



SF₆-Aciditor

Version 1.2

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1 General Information

1.1 Information about the Manual

This manual describes a safe and adequate handling of the SF₆-Aciditor. Following the instructions of the indicated safety aspects and instructions as well as the national and/or local rules and general safety regulations concerning the prevention of accidents are absolutely imperative.

Before starting the work with the device read the manual completely and thoroughly particularly the chapter *security* and respective safety references. Assure that you/the operator comprehend the terms described.

The manual is part of the device. It has to be stored together with and next to the device at any time.

1.2 Explanation of Symbols

Important and safety-relevant references in this manual are characterized by symbols. These indications which are in-line with industrial safety must be respected and followed at any time.



Information!

This symbol calls information, which are to be considered for efficient and perfect handling of the equipment.



NOTE! Danger for real values!

This symbol indicates references, which can lead to damages, malfunctioning and/or loss of the device.



WARNING! Danger by electric current!

This symbol marks references, which can lead to health impairments, injuries, lasting body damages or to death due to electric current.



VERY DANGEROUS! Injury or mortal danger!

This symbol marks references, which can lead to health impairments, injuries, lasting body damage or to death.

1.3 Scope of Supply

Assure that you have received the full scope of supply. If there is any part missing, please contact the G.A.S.-hotline immediately.

The scope of supply consists of:

- SF₆-Aciditor
- SO₂-Sensor foil sealed
- Transport case
- Battery charger
- Manual SF₆-Aciditor
- Instrument's quality test report
- 4 m long PTFE connecting hose with wire coating, self-closing stainless steel couplings on both ends

1.4 Liability and Guarantee

All data and reference within this manual are compiled under the valid regulations, the state-of-the-art as well as G.A.S. experiences of several years.

The manual has to be stored together with and close to the device at any time and accessible to all persons, who work with it.

This manual must be read carefully before starting to work with the equipment! G.A.S. does not overtake any liability for damage and disturbances, resulting from neglect or ignorance of the manual's instruction.

The text and graphics do not correspond necessarily to the scope of supply. The figures and/or diagrams do not correspond to the yardstick 1:1.

The actual scope of supply might deviate from special (customized) equipments, the recourse of additional order options or due to newest technical changes concerning the data and references described herein as well as the graphic representations. For questions please contact the G.A.S.-hotline.

G.A.S. reserves the right to realize technical changes of the product due to improvements without explicitly mentioning them.

1.5 Copyright

The manual is confidential. It is beyond doubt exclusively made and also meant for the personnel directly dealing with the equipment. All data, texts, designs, pictures and other representations within this manual are protected in the sense of the copyright law and are subject to further commercial patent rights. Each abuse is liable to prosecution.

Passing it on to third persons as well as duplications in any kind and form - also in part - as well as the use and/or report of contents are not permitted without written agreement of the manufacturer. Offences lead to payment of damages. We reserve ourselves the right for further legal actions as well as all further rights according to the practice of commercial patent rights.

1.6 Return and Disposal

For a professional redemption, the device or/and its components must be returned to the manufacturer or to a third party authorized by the manufacturer!

1.7 Customer Service

For questions concerning the equipment a customer service is available:

- Phone: ++49 231 / 97 42 - 65 50
- Fax: ++49 231 / 97 42 - 65 55
- E-Mail: info@gas-dortmund.de

The telephone hotline is attainable from Monday to Friday from 8:00 to 17:00 hours. In urgent cases and if you use fax or e-mail, please indicate your telephone number.

G.A.S.

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2 Transport, Packing and Storage

2.1 Inspection after Transport

Check the supply immediately after delivery concerning its completeness and/or transport damages. If you detect outwardly recognizable transport damage, do not receive the supply, or only under reservation. State the extent of the damage on the provided delivery note and/or the transportation documents of the feeder. Generate a complaint. Lodge a complaint of covered defect immediately after recognizing, as claims due to transport damages can only be made valid within the complaint periods (usually 7 days).

