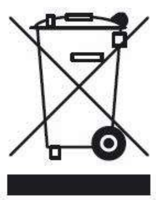
USER MANUAL

3S-OIW

Fluorescence Sensor Refined Oil / PAH / BTEX



Electrical equipment marked with this symbol can not be disposed of through home or public waste disposal systems after 12 August 2005. In accordance with local and national European regulations (EU Directive 2002/96 / EC), users must return the equipment which is unsuccessful or can no longer be used to the manufacturer, which have to provide free of charge disposal.
Note: To return devices at the end of their useful life, accessories supplied by the manufacturer and all auxiliary items for recycling, contact the manufacturer or the vendor of the device to arrange proper disposal.

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1 - SAFETY INFORMATION

1.1 Warnings and safety information

Before installing and operating the analyzer, read this manual thoroughly. Please pay particular attention to all the labels applied to the analyser and to all the hazard information indicators in this manual.

This symbol indicates that you must refer to this manual for proper use of the equipment. Only qualified operators, properly trained on the use and maintenance of the analyser can carry out service activities on the equipment.

This symbol indicates the existence of a risk of electric shock and/or electrocution.
Only operators qualified for these activities can perform maintenance and control operations on the equipment bearing this label, always after unplugging it.

Parts involved:
- input terminal block in the upper box

The instrument operates with low power UV radiation. Do not look directly at the light source and do not disassemble the light source enclosure.

Parts involved:
- UV source

The manufacturer shall not be held responsible under any circumstances for improper use of the equipment.
The head of department and the machine operator must comply with the following rules and with the provisions of current legislation on the safety and health of workers.
The use, maintenance, and repair of the instument are permitted only to persons authorised for such operations. These operators must be physically and mentally capable to perform such activities, which can not be performed under the influence of alcohol and drugs.
When the instrument is not being used it must be protected from voluntary or involuntary activation, after disconnecting the power supply.
Failure to follow the instructions given and/or failure to pay attention to the hazard indicators may cause serious risks of physical damage to operators and breaks or malfunctioning of the analyzer.
All the components of the instrument are placed within a panel closed by a door with a special key, supplied only to maintenance operators.
The instument must then be used under operating conditions with the door closed.

2 - GENERAL INFORMATION

2.1 Technical specifications

Measured parameters	Oil-in-water, BTEX, aromatic hydrocarbons, PAH/PAC. Can be correlated to sum parameters as COD, TOC, BOD.
Measuring principle	Fluorescence photometry
Measuring range	0 - 30 ppm as phenol equivalents 0 - 10 ppm as NDSA equivalents
Reproducibility	± 3 % of the full scale
Limit of detection	0.1 ppm (phenol equivalents)
Analysis Frequency	1 s
Sample	Pressure: pressure-free vessel (depth up to 60 m) Temperature: 5 - 50 °C (41 - 122 °F) Flow Rate: 80 to 500 mL/min Connection: 6 mm (¼-in.) Drain: pressure-free, atmospheric drain
Body material	Stainless steel 316L
Dimensions	∅ 50 mm, L 175.8 mm
Weight	Approx. 1 Kg (2.2 lbs)
Power Supply	Voltage: 5 - 12 VDC Power consumption: max. 0.5 VA
Outputs	ModBUS RTU RS485
Installation	With optional fast-loop reservoir (not included), pipe-mounted or wall mounted with appropriate brackets
Protection Grade	IP68

2.2 Instrument description

The 3S-OIW is a sensor for water monitoring. The sensor works with the principle of UV fluorescence and can be used to detect many common pollutants such as hydrocarbons/oil-in-water, BTEX, PAH/PAC. In many cases the measurements can be correlated with sum parameters like CODeq, TOCeq, BODeq. The design is compact and robust, the stainless steel body offer great protection up to a depth of 60 m.

2.3 Applications

The instrument can be used to monitor the concentration of various parameters in aqueous samples and it finds application in civilian and industrial wastewater control, oil industry, hydrocarbons transport and storage and every other application that requires a fast and sensitive determination of possible pollutants.

