Technical Information

Turbimax CUS51D

Sensor for turbidity and solids content
Installation and immersion sensor for low, middle and high turbidity and solids concentrations

Application

Turbimax CUS51D is a sensor for all applications of wastewater treatment.
- Turbidity measurement in the outlet
- Suspended solids in the activated sludge basin and in the recirculation
- Suspended solids in the sludge treatment

Your benefits

- All sensor principles (90°, 135° and four-beam pulsed light) are included in the sensor head and allow optimal adaption to the measurement task.
- The sensor is factory-calibrated (basis formazine, FNU). All selectable applications (e.g. activated sludge) are precalibrated and allow quick and easy commissioning.
- Standardized communication (Memosens technology) allows "plug and play".
- Intelligent sensor – all characteristics and calibration values are stored in the sensor.
- Calibrations provided by the customer with up to 5 points – realizable in lab or on site.
**Function and system design**

**Measuring principle**

**Turbidity measurement**

For turbidity measurement a light beam is sent through the medium and is diverted from its original direction by optically denser particles, e.g. solid matter particles. This process is also called scattering.

![Deflection of the light](image)

The impinging light will be scattered in different angles. Two angles are of interest in this matter:

- The scattered light in the 90° direction is less influenced by the size of the particles.
- The scattered light in the 135° direction gives enough information also at a high number of particles.

![Principle operating mode of the turbidity sensor](image)
If only a small number of particles is in the medium, most of the light will be scattered to the 90° channel and less light will be scattered to the 135° channel. When the number of particles increases the relationship will change (more light scattered to the 135° channel, less light scattered to the 90° channel).

The turbidity sensor CUS51D is equipped with two independent sensor units that are arranged in parallel. The application-specific analysis of both signals results in stable measured values.

This allows the optimal turbidity and suspended solids measurement:
- For low turbidity values preferably the 90° channel is used.
- For average and high turbidity values and for suspended solids measurement the 135° channel is used.
- The dual sensor technology allows operation with a large range of soiling compensation, e.g. suspended solids measurement in the activated sludge basin (basis: four-beam pulsed light).

The measuring principle depends on the application and is automatically selected by the sensor.
Measurement methods

Four-beam pulsed light method
The method is based on two light sources and four light receivers. Long-life LEDs are used as monochromatic light sources. To eliminate interference from extraneous light sources, these LEDs are pulsed.
Two measuring signals are detected at the four light receivers. The eight measuring signals are processed in the sensor and are converted into turbidity units and solids concentrations.
The four-beam pulsed light method compensates the sensor soiling as well as the wearing of the optical components.
The number of the used signals depends on the application.

90° scattered light method
The measurement uses a wavelength of 860 nm like described in ISO 7027 / EN 27027.
The transmitted light beam is scattered by the solid matter particles in the medium. The scattered beams are detected by scattered light receivers which are arranged at an angle of 90° to the light sources. The turbidity of the medium is determined by the amount of the scattered light.
**135° backscattered light method**

The transmitted light beam is scattered by the solid matter particles in the medium. The backscattered beams are detected by scattered light receivers, which are arranged next to the light sources. The turbidity of the medium is determined by the amount of backscattered light. This method is used to measure high turbidity values.

\[ I_s = I_0 \cdot C \cdot A \cdot f(\alpha) \]

- **I\textsubscript{0}** = Intensity of transmitted light
- **I\textsubscript{s}** = Intensity of backscattered light
- **A** = Geometric factor
- **C** = Concentration
- **P** = Particle
- **f(\alpha)** = Angle dependence

**Sensor monitoring**

The optical signals are continuously monitored and checked for plausibility. Discrepancies are reported via error messages by the transmitter.

The sensor check system of the Liquiline M reports the following failure conditions:

- Implausible high or low measuring values
- Disturbed controlling due to erroneous measuring values
Measuring system

A complete measuring system comprises:
- Turbidity sensor Turbimax CUS51D
- Transmitter Liquiline
- Assembly:
  - Assembly Flexdip CYA112 and holder system Flexdip CYH112 or
  - Retractable assembly, e.g., Cleanfit CUA451

Measuring system with immersion assembly (example)

1  Holder system Flexdip CYH112
2  Transmitter Liquiline
3  Weather protection roof
4  Assembly Flexdip CYA112
5  Turbidity sensor Turbimax CUS51D
Measuring system with immersion assembly (example)