2.2 Transport

The equipment should be moved only within the provided carrying case. By this means, transport damages can be avoided.

2.3 Packing

If no redemption agreement concerning the packing was agreed upon, separate the different materials according to kind and size and supply it to further use or recycling.



Information!

Dispose the packing material always environmentally friendly and according to the valid local regulations. If necessary, ask a recycling company.

2.4 Storage

Store the device only under the following conditions:

- Until the use of the equipment keep the provided suit-case locked
- Do not store unsecured
- Do not store outside
- Store only dry and dust free
- Avoid mechanical vibrations
- Do not expose the device to aggressive media
- Protect the device against sun exposure
- Storage temperature: -10 to 60 °C
- If you do not use the device, check the storage condition, regularly
- Protect against unauthorized access

3 Cleaning and Maintenance

Natural aging and the wear of certain components of the equipment require a regular cleaning and maintenance.

3.1 Cleaning

Clean the device only with a dry or easily damp cloth.



NOTE! Danger for real values!

Do not use cleaning agents, which contain solvents, acids or bases.

3.2 Maintenance

Maintenance of the device should only be carried out at G.A.S. or through specially trained and by G.A.S. authorized personnel.

3.3 Exchange of sensor / Calibration

The sensor of the SF₆-Aciditor has a lifetime of two years and has to be exchanged after this time period. How to exchange the sensor is described in chapter 6.4 of this manual. New calibrated sensors should only be purchased from G.A.S..



Information!

Using the SO₂-sensor more than two years is not recommended due to an signal degradation of < 2 % per month.

4 Security

This section gives an overview of all important safety aspects for an optimal protection of the personnel as well as for the safe and trouble free use of the device. Additionally, the individual chapters contain concrete safety references with respect to the prevention of direct dangers which are indicated by symbols.

4.1 Intended Use

The device may **not** be operated by introducing highly aggressive gases or liquids! The working reliability is only ensured when the equipment is applied for its purpose:

To measure SO₂ up to 100 ppm_v (standard) in SF₆ or in other non aggressive gases !



NOTE! Danger for real values!

Each use of the device, that differs from the intended use is forbidden and will be regarded as “out of purpose”.

All claims or requirements of any kind against the manufacturer and/or its authorized persons that arise due to damages from a not intended use of the device will be rejected. All damages that arise from a not intended use are of the operator's responsibility.

The intended use of the equipment and its correct handling according are described in the operating instructions of this manual. Other parts than the parts belonging to the scope of supply, may only be used after G.A.S.' approval.

4.2 Responsibility of the Operator

This manual must be kept in direct access and together with the device and accessible to the operating staff at any time. The hints, information and instructions are to be followed without any restrictions or reservation!

Besides the indicated safety references and instructions in this manual, the local rules for the prevention of accidents and the general safety regulations - valid for the area of application of the device - as well as the valid environmental-protection regulations are to be considered and respected.

The technical responsible as well as the operator should take care of a trouble free use of the device as well as of clear definitions of the competences during operation, maintenance and cleaning.

4.3 Requirements of Personnel

Only authorized and trained technical personnel may work with the instruments. The operator must have received an instruction over existing and all possible dangers.

Technical personnel in this context are defined as skilled employees who are knowledgeable due to their educational background. In case the foreseen personnel do not have the necessary qualifications to operate the instrument, it must be trained.

The competencies for the work on and with the device must be specified and kept undoubtedly at any time so that with respect to security issues no unclear situation might come up.

The equipment should only be operated by reliable and responsible personnel. Personnel that might be under the influence of drugs or alcohol are to be kept off the device at any time. Further to that non-authorized personnel should not operate the device.

Any changes of the equipment, which impair security of the personnel must immediately be reported to the operator and every person dealing with it.

4.4 Dangers

The equipment was subject to an endangerment analysis. The construction and execution of the device corresponds to the today's state-of-the-art. The device is reliable in service when operated according to its intended use.