2.4 Method description

Fluorescence spectroscopy, or fluorimetry, is a technique that measures the amount of light emitted by a fluorescent sample when excited with an incoming radiation of appropriate wavelength. Fluorescence is a property of some substances that are able to absorb energy from the incoming light and then release it as a radiation with a lower energy (longer wavelength) and partially as heat.

It's strictly related to absorption spectroscopy where a sample absorbs part of the incoming radiation and releases it exclusively as heat.

In fluorescence spectroscopy we can measure the intensity of the emitted radiation and correlate it to the concentration of the analyte.

Compared to the absorbance spectroscopy the technique presents a greater selectivity and sensitivity, since only fluorescent compounds are detected.

The light beam from an LED source in the UV region irradiate the sample. Some photons get absorbd by the substances in the sample and re-emitted as a polychromatic radiation (photons with different wavelengths). A second filter selects a target wavelength and its intensity is measured by a detector and correlated to the analite concentration. The light emitted by the sample is diffused in every direction therefore the detector is placed at an angle to avoid interference with the incident light.

3 - INSTALLATION

3.1 Opening the package

For safety reasons, when removing the packaging of the equipment, please check for any visible defects and, if necessary, inform the supplier.

Parts inside the package apart from the user manual:

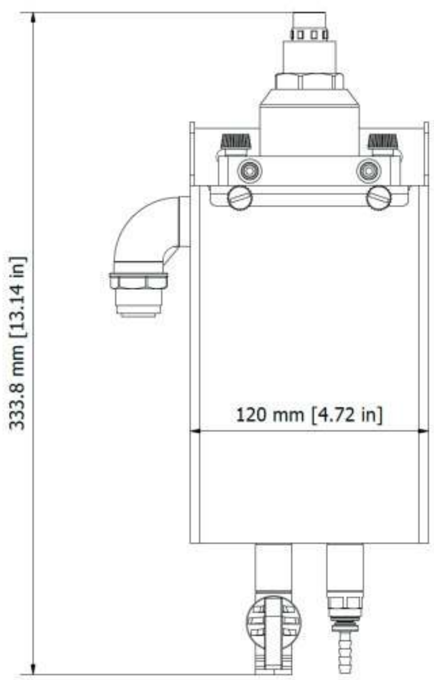
A	3S-OIW Fluorescence sensor refined oil / PAH / BTEX
B	Probe cable (6 m)

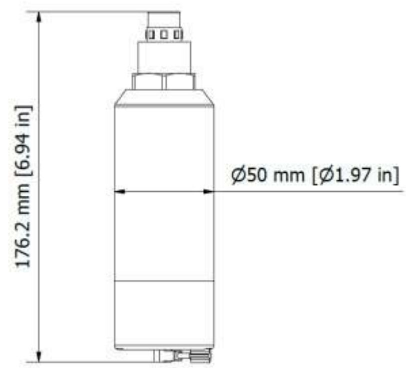
3.2 Product code

The product code is an alphanumeric code that identify your 3S Analyzers product and its configuration. For the 3S fluorescence sensor the code is the following:

