ou des densitomètres de type à vibration

Note 1 à l'article: L’exactitude de ces appareils de mesure est généralement de ± 0,001 kg/l.

3.11
niveau d’électrolyte
position de la surface de l'électrolyte à l'intérieur de l'élément en cours de fonctionnement

Note 1 à l'article: La hauteur des niveaux recommandés est indiquée par des marques de niveau d'électrolyte maximal et minimal sur l'élément ou sur le bouchon de remplissage.

Note 2 à l'article: Les réglages de niveau tels que l'approvisionnement en eau ne sont réalisés que lorsque l'élément atteint, sous l’effet de la circulation du courant de charge et du dégagement gazeux, un état de charge complète afin d'éviter un déversement dû à un débordement d'électrolyte.

3.12
température de référence
<pour des valeurs spécifiques> température pour laquelle les propriétés telles que la densité de l'électrolyte, le niveau maximal d'électrolyte et la capacité de la batterie sont spécifiées par le fabricant de la batterie

Note 1 à l'article: La valeur de la température de référence pour l'indication des paramètres peut différer en fonction du type et de l'application de la batterie.

3.13
additif
<d'électrolyte> composé qui, ajouté délibérément à l'électrolyte, modifie certaines propriétés de l'élément

Note 1 à l'article: Les additifs et leurs niveaux sont spécifiés par le fabricant de la batterie. Des additifs non spécifiés peuvent endommager les éléments et entraîner une annulation des conditions de garantie.

Note 2 à l'article: Les sulfates de métaux alcalins ou l'acide phosphorique sont des exemples d’additifs d’électrolyte.

3.14
impureté
constituant présent dans l'électrolyte qui altère les performances et la durée de vie d'un élément

Note 1 à l'article: Le type et la quantité maximale admissible d'impuretés sont spécifiés dans les Tableaux 3 et 4.

4 Préparation de l'électrolyte pour les batteries plomb-acide

L'électrolyte doit être préparé à partir d'acide sulfurique très concentré qui est versé dans de l'eau purifiée et non l'inverse. L’eau purifiée qui doit être utilisée est celle spécifiée dans l’IEC 62877-2.

L'acide sulfurique concentré et dilué a un effet fortement irritant et brûlant sur la peau et un effet corrosif sur les vêtements et sur de nombreuses matières. L'électrolyte ne doit être préparé que par le fabricant de batteries ou par du personnel qualifié. Un équipement de protection individuel adéquat tel que des lunettes, des écrans faciaux, des gants de caoutchouc, des tabliers, etc., doit être utilisé.

Le mélange d'acide sulfurique à concentration élevée et d'eau est très exothermique. Afin d'éviter toute projection d'acide chaud, l'acide sulfurique doit toujours être versé dans l'eau, et non l'inverse. Les fiches de données de sécurité concernées (FDS) doivent être consultées.