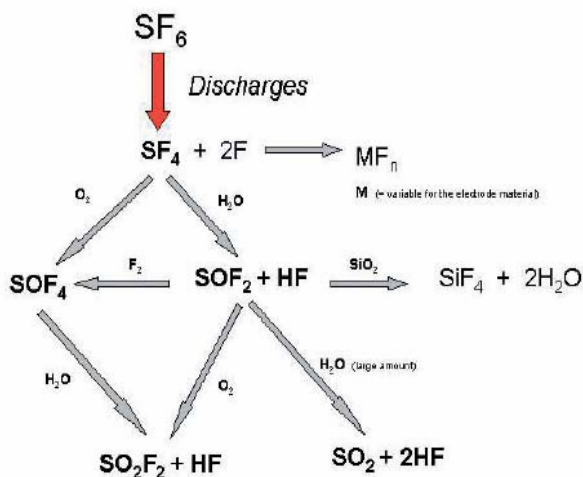


VERY DANGEROUS! Injury or mortal danger!

The equipment is not certified for the employment in areas with explosive gas air mixtures (zone 0).

5 Introduction

The increased application of SF₆ in gas-insulated electrical equipment, such as switchgear or transmission lines, has led to many recent analytical investigations on the stability and decomposition of SF₆. Although SF₆ shows great chemical inertness it decomposes under electrical stress, in the presence of arcs, sparks or partial discharges. Among the products found are species such as SOF₂, SO₂F₂, SOF₄, S₂F₁₀, SO₂, HF, SiF₄ and others.



The decomposition of SF₆ further depends on gas pressure, electrode materials and the inner surface materials of the equipment. Despite the proven reliability of such components in the electrical power distribution systems, failures occur due to the above mentioned SF₆ aging under electrical stress.

The laboratory analysis of decomposition products were carried out by gas chromatography, gas chromatography/mass spectrometry or infrared spectroscopy. The methods described above are complicated, expensive, require specially trained personnel and can only be used in a laboratory.

Using ion mobility spectrometer (IMS) a good quality assessment of the SF₆ in SF₆-filled compartment can be achieved. The IMS is calibrated to measure all kind of decomposition products in sum and in combination with a moisture sensor and SF₆ percentage sensor a comprehensive monitoring of the SF₆ can be achieved. For monitoring the quality of SF₆ G.A.S. recommends to use a multi-functional device with a combination of the above mentioned sensors such as, the SF₆-Analyser or SF₆-Breaker-Analyser, that allows to implement a Condition Based Maintenance (CBM) and a fault detection at an early stage via a gas analytical approach (see www.gas-dortmund.de).

5.1 Working Principle

The **SF₆-Aciditor** is a stand-alone device designed to quickly and accurately measure the amount of sulfur dioxide (SO₂) in SF₆. Because the unit contains an automatic flow and pressure control module, the user does not need to be concerned with setting the correct flow rate, or compensating for variations in equipment pressure. All readings are displayed in real-time on the touchpad display, in parts per million volume (ppm_v).

The **SF₆-Aciditor** has been particularly developed to be used on arced or otherwise stressed SF₆. Unlike conventional decomposition testers, which require disposable detector tubes, this unit uses an electro-chemical sensor (catalytic principle).

The applied electro-chemical sensor incorporates a gold based, three electrodes and acid electrolyte system.

The introduced SF₆ diffuses into the SO₂-sensor. Here it reacts at the sensing electrode through an oxidative process, according to the following equation:

Equation 1: **Sensing process**

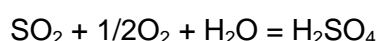
Sulphur Dioxide (SO₂): $SO_2 + 2H_2O = H_2SO_4 + 2H^+ + 2e^-$

The Counter electrode acts to balance the reaction at the sensing electrode, by means of an oxygen reduction forming water as a consequence.

Equation 2: **Counter reaction:**

Oxygen Reduction: $1/2O_2 + 2H^+ + 2e^- = H_2O$

The two equations represent the overall cell reaction as follows:



In case of a SO₂ presence within the SF₆ under inspection, equation 1 changes its electro-chemical potential and electrons are released consecutively. Thus a change of current is detected and converted to ppm_v-values.