3S-OIW

3.3 Wall mounting dimensions

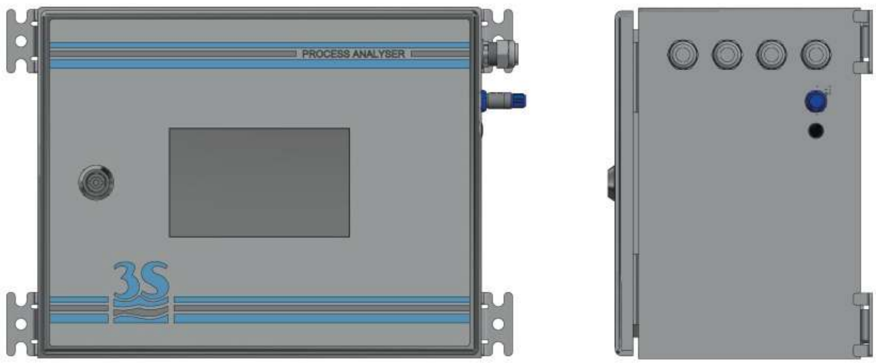


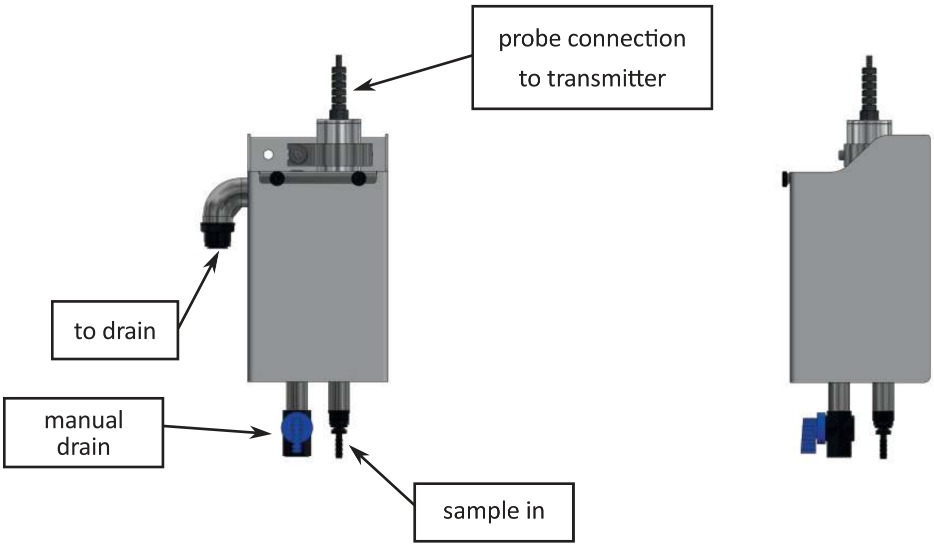


Recirculating sample reservoir cod. A46U10020 is included in the scheme as a reference, has to be purchased separately.

3.4 Mounting the instrument (example with 3S-PC1000)

The 3S-PC1000 controller and the sample reservoir must be mounted vertically on a wall or support suitable for their weight and not subject to vibrations. Use suitable screws (not included in the supply) and fasten them only on the side brackets (ear clips) of the instrument and in the holes of the tank metal plate. Mount them so as to get the display at eye height (160 cm, 63 in).
Since the probe connections and flow sensor connectors are on the right side of the analyzer, install sample reservoir underneath the analyzer, in a way that is reachable from the right side. Please, also consider that the surrounding space must allow easy opening of the analyzer door and easy access to the sample reservoir for cleaning or mantainance.
A minimum distance of 10 cm is required between the sides of the instrument and any other obstacle.





The sample reservoir (cod. A46U10020) can be mounted preferably under the instrument. The sample line must be connected to the inlet below the container, optionally a flow sensor can be installed on the same line to detect the presence of the sample.
The reservoir has a side arm to drain the excess liquid and to maintain a constant sample flow. The side arm must be connected to the drain.
When the container is installed in a proper position the probe can be inserted into its slot and secured with the clamp.
Finally, attach the probe connector to the analyzer.

3.5 Probe connection to the data acquisition system

To connect the probe to the data acquisition system (3S-PC1000, not supplied with the probe or other controller), proceed as follows:

- Connect the wires from the probe extension cord according to the following table:

Red	Black	White	Green
5-12 VDC	GND	RS485 D-	RS485 D+

- Connect the connector of the extension cord to the probe (probe must be already correctly installed in its final position).

- Turn on the controller

3.6 ModBUS connection parameters

The probe has a ModBUS RTU interface for the transmission of measurement data and settings read/write. Connect your data line to the D+/D- wires as described in the previous paragraph.
Configure your network using the following parameters:

Protocol	ModBUS RTU
Baudrate	9600
Node number	1
Byte order	Little endian
Word order	Little endian

3.7 ModBUS commands

Get node number

Use this command to read the device current node number. Use fixed device address 0x255 to communicate with an unknown device address.

Command: Read Register (0x03)
Address: 0x3000
Data length: 1
Data format: u16

Set node number

Set a new device ModBUS node number.

Command: Write Register (0x10)
Address: 0x3000
Data length: 1
Data format: u16

Get serial number

Get the serial number of the sensor as a string of charachters.