1 Transmitter Liquiline
2 Weather protection roof
3 Holder system Flexdip CYH112
4 Assembly Flexdip CYA112
5 Turbidity sensor Turbimax CUS51D

Measuring system with retractable assembly (example)

1 Turbidity sensor Turbimax CUS51D
2 Transmitter Liquiline
3 Retractable assembly Cleanfit CUA451
4 Flow direction
**Input**

<table>
<thead>
<tr>
<th>Measuring variables</th>
<th>Turbidity</th>
<th>Solids content</th>
</tr>
</thead>
</table>

| Measuring range     | CUS51D-**C1 | Turbidity       | 0 to 9999 FNU  |
|                     | CUS51D-**D1 | Turbidity       | 0 to 9999 FNU  |
|                     |            | Solids content  | 0 to 150 g/l   |
|                     |            |                 | 0 to 15 %      |

**Power supply**

The sensor will be connected to the transmitter as follows:

- With the M12 plug (version CUS51D-xxxxBxxx) or
- the fixed cable has to be connected to the terminal as follows (version CUS51D-xxxxAxxx):

![Sensor connection](image)

The maximum cable length is 100 m (328 ft).
Performance characteristics

Maximum measured error  
< 2 % of the measured value or 0.1 FNU (the respectively larger value is valid)

Wavelength  
860 ± 30 nm

Factory calibration  
FNU, FTU and solids concentration according to the application table  
Standard: 3 points

Applications  
The sensor is factory calibrated in the application "formazine" with the unit FNU. Further precalibrated applications are optimized for the corresponding medium. The calibration can be performed up to 5 points.

<table>
<thead>
<tr>
<th>Application</th>
<th>Recommended working ranges</th>
</tr>
</thead>
<tbody>
<tr>
<td>Factory calibration formazine</td>
<td>0 to 4000 FNU</td>
</tr>
<tr>
<td>Application activated sludge</td>
<td>0 to 15 g/l</td>
</tr>
<tr>
<td>Application digested sludge</td>
<td>3 to 100 g/l</td>
</tr>
<tr>
<td>Application primary sludge</td>
<td>3 to 50 g/l</td>
</tr>
<tr>
<td>Model titanium dioxide</td>
<td>0 to 150 g/l</td>
</tr>
<tr>
<td>Model kaolin</td>
<td>0 to 5 g/l</td>
</tr>
<tr>
<td>Model return sludge</td>
<td>0 to 50 g/l</td>
</tr>
</tbody>
</table>
Installation conditions

Mounting applications:
- with retractable assembly Cleanfit W CUA451
- with wastewater assembly Flexdip CYA112 and holder system Flexdip CYH112
- with flow assembly Flowfit W CUA250

Arrow 1 shows the flow direction.
The installation angle $\alpha$ must not exceed 90°.
The recommended installation angle is 90°.
The optical windows of the sensor have to be aligned parallel to the flow direction ($\alpha = 90°$) or face the flow direction ($\alpha < 90°$).
For manual insertion/retraction of the assembly the medium pressure may not exceed 2 bar (29 psi).

The arrow shows the flow direction.
The installation angle is 45° (recommended) or 90°.
If you use the sensor in open basins, install the sensor in a way no bubbles can build up around the optical windows.

The installation angle is 90°.
Pipe installation

The following figure illustrates various installation positions in pipes and indicates whether they are permitted or not.

- The pipeline diameter must be at least 100 mm (4") if reflective materials (e.g. stainless steel) are used. An onsite calibration is recommended.
- Install the sensor in places with uniform flow conditions.
- The best installation location is in the ascending pipe (it. 1). Installation is also possible in the horizontal pipe (it. 5).
- Do not install the sensor in places where air may collect or foam bubbles form (it. 3) or where suspended particles may settle (it. 2).
- Avoid installation in the down pipe (it. 4).
- Turbidity measurement < 200 FNU should not be performed in pipes.
- Avoid installations behind pressure reduction steps which can outgas.