The applied sensor carries a transmitter board that includes a temperature compensation and a calibration in the specified range.

While the sensor must be replaced (by the user) every 2 years, its accuracy and sensitivity do not strongly degrade due to use (<2% per month). Calibration is not required. The universally accepted CIGRE B3.02.01 standard for re-usable SF₆ is currently **12 ppm_v** for SO₂/SOF₂ – which falls well within the 0-100ppm_v (standard) range of the SF₆-Aciditor.

Main features:

- Compact, lightweight
- Low maintenance effort
- Cost effective
- No consumables required
- Highly sensitive
- Touch-screen interface
- Fast results, typically < 15 seconds
- Battery supply (min. 10 hours)

6 System Operation

6.1 Loading of Battery

The SF₆-Aciditor is equipped with a 3.2Ah Lithium-Ion battery which allows to operate the device for more than 10 hours. If the voltage which is always displayed during operation drops under 21V a warning message “Low battery” appears on the display. An automatic shutdown of the SF₆-Aciditor will be executed if the voltage drops under 18V. The voltage is at maxima at 25.2V.

For recharging the battery:

1. Turn off the SF₆-Aciditor.
2. Connect the power plug connector of the delivered battery charger to the power socket.
3. Plug the instrument's connector into the socket on the back plane (see picture).
4. Wait until the red charge lamp of the battery charger is extinguished. The battery is charged with a charge current of 1.5 A and a voltage of 25.2V. The maximum charge time of an empty battery is approx. 2,5 hours.
5. Disconnect the plugins.
6. The SF₆-Aciditor is again ready for measuring.



6.2 Insertion of the SO₂-Sensor

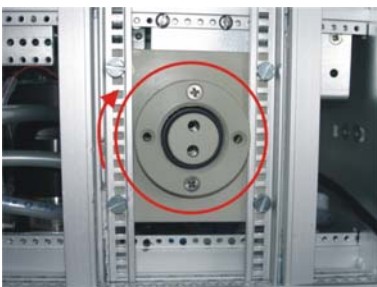
Before operation of the SF₆-Aciditor the SO₂-Sensor that comes in a separate plastic foil has to be insert. How to insert the sensor inside the SF₆-Aciditor is described step by step as follows:

1. Assure that the SF₆-Aciditor has been turned off.



2. Unscrew the marked screws on the back panel of the SF₆-Aciditor and turn down the partial back panel.

3. Open the foil sealing of the SO₂-sensor and take out the sensor.



4. Insert the winding of the SO₂-sensor into the indicated thread of the back plane (red marked in the picture) and turn it right while pressing it lightly.



5. Turn the sensor until reaching the bedstop. Mount the adapter as shown on the picture and fix the screw (red marked).



6. Turn the partial back panel up and fix the marked screws.

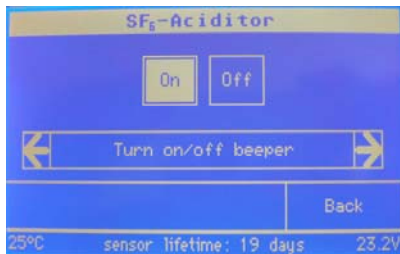


Note:

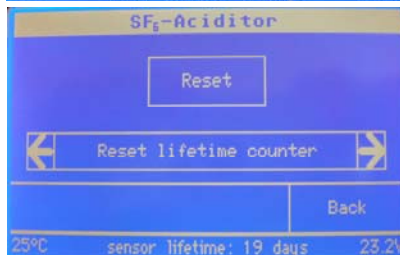
Carry out the following steps without a gas connection to the hose!



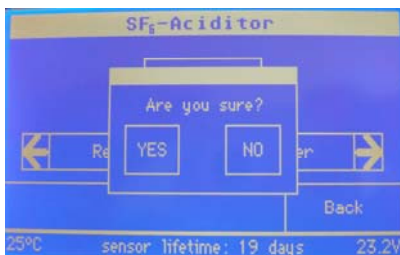
7. Turn on the SF₆-Aciditor using the “Power”-switch on the front panel of the device and wait until the main screen is displayed (see picture). Pressing “Settings” on the touchpad display opens the first menu point.



