



**INGOLD**

Leading Process Analytics

## Automated pH measurement – Indispensable in Sugar Beet Processing

**During processing of sugar beet, the pH value of the flume water is an important control parameter for the extraction and carbonatation steps. At the same time, an automatic electrode cleaning system guarantees reliable measurement data and also prolongs the operational life of the electrodes.**

### **Sugar beet cultivation in Germany**

Currently, sugar is produced in 127 countries around the world, beet sugar accounting for approx. 26% of the total market volume. According to the statistics of the German Sugar Association (WVZ) for 2005/06, sugar beet is grown in Germany on 45'198 farms. In 2005, the cultivation area for beet amounted to 419'000 ha. or about 4% of the total arable farm land. The beet grown and harvested on this area was processed in 26 sugar factories to produce about 4 million tons of sugar.

### **pH measurement in flume water**

The pH value has a large influence on the process control of the individual stages of sugar production. Therefore in every sugