

Standardized Guidelines and valuable Information regarding Turbidity measurement

Turbidity measuring is an important parameter for the quality assessment of liquids. Different standardized guidelines are published to guarantee the comparability of the measured turbidity values within the brew and water industry. There are only some company-, user- or application specific standard measurement procedures common in other industries, but the measurement method is typically selected in accordance to the specific requirements of the various applications.

[Turbidity measurement according to DIN/EN](#)

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DIN/EN 27027 (ISO 7027)

International Organization for Standardization: [ISO homepage](#)

Deutsches Institut für Normung E. V. (German Institute for standardization): [DIN/EN homepage](#)

The standardization work DIN supports the economical goal of a Common Market in Europe as well as a global market, free of technical obstacles. This requires an European and an international standardization. The European standardization is accomplished by three organizations CEN (Comité Européen de Normalisation), CENELEC (Comité Européen de Normalisation Electrotechnique) and ETSI (European Telecommunications Standards Institute). The national member organizations co-ordinate the European standards and implement these. The standardization organizations have - excluded ETSI - for each country only one member, who has to represent the entire interests of standardization of his country. The vote of the members during an election depends by the economic power of their nation. The German interests are represented by DIN (German Institute for standardization).

CEN [homepage](#)

CENELEC [homepage](#)

ETSI [homepage](#)

The DIN EN 27027 is the standard for turbidity measurement of potable water in Europe.

Turbidity measurement according EN 27027

Turbidities lower than 40 FNU	
Principle of measurement:	ratio measurement: scatter light/transmission
Measurement angle:	90° ±2,5°
Beam dimension:	0° with maximum 1,5° convergence
Measurement wavelength:	860nm / tolerance +30nm
Calibration standard:	Formazin
Turbidities higher than 40 FNU (see chapter " direct light turbidity " at the end of this page)	
Principle of measurement:	Absorption (direct light measurement)
Measurement angle:	180°
Beam dimension:	0° with maximum 1,5° convergence
Measurement wavelength:	860nm / tolerance +30nm
Calibration standard:	Formazin

EPA

Environmental Protection Agency [EPA homepage](#)

The US Environmental Protection Agency is an organization of the government of the United States, with the responsibility to coordinate and observe the protection of the environment and the protection of the human health. The EPA was founded under president Nixon on 2 December 1970. Seat of the organization is Washington, D.C. The administrator of the EPA is Stephen L. Johnson, its representative is Marcus Peacock. The organization counts currently approximately 17,000 employees.

One of the major areas of responsibility is to accomplish the environmental laws. The Office OF Criminal Enforcement, Forensics and training, shortened OCEFT, has its own execution and determination authority since 1982. It received the full police authorization in 1988. ([OCEFT homepage](#))

The US EPA standard for turbidity measurement of potable water is different from the standard of the ISO/EN/ or DIN.

Turbidity measurement according US EPA standard.

Principle of measurement:	ratio measurement: scatter light/transmission
Measurement angle:	90° (no tolerance specified)
Beam dimension:	not specified
Measurement wavelength:	full spectrum of a tungsten lamp
Calibration standard:	Formazin

MEBAK

Mitteuropäische Brautechnische Analysenkommission

Central European brew-technical analysis commission [MEBAK homepage](#)

The MEBAK members are mainly the national and private brew-technical institutes of Germany, Austria, Czech Republic and Switzerland as well as the national breweries and their suppliers.

The purpose of the association is the development of basic procedures to guarantee the quality of raw materials, intermediate, secondary and finished products as well as in the development of tools and equipment preferably used for malt- or beer production.

The MEBAK published a five volume edition of brew-technical analysis methods, which are internationally established and used as teaching material for the education and training of the brewers in institutes like technical university Munich Weihenstephan, Doemens institute or Charles University in Prague.