8. Pressing the right arrow leads to the second menu point for resetting the lifetime counter.



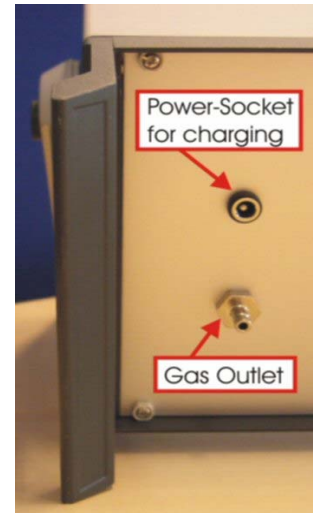
9. For resetting the lifetime counter press “Reset” on the touchpad display.



10. Confirm the resetting by pressing “YES”. Executing “Back” on the touchpad display switches back to the main screen. The SF₆-Aciditor is now ready for operation or can be turned off using the power button on the front panel.

6.3 Operation of the SF₆-Aciditor

For operating the SF₆-Aciditor the following instructions and information are needed.



The following steps explain how to operate the SF₆-Aciditor in detail.

1. Turn on the SF₆-Aciditor using the "Power"-switch on the front panel of the device and wait until the main screen is displayed (see picture).
2. Connect a sampling bag or a recycling system at the "Gas Outlet" on the back of the SF₆-Aciditor (optional).



3. Connect the SF₆-Aciditor (Gas Inlet) with the delivered hose (equipped with self-sealing quick-connectors) and appropriate adapters to the SF₆-filled compartment.
4. Open the valve at the SF₆-filled compartment.



Information!

The SF₆-Aciditor has no internal valve. If there is an open connection to an SF₆-filled compartment, the gas passes through the device with 20 L/h. This, independently whether the device is turned on or off !!

5. To clean the tube press the “Purge”-button for approx. 4 seconds.
6. After letting off the finger, the measurement immediately starts. The final value of the measurement is reached when there are no further changes of the displayed value. The SF₆-Aciditor needs less than 2 minutes to reach the final value. The SF₆-Aciditor works at ambient pressure and is temperature compensated up to 60 °C.

**Information!**

The SF₆-Aciditor has an internal flow rate regulation. Independently from the compartment pressure the SF₆-Aciditor measures at ambient pressure with a flow of **20 L/h**. Allowed inlet pressure: **0.5 to 35 bar**.

7. After measuring a SO₂ content over zero the sensor has to be purged. Please look at chapter 6.4.
8. Disconnect the SF₆-Aciditor from the SF₆-filled compartment.
9. Disconnect the connected sampling bag or recycling system from the “Gas Outlet” on the back of the SF₆-Aciditor (optional).

**Information!**

Using a recycling system or sampling bag closely watch the filling status of it !! The SF₆-Aciditor **has no automatic turn off or any other safety system** in case of an overpressure inside the device because of a filled sampling bag or recycling system.

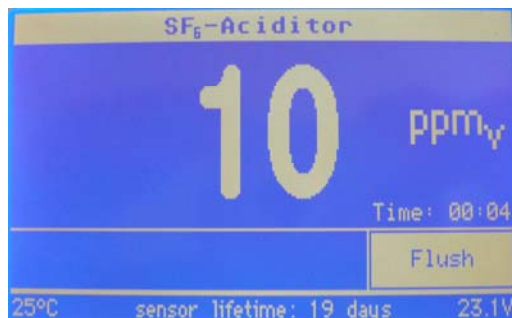
10. Assure that the hose has been disconnected. Turn off the SF₆-Aciditor by pressing the “Power”-switch on the front panel. For a longer lifetime of the sensor ambient air will be pumped through the sensor for 10 seconds. The sensor needs some residual humidity to extend its lifetime. Therefore ambient air is automatically pumped through the sensor to store it with some humidity.