Command: Read Register (0x03)
Address: 0x0900
Data length: 7
Data format: char[14]

Get hardware and software versions

Get the hardware and software versions of the sensor.

Command: Read Register (0x03)
Address: 0x0700
Data length: 2
Data format: hw_version: u16, sw_version: u16

Start measurements

This command turns the UV source on and starts the measurement routine of the sensor.

Command: Read Register (0x03)
Address: 0x2500
Data length: 1
Data format: ignore

Get temperature

Get the temperature value measured by the probe.

Command: Read Register (0x03)
Address: 0x2600
Data length: 2
Data format: f32

Get signal value

Get the signal (OIW) value measured by the probe.

Command: Read Register (0x03)
Address: 0x2602
Data length: 2
Data format: f32

Get brush error

Read the probe error register. If equal 0xFF the brush is in the wrong position and measurements stop.

Command: Read Register (0x03)
Address: 0x2604
Data length: 1
Data format: u16 (0x00 = OK, 0xFF = error)

Stop measurements

Stop the measuring routine.

Command: Read Register (0x03)
Address: 0x2E00
Data length: 1
Data format: ignore

Get calibration factors

Get the span and offset values as an array of two floats.

Command: Read Register (0x03)
Address: 0x1100
Data length: 4
Data format: span: f32, offset: f32

Set calibration factors

Set the new calibration factors, span and offset.

Command: Write Register (0x10)
Address: 0x1100
Data length: 4
Data format: span: f32, offset: f32

Activate brush

Make the brush rotate once.

Command: Write Register (0x10)
Address: 0x3100
Data length: 0
Data format: ignore

Get brush interval

Get the interval between brush cleaning operation.

Command: Read Register (0x03)
Address: 0x3200
Data length: 1
Data format: u16

Set brush interval

Set the interval between brush cleaning operation.

Command: Write Register (0x10)
Address: 0x3200
Data length: 1
Data format: u16

Get brush mode

Read the current brush mode, automatic or manual.

Command: Read Register (0x03)
Address: 0x1b00
Data length: 1
Data format: u16 (0x00 = MANUAL, 0x01 = AUTO)

Set brush mode

Set the current brush mode as automatic or manual.

Command: Write Register (0x10)
Address: 0x1b00
Data length: 1
Data format: u16 (0x00 = MANUAL, 0x01 = AUTO)

4 - CALIBRATION

4.1 About the method

The probes are calibrated using standard solutions which are analyzed in the same way as the sample.
In order to ensure correct measurement performance, the probes should be calibrated periodically, best results are obtained if they have been recently cleaned and serviced.
Due to the nature of some analtycal methods the concentration/signal plot is not linear in the whole range of our interest. Therefore the analyzer uses a multi-point calibration curve. The first point is the blank (zero), which is usually done by analyzing demineralized water. A part from the blank, other points are needed for the calibration curve, covering the whole range of interest.
The probe can be calibrated internally (via the ModBUS interface) or externally (via the controller).

4.2 Internal calibration

The probe has the possibility to store blank and slope values. If a linear calibration is enough, the probe can be calibrated internally via the ModBUS interface (see section 3.7).
After collecting the values for blank and span, trace a calibration curve and take note of offset and slope values. Overwrite the corresponding registers to calibrate the probe.
The new values transmitted by the probe will use the new calibration curve.

4.3 External calibration

If a non-linear calibration curve or deeper data analysis are needed, the probe can be calibrated using an external controller.
In this case the logic must be implemented in the controller. The 3S-PC1000 controller is able to manage two probes with independent calibration curves, up to five points each.
Please refer to the 3S-PC1000 or other controller user manual for the instructions to perform a multi-point calibration with the 3S-OIW probe.

4.4 Blank calibration

The blank calibration is simply performed by analyzing demineralized water. The blank calibration is particularly sensitive to impurities so is advisable to thoroughly clean the probe before starting the calibration.
To perform a blank calibration, submerge the probe in pure water. If the result is stable, take note of it.

4.5 Span calibration

The instructions shows a multi-point calibration. Single-point calibration is performed in the same way.
Some probes require a non-linear calibration. In that case we need to make measurements at different concentrations to draw the calibration curve. If the probe response is linear only one point is necessary.
As an example the next paragraph describes a 5-point calibration of an oil-in-water probe using the oil of interest as standard.

Since different substances can have very different response, it is recommended to calibrate the analyzer using the specific oil we want to monitor. Also, to minimize matrix effects, it is important to dilute the oil in the same water present at the installation site.
To perform a multi-point calibration, proceed as follow:

Chemicals

- Isopropanol
- A sample of oil we have to detect

Instrumentation

- A 1000 uL automatic pipette
- 2 L glass beacker
- 10 mL volumetric flask
- 1000 mL measuring cylinder
- Magnetic stirrer

Stock solution

Prepare a stock solution (10000 ppm) of the oil. Take 100 uL of oil using the pipette and insert it into the 10 mL volumetric flask, fill the flask with isopropanol upto the flask mark.

Blank

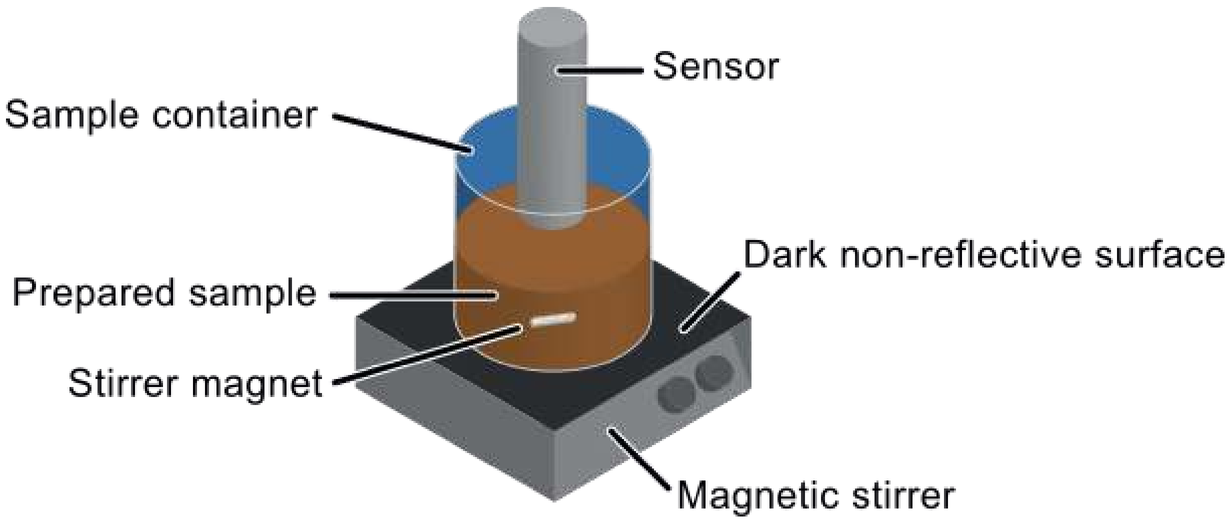
The blank is measured using the an oil-free water, as similar as possible to the water that we will found on the site of the application. If such water is not available, use tap water. The blank is the first point of our calibration curve.

Standard

We need other four points in addition to the blank. The four points must be equal to 25%, 50%, 75% and 100% of the full scale. The easiast procedure is to operate with the method of the standard additions, in this way you don't have to prepare all the calibration solution beforehand. We will start with a water sample and adding small aliquote of analite to it, increasing its concentration for each point measured.

Procedure

The instrument can be easily calibrated using the method of the standard additions.
Fill the 2 L beaker with 800 mL of the blank water and place it on the magnetic stirrer, add the magnetic bar.
Clean the probe with a clean cloth and a drop of isopropanol. Place the probe into the beacker, dipped 2-3 cm into the solution, at least 5 cm from the container walls. You can use a stand to help the probe stay in position. Make sure no air bubbles are trapped below the sensor. Be also sure to place a dark, non reflective sheet on the stirrer plate, under the beaker.
Turn on the stirrer at 500 rpm and wait at least 90 seconds for the sensor to give a stable reading. Take note of the sensor reading, this is your blank.
Now, using the micropipette take the amount of stock solution that, diluted in 800 mL of water gives the concentration of the first point. For example, if you want to prepare a 5 ppm solution take 400 uL of stock solution and add it to the 800 mL of water you have in the beaker. After waiting at least 90 seconds, take note of the sensor response, this is your first point. For the other points, continue to add amount of stock solution to the same beaker, keeping it well stirred. For each point check the sensor voltage response and take note of it.



