EXNER
Process Equipment

Economical turbidity measurement in the food and beverage industry

Dairies and breweries are among the forerunners in the use of turbidity measurement. Aspects such as quality assurance, cost and process optimisation and conservation of resources are the primary objectives here.

Particularly with medium to high turbidity values such as those in milk, cream or whey, for example, or those that are predominant in breweries in the field of yeast management, turbidity measurement using the backscatter principle constitutes a reliable and at the same time economical measurement method. In order to exclude the effects of the colour of the medium to be measured, a light source with a wavelength in the near-infrared range (NIR) is generally used.

In backscatter measurement, the intensity of the light returned from the medium is measured. Here, both the sender (LED) and the receiver (detector) are in a single plane. I.e. the light is reflected at an angle of 180 degrees. In contrast to this, transmitted sensors which are based on the principle of absorption measurement are used for low to medium turbidities. Here, a beam of light is conducted through the medium at an angle of 180 degrees and the light loss is determined on the opposite side by means of a detector. The following applies here: the higher the absorption, the lower the transmission of the medium. However, this measurement method reaches its physical limits with high turbidity values.

Constantly increasing demands on plant engineering

Where turbidities and thus the appropriate changeover point in phase separation, for example, used to be determined by means of sight glasses, time-controlled processes or through conductivity measurements, companies today increasingly rely on optical measurement technology. In addition to the reduction of cleaning media, the primary objectives are the minimisation of system downtimes owing to cleaning processes, as well as the reduction of water consumption and the volume of resulting wastewater.

No clear determination of the proportion of milk in water, for example, is possible when testing using a sight glass. The estimation is also always dependent on the assessment of the respective person or of a changing group of people. Determination of the corresponding changeover points through time controlled processes also holds drawbacks. Here, the time for switching and distribution to different tanks and/or in the direction of wastewater disposal, for example, is normally determined based on experience plus a safety margin. This can result in increased product losses and even increased wastewater costs because exact determination of the optimal switching time depending on the actual process is not possible using the specified process. When using conductivity measurement to determine changeover points, the problem of temperature compensation must be taken into account. In concrete terms, this means that the effect of temperature on the conductivity value must be taken into account accordingly. The measurement is also electrically derived, which makes analysis somewhat slow and whereby the switching point can vary.

Requirement for the turbidity measurement technology used

Owing to the constant optimisation of the processes, the requirements for the measuring instruments used are also continuously increasing. The requirements for accuracy in differentiation of the media composition and the reproducibility of the measurement values are thus higher. At the same time, interference factors such as air bubbles in the medium, deposits on the sensor's apertures or resulting from mechanical wear must be kept as low as possible or excluded.

With regard to insertion into the pipe, various process integrations are essential. These stretch from a clamp connection through to elastomer-free insertion using a metallic sealing contour. In addition to the hygienic connection of the turbidity measurement technology to the process, the ability to clean the components which come into contact with the medium also plays a significant role. Here, attention must be paid not only to the avoidance of dead space, but also to an appropriate surface finish. The ability to clean and sterilise all parts which come into contact with the medium using CIP/SIP processes is considered to be a matter of course. But it's not just cleaning of the components which come into contact with the medium which plays a significant role when it comes to the food and beverage industry. Depending on the application, external dedusting is also vital. For this reason, the measurement technology used must likewise have appropriate IP protection.

From the user's point of view, simple connection and installation also plays a relevant role in the selection of the appropriate turbidity measurement technology. Added to this are simple on-site operation and the quick and reliable ability to test the turbidity sensors used in the field and calibrate them where necessary.

NIR backscatter sensors with innovative measurement optics for economical turbidity measurement

Together with the distribution and development partner, Seli GmbH, Exner has developed a backscatter sensor which effectively excludes the drawbacks of existing systems by means of an innovative design for the optical assembly. The use of a long-lasting LED which emits light in the near infrared (NIR) range with a wavelength of 880 nm allows for a colour-neutral measurement. The patented ball lens in the measurement optic likewise combines several advantages here. Owing to the special lens shape, measurement is done right at the interface with the medium, whereby measurement errors are excluded, particularly at high turbidity values, through a combination of absorption and reflection. The ball shape also prevents strong turbulence at the interface. The result is high measurement accuracy and reproducibility. In contrast to flat apertures, it is also not possible for air bubbles to collect on the ball lens and thus distort the measurement. The lens, made from robust sapphire, is not sensitive to abrasion and sits directly in the measured medium, whereby continuous cleaning of the lens is ensured. Simply on-site operation via a touch display, suitability for CIP/SIP processes, and testing and calibration of the sensors in the field through the use of NIST-traceable reference standards are a matter of course in the backscatter sensor described.

Areas of application in the food and beverage industry

In contrast to absorption measurement, which is predominantly used for low to medium turbidity, measurement using the principle of backscatter is predestined for determination of medium to high turbidity values. These are found in milk processing, e.g. in cream, whey or yoghurt, as well as in breweries in the field of yeast cultivation and yeast recovery, among other places. More applications can be found in the production of mayonnaise, the processing of juice concentrates or the determination of the concentration of significantly cloudy crushed grape dregs.

The turbidity measurement sensors are used in a wide variety of process steps. These include the control of separators through determination of the turbidity at their inlets and/or outlets, monitoring or cleaning during the flushing of tanks and pipes, detection of filter breaks, monitoring of phase separation or colour-independent concentration measurement, for example.

Cost reductions as well as improved conservation of resources and product yields

In conclusion, it can be stated that the use of appropriate turbidity measurement technology can not only allow for the realisation of cost and process optimisations, but is also associated with corresponding conservation of resources. This is made visible in the reduction in wastewater costs owing to a lower wastewater burden as well as through the reduction in fresh water consumption through the reduction of plant downtimes owing to optimised cleaning processes and the minimisation of the use of cleaning agents without having a negative effect on the product quality. At the same time, it is possible to increase the product yields and reduce the product loss.