Stability of beer (90° Side scatter)

Recommendation acc. brew-technical analysis methods volume II 2.15.1.2

Principle of measurement:	ratio measurement: scatter light/transmission
Measurement angle:	90° +2,5°
Beam dimension:	0° with maximum +-1,5° tolerance
Measurement wavelength:	650nm / tolerance +-30nm
Calibration standard:	Formazin / alternative: AEPA- turbidity standard (Styrene Divinylbenzol)

Filtration control (forward scatter)

(in addition to the above specified 90° measuring angle)

Principle of measurement:	ratio measurement: scatter light/transmission
Measurement angle:	11° - 25°
Beam dimension:	not specified
Measurement wavelength:	not specified
Calibration standard:	Formazin

Lauter wort (forward scatter)

Recommendation acc. brew-technical analysis methods volume II 1.3

Principle of measurement:	ratio measurement: scatter light/transmission
Measurement angle:	11° - 25°
Beam dimension:	not specified
Measurement wavelength:	not specified
Calibration standard:	Formazin

EBC

European Brewery Convention [EBC homepage](#)

The European Brewery Convention was founded in 1947 and supports the brew-scientific activities in Europe. The goal of the EBC is, the development of analytic methods to guarantee beer quality and to ensure a continuously high quality of raw materials and brewing procedures. Parameter like turbidity, color and the bitter value of beer are measured in EBC units. The current technology and engineering forum has been founded in 1990 by the EBC, with the task to develop simple technical procedures to optimize production and quality management in malt-houses and breweries. The successful work has caused the standardisation of many processes as well as the optimization of the hygienic design of process equipment and therefore a rising product quality.

Stability of beer (90° Side scatter)	
Principle of measurement:	ratio measurement: scatter light/transmission
Measurement angle:	90° (no tolerance specified)
Beam dimension:	not specified
Measurement wavelength:	not specified
Calibration standard:	Formazin / alternative: AEPA- turbidity standard (Styrol-Divinylbenzol)
Filtration control (forward scatter) (in addition to the above specified 90° measuring angle)	
Principle of measurement:	ratio measurement: scatter light/transmission
Measurement angle:	11° - 13°
Beam dimension:	not specified
Measurement wavelength:	not specified
Calibration standard:	Formazin / alternative: AEPA- Standard (Styrol-Divinylbenzol)

ASBC

American Society of Brewing Chemists [ASBC homepage](#)

The ASBC publishes like the EBC standard procedures to ensure quality of raw materials, brewing procedures and beer. The ASBC turbidity unit is not common in Europe and has been replaced partially as well in the USA by the EBC turbidity unit.

Principle of measurement:	not specified
Measurement angle:	not specified
Beam dimension:	not specified
Measurement wavelength:	580nm (no tolerance specified)
Calibration standard:	Formazin / measuring unit ASBC ¹

¹ conversion rate: 69 ASBC = 1 EBC

IOB

Institut of Brewing & Distilling [IOB homepage](#)

The Institute of Brewing & Distilling (IOB or IBD) is an organization engaged in the education of brewers and distillers. The IOB recommends as well as EBC and ASBC guidelines for turbidity measurement instruments, which agree with the EBC guidelines.

Principle of measurement:	ratio measurement: scatter light/transmission
Measurement angle:	90° (no tolerance specified)
Beam dimension:	not specified
Measurement wavelength:	not specified
Calibration standard:	Formazin / alternativ: AEPA- turbidity standard (Styrol-Divinylbenzol)

Filtration control (forward scatter) (in addition to the above specified 90° measuring angle)

Principle of measurement:	ratio measurement: scatter light/transmission
Measurement angle:	11° - 13°
Beam dimension:	not specified
Measurement wavelength:	not specified
Calibration standard:	Formazin / alternative: AEPA- turbidity standard (Styrol-Divinylbenzol)

Formazin

Formazin is a poisonous chemical substance!

Please take notice to the [safety instructions](#) before handling Formazin.

Formazin is an aqueous suspension of an insoluble polymer and results from the reaction between a Hydraziniumsulfate and a Hexamethylentetramine. The median particle size of Formazin is 1,5 µm and the standard deviation of size is 0,6 µm.

A 1000 EBC / 4000 FTU Formazin suspension is recommended to make calibration standards for turbidimeters. The 1000 EBC / 4000 FTU suspension has a better shelf-life of up to 6 months compared to lower concentrations. In case you follow EN27027 (ISO 7027) you have to use a 400 TEF suspension to prepare your calibration standards*.