Environment

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambient temperature</td>
<td>-20 to 60 °C (-4 to 140 °F)</td>
</tr>
<tr>
<td>Storage temperature</td>
<td>-20 to 70 °C (-4 to 158 °F)</td>
</tr>
<tr>
<td>Ingress protection</td>
<td>IP 68 (1 m (3.3 ft) water column during 60 days, 1 mol/l KCl)</td>
</tr>
</tbody>
</table>

Process

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Process temperature</td>
<td>-5 to 50 °C (23 to 120 °F) max. 80 °C (175 °F) short term (1 h)</td>
</tr>
<tr>
<td>Process pressure</td>
<td>0.5 to 10 bar (7 to 145 psi) absolute</td>
</tr>
</tbody>
</table>
| Minimum flow               | No minimum flow required. Make sure that there is a sufficient turbulence for solids with a tendency to sedimentation.
Mechanical construction

Dimensions

Cleaning system

Cleaning system with pressurized air
Consumption: 50 l/min (13.2 gal/min)
Primary pressure: 1.5 to 2 bar (22 to 30 psi)
Connection: 6/8 mm or 6.35 mm (¼")

Weight
approx. 0.7 kg (1.5 lbs) without cable

Materials
Sensor
Optical windows
O-rings
Stainless steel 1.4404 (AISI 316 L)
Sapphire
EPDM

Process connections
G1 and NPT ¾"
Certificates and approvals

EMC compatibility

Ordering information

<table>
<thead>
<tr>
<th>Product structure</th>
<th>Approval</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>AA</td>
</tr>
<tr>
<td></td>
<td>Non-hazardous area</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Application, measuring range</th>
</tr>
</thead>
<tbody>
<tr>
<td>C1 Process water</td>
</tr>
<tr>
<td>D1 Process water; solids</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Adaption cable</th>
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</thead>
<tbody>
<tr>
<td>A Fixed cable, crimp sleeves</td>
</tr>
<tr>
<td>B Fixed cable, M12-plug</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cable length</th>
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</thead>
<tbody>
<tr>
<td>2 3 m (9.9 ft)</td>
</tr>
<tr>
<td>3 7 m (23 ft)</td>
</tr>
<tr>
<td>4 15 m (49.2 ft)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CUS51D- order code</th>
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<table>
<thead>
<tr>
<th>Accessories code</th>
<th>Accessories mounted</th>
</tr>
</thead>
<tbody>
<tr>
<td>IA</td>
<td>Air cleaning, 6/8 mm</td>
</tr>
<tr>
<td>IB</td>
<td>Air cleaning, 6.35 mm (1/4&quot;)</td>
</tr>
</tbody>
</table>

Note!
To complete your order code, simply add the accessories code to the end of order code. If you have any questions, please contact your local sales office.

Scope of delivery
The scope of delivery comprises:
- 1 sensor Turbimax CUS51D in the ordered version
- 1 Operating Instructions BA461C/07/en
**Accessories**

**Assemblies**
- Retractable assembly Cleanfit CUA451
  - retractable assembly with ball valve; for turbidity sensors; material: stainless steel
  - ordering acc. to product structure (Technical Information TI369C/07/en)
- Wastewater assembly Flexdip CYA112
  - Modular assembly system for sensors in open basins, channels and tanks
  - Versions in stainless steel or PVC
  - Ordering acc. to product structure (Technical Information TI432C/07/en)
- Flow assembly Flowfit CUA250
  - for CUS31/CUS41/CUS51D
  - ordering acc. to product structure (Technical Information TI096C/07/en)

**Holder system**
- Holder system Flexdip CYH112 for water and wastewater assembly Flexdip CYA112
  - Modular holder system for sensors and assemblies in open basins, channels and tanks
  - The holder system CYH112 works for nearly any type of fixing – fixing on the floor, wall or directly on a rail.
  - Material: stainless steel
  - Ordering acc. to product structure (Technical Information TI430C/07/en)

**Cleaning system**
- Cleaning system with pressurized air
  - Connection: 6/8 mm or 6.35 mm (⅛”)
  - Materials: POM/V4A
  - 6/8 mm order number: 71110782
  - 6.35 mm (⅛”) order number: 71110783

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**Cleaning system**

<table>
<thead>
<tr>
<th></th>
<th>Version</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>6 mm</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>0.35 mm</td>
<td></td>
</tr>
</tbody>
</table>

**Compressor**
- For cleaning system
- 230 V AC order number: 71072583
- 115 V AC order number: 71096199
Transmitter

Liquiline CM44x
- Multiple-channel transmitter for the connection of digital sensors with Memosens technology
- Power supply: 85 to 265 V AC, 18 to 36 V DC or 20 to 28 V AC (not CM448)
- Universally upgradeable
- SD card slot
- Alarm relay
- IP 66
- Ordering acc. to product structure (Technical Information TI444C/07/en)