The following table will give you an example of four points made with this technique.

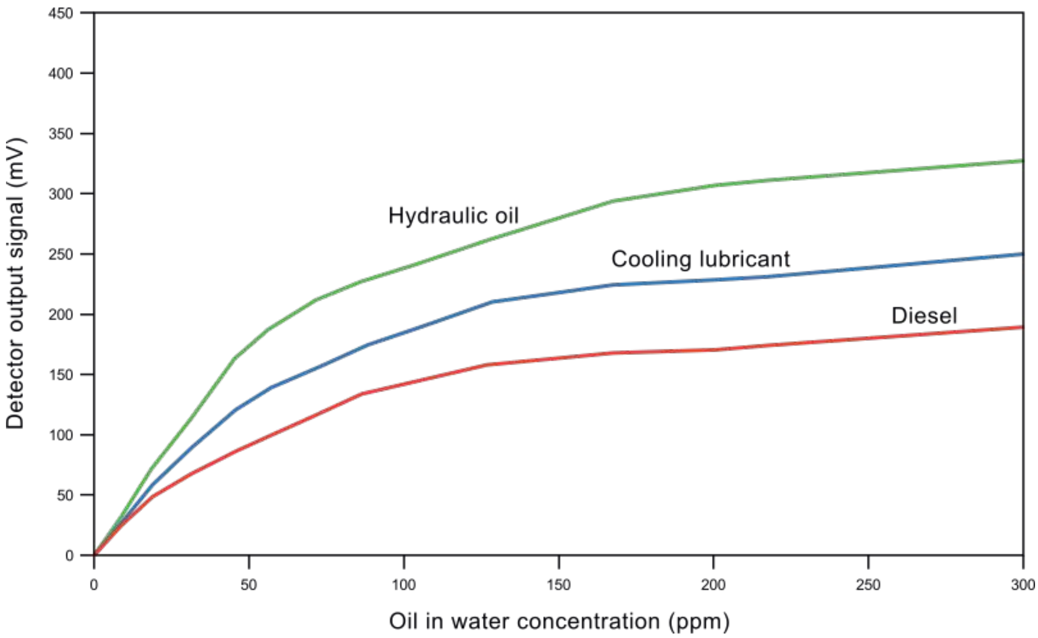
Total concentration (ppm)	Volume addition (uL)	Total volume (mL)
0	0	800
5	400	800
10	400	801
15	400	801
25	800	802

The total volume change after each addition is not significant, thus the volume variation can be ommitted.

4.6 Process cal

Different substances can have different response factors, therefore you should expect your calibration curves to be dependent on the substance you use for the calibration.
For this reason it is recommended to choose a calibration standard which is as similar as possible to the compound of interest. Your target compound itself is of course the best standard choice.
In many cases though, it is more convenient to use a common standard to calibrate the instrument on site and then align the results with laboratory data.
This can be done with process calibrations. The process calibration applies a scale factor to the measurement to align it to the value of the actual sample.
The process calibration can be performed through the following steps:

1. Take a sample representative of the water stream to be analyzed, at least 1 liter. Follow good sampling techniques to have reliable results.
2. Determine the concentration of the analite of interest using a reference instrument or a laboratory analysis of the sample .
3. Submerge the probe in the sample and wait for a stable result.
4. Calculate a multiplication factor and apply it to the calibration factor. Recalibrate the probe with the new calibration factor, either internally or externally.
5. The calibration is now over, the following measurements will be calculated with the new process factor.


Detector output signal (mV)
450
400
350
300
250
200
150
100
50
0
0
50
100
150
200
250
300
Oil in water concentration (ppm)
Hydraulic oil
Cooling lubricant
Diesel