**Information!**

Before turning of the SF₆-Aciditor the hose has to be disconnected. Otherwise SF₆ instead of air will be pumped through the sensor and the lifetime of the sensor will decrease.

6.4 Purging of the SF₆-Aciditor

After measuring a SF₆ sample with an SO₂ concentration above zero the SO₂-sensor has to be purged with ambient air. Therefore keep SF₆-Aciditor turned on, **disconnect the hose** at the gas inlet and press “Flush” on the touchpad display. The pump starts pumping ambient air through the sensor (see picture).



Air has to be pumped through the sensor until the SO₂ concentration has again reached 0 ppm_v. The pumping process can be aborted by pressing “Flush” on the touchpad display. The SF₆-Aciditor is again ready for operation.



Information!

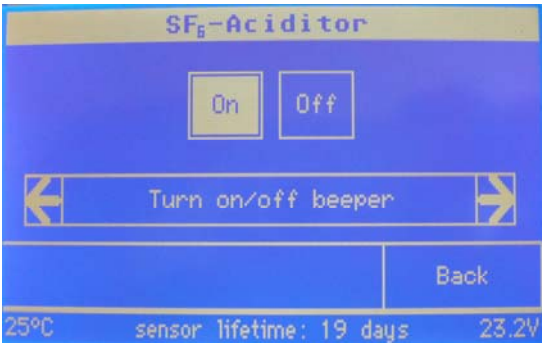
For a longer lifetime and a correct reading the SO₂-sensor has to be purged after each time measuring a SO₂-concentration > 0 ppm_v.

DO NOT FORGET TO DISCONNECT THE HOSE BEFORE !!

6.5 Settings

For adjusting the settings of the SF₆-Aciditor press “Settings” on the touchpad display. The following screen appears.

6.5.1 Turn on/off beeper



In the first menu point the beeper for all acoustic signals like keypad tones, alarm tones, etc. can be turned on and off. The white marked button “On” shows the active status of the device. To switch to the other status, touch the non marked button.

In order reach the next menu point press the right arrow on the touchpad.

6.5.2 Reset lifetime counter



In the second menu point of settings it is possible to reset the lifetime counter of the SO₂-sensor. The SO₂-sensor has a recommended lifetime of two years. The lifetime counter which is displayed on the bottom of the screen in every menu point counts up every day. After two years installed in the SF₆-Aciditor a warning reminds the operator to exchange the SO₂-sensor. The lifetime counter has to be reset after every installation.

**Information!**

Using the SO₂-sensor for more than two years leads to an incorrect reading of the sensor. (<2% per month of signal degradation)

Pressing the left arrow on the touchpad switches back to the first menu point of "Settings". To go back to the main screen press "Back".

6.6 Exchange of the sensor

The SO₂-sensor installed inside the SF₆-Aciditor has a recommended lifetime of two years to guarantee a correct reading. The lifetime counter on the bottom of the screen reminds the operator when to replace it. The exchange the SO₂-sensor is described in detail below.



Information!

Using the SO₂-sensor for more than two years is not recommended due to the excessive signal degradation (<2% per month).

1. Assure that the SF₆-Aciditor is turned off.

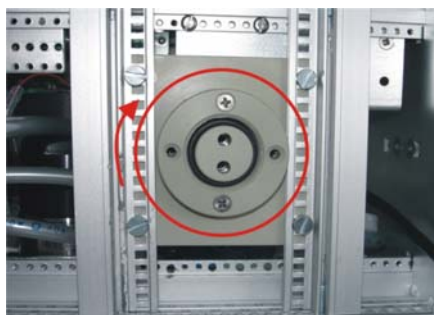


2. Loosen the marked screws on the back panel of the SF₆-Aciditor and turn down the partial back panel.

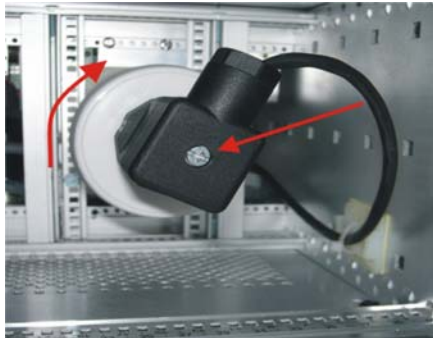


3. Loosen the screw of the adapter (red marked) and remove the adapter from the sensor. Turn the sensor until the sensor is out of the thread of the backplane.

