



Optical or Acoustic Process measurement of liquids

- **Turbidity**
- **Colour**
- **Oil in Water**
- **Water in Oil**
- **Oil on Water**

12° forward scatter light Turbidity Measurement

What does turbidity mean?

Turbidity is an optical impression, which describes the characteristic of a transparent product, to scatter light. A focused light beam will be attenuated and scattered in hazy products, so that this product can become practically opaque in bigger layers.

What causes turbidity?

Turbidity is caused by particles in transparent products. A particle is defined as something with a different refractive index as the carrier product. Some examples of particles are minerals, yeast cells, metals, oil drops in water, milk in water, gas bubbles and aerosoles.

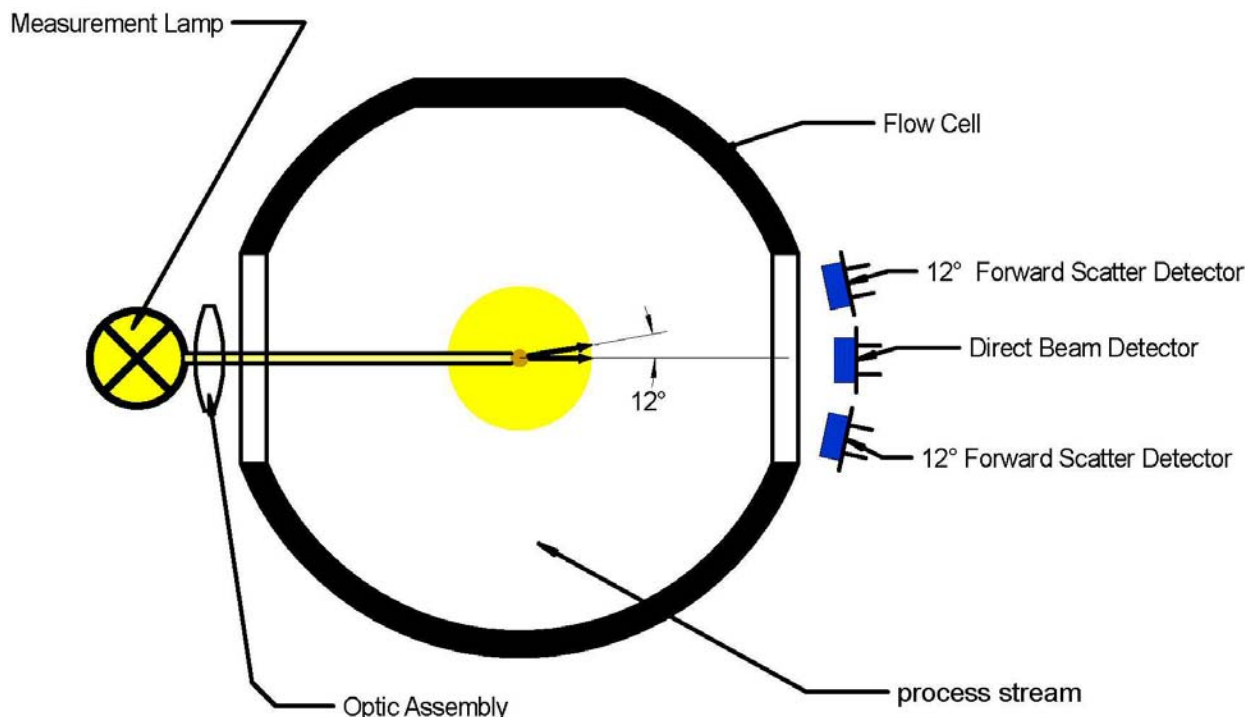
Measurement of turbidity

Turbidity is not a clearly defined magnitude like e.g. temperature or pressure. Turbidity is a subjective impression. For this reason turbidity measurement systems will be typically calibrated by using a comparison's standard such as Formacine and Diatomatious Earth.

Measurement method

The 12° forward scattered light turbidity measurement method:

- Forward scattering (12°) The position of the detector is 12° shifted to the axis of light beam



An intense collimated beam of light is projected through a sample contained within the sensor. The intensity of this light beam is measured by the direct beam detector, located opposite to the light source. The light, scattered by particles inside the sample is measured by a scatter light detector. Depending on sensor specification, this detector is located 12°, displaced from the direct light axis. The signals caused by scattered and direct light will be amplified and processed by the electronics. The results displayed, is the turbidity value.

$$\frac{\text{Scattered light signal}}{\text{Direct light signal}} = \text{Turbidity}$$

The particles inside the liquid flow decrease the intensity of direct light, and increase the intensity of the scattered light, i. e. the turbidity rises. Colour decreases the intensity of direct and scattered light in same ratio i. e. the turbidity value is constant. Lamp ageing and window coatings are compensated as well by this ratio.

Very Important:

When comparing measurement results. The same methods must be compared to one another. For example, 90° vs. 90°, 12° vs. 12°. Never 90° vs. 12°.

The measurement methods will respond different, depending on current particle distribution inside the actual sample.

12° forward scatter light:

The forward scatter method is a mass related measurement principle which will allow calibration in mg/l if necessary.

A big particle in the measured product will cause a high measurement signal and a small particle in the measured product will cause a low measurement signal.

Typical applications:

- Oil in Water
- Oil in Condensate
- Filtration control
- Product Turbidity
- ...

Typical Measurement units

ppm: P arts p er m illion	FNU ¹ : F ormacine n ephelometric u nit
FTU: F ormacine T urbidity U nit	mg/l: M illigram per liter
TEF: T rübungseinheiten F ormazin (German for FTU)	gr/l: G ram per liter
EBC: E uropean b rewery c onvention	% TS: P ercent total solids
NTU ¹ : N ephelometric t urbidity u nit	

The dependencies on the different measurement units

1 FTU = 1 TEF = 1 NTU¹ = 1 FNU¹ = 0,25 EBC

¹Nephelometry describes the method of side scatter turbidity measurements, these units are used at 90° side scatter turbidimeters only.

Based on comparisons measurements, by using a 12° forward measurement system we have found the following dependencies.

1 FTU = 1 TEF = 0,25 EBC = 2,05ppm = 2,05 mg/l = 0,00205 g/l = 0,0000205 % TS

* At a specific particle weight of 1 kg/dm, 1mg/l particles in 1 kg of water will correspond to 1 ppm.

Typical ranges

The original design of scatter light turbidimeter was used for the detection of low turbidities. The resolution of these instruments is suited easily in ranges lower as 0.1 ppm (approx. 0.05 TEF / FTU / FNU / NTU or approx. 0.01 EBC) and better. The maximum range is in ideal case lower as 200 ppm, but there are as well systems available with a range of more as 8000 ppm.