The stability of the Formazin suspension depends on the storage conditions. Formazin should be stored in darkness at a temperature of 8°C - 10°C to guarantee maximum stability.

The suspension has to be shaken carefully for at least 3 minutes before use. After shaking you have to wait for approximately 15 minutes to allow a degassing of the suspension. Then you have to stir the suspension carefully for homogenisation. Make sure that no air bubbles occur during stirring of the suspension. Now you can make calibration standards with turbidities lower than 1000 EBC / 4000 FTU by diluting the suspension.

Please take notice:

- It is very difficult to prepare calibration standards lower than 0,5 EBC, this standards will be typically made by using specially distilled and filtered water and a high precision scale.
- The diluted calibration standards are substantially less stable than the 1000 EBC suspension. They should be prepared and used immediately at the same day*.
- The turbidity of Formazin is named in different measurement units (see .

Turbidity units based on Formazin

The undiluted suspension has a turbidity value of:

1000 EBC (**E**uropean **B**rewery **C**onvention)

4000 TEF (**T**rübungseinheiten **F**ormazin)

4000 FTU (**F**ormazin **T**urbidity **U**nits)

4000 FNU (**F**ormazin **N**ephelometric **U**nits / unit used for 90° side scatter turbidimeter only!)

4000 FAU (**F**ormazin **A**ttenuation **U**nits /according to EN27027 direct light/absorption for turbidity >40 FNU)

40000 Helm units

69000 ASBC (**A**merican **S**ociety of **B**rewing **C**hemists)

* suspension of 100 EBC (400 FTU) has a shelf-life of maximum 2 weeks according DIN/EN 27027 (ISO 7027) guideline.

Diatomaceous earth SiO₂

Please take notice to the [safety instructions](#) before handling of Diatomaceous earth

Diatomaceous earth (DE), is a whitish, powdered substance, which consists mainly of the silica dioxide shells of fossil algae (Diatomeen).

Diatomaceous earth is used frequently for the calibration of turbidimeter. You can find different conversion factors in the literature compared with Formazin, because Diatomaceous earth is available in different qualities and particle sizes. The dry Diatomaceous earth powder has the advantage that it can be stored for an almost unlimited period of time. You can use the prepared calibration standard for 1-2 hours only, because Diatomaceous earth pours in water. Take notice to a homogenous deviation during a calibration with Diatomaceous earth (frequently stirring) because Diatomaceous earth has the tendency to sedimentate. Diatomaceous earth is available from different vendors in different qualities and particle sizes you have to use the same vendor, quality, particle size and batch number to reproduce your calibration.

Typical calibration standards based on Diatomaceous earth:

JTU* (Jackson Turbidity Unit)

JCU* (Jackson Candle Units)

ppb (parts per billion)

ppm (parts per million)

g/l (gram per litre)

mg/l (milligram per litre)

%TS (percent total solids)

* The units JTU and JCU are based on the Jackson Candle Turbidimeter (Jackson candle tube) the forerunner of modern forward scattered light turbidimeter and not very common anymore.

Direct light turbidity

The direct beam turbidity measurement is probably the most used turbidity measuring technique and is suitable for measuring ranges of approximately 40 up to 40000 TEF. The turbidity is measured typically in NIR spectrum at a wavelength of approximately 750nm, then color influences (colors absorb within the visible spectrum between 400-700nm only) cannot affect the turbidity values. This measuring method is e.g. recommended in the German standard DIN 38404 part 2 and its European version [EN 27027](#).

The standard recommends a manual measurement method to measure turbidities above 40 NTU, using a transparent cylinder and an insertable disc. The 90° scattered light method is recommended to measure lower turbidity values. The standard contains as well a detailed procedure for the production of a 400 NTU Formazin suspension and a guideline for the calibration of turbidimeters.

Typical turbidity units based on the principle of direct light measurement:

% (percent transmission)

A* (spectral Absorption value)

* The spectral Absorption value will be also designated as EXT (Extinction), CU (Concentration Unit), AU (Absorption Unit).

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