4. Open the foil sealing of the new SO₂-sensor and take out the sensor.



5. Insert the winding of the SO₂-sensor into the indicated thread of the back plane (red marked in the picture) and turn it right while pressing it lightly.



6. Turn right the sensor until reaching the bedstop. Mount the adapter as shown on the picture and fix the screw (red marked).



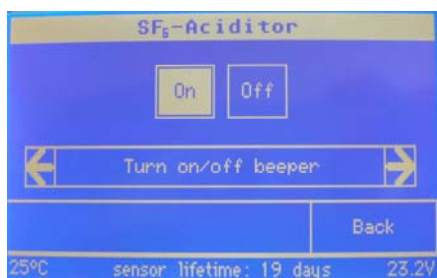
7. Turn up the partial back panel and fix the marked screws.


Note:

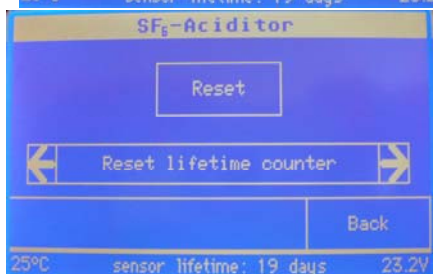
Carry out the following steps without a gas connection to the hose!



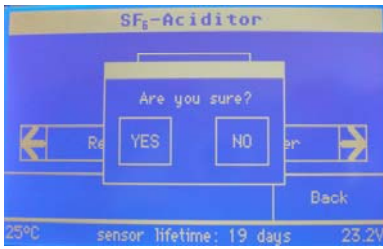
8. Turn on the SF₆-Aciditor using the “Power”-switch on the front panel of the device and wait until the main screen is displayed (see picture). Pressing “Settings” on the touchpad display opens the first Setting menu point.



9. Pressing the right arrow leads to the second menu point for resetting the lifetime counter.



10. For resetting the lifetime counter press “Reset” on touchpad display.



11. Confirm the resetting by pressing "YES". Executing "Back" on the touchpad display switches back to the main screen. The SF₆-Aciditor is now ready for operation again or can be turned off using the power button on the front panel.

7 Technical Data

Measurement Principle	Electro-chemical (catalytic principle)
Range	0-100 ppm _v (standard), alternatively 0-10 ppm _v or 0-500 ppm _v
Readings	Temperature compensated Resolution: 1 ppm _v for 0 - 100 ppm _v sensor 0.1 ppm _v for 0 - 10 ppm _v sensor 3 ppm _v for 0 – 500 ppm _v sensor
Response time T 90	<15s
Humidity range	Up to 90 % non-condensating
Lifetime	2 years from installation
Maximum zero shift	0.1 ppm _v for all sensor types
Long-term stability	< 2 % signal degradation per month (linear)
Flow rate	< 20 L/h
Measuring time	approx. 2 minutes
∅ Gas consumption	approx. 0.7 L per measurement at ambient pressure
Pressure	0.5-35 bar (gaseous) / automatic flow rate regulation
Operation	Purge function for hose cleaning Cleaning function with ambient air
Display	Touchpad – Graphic display (240x128 Pixel)
Supply	Lithium-Ion battery with min. 10 h capacity Rechargeable 100-265 AC V 50/60Hz Battery voltage displayed
Temperature	Storage: -10 to 60 °C Operation: 0 to 50 °C
Calibration	None required
Dimension	280 x 140 x 300 mm (WxHxL)
Weight	approx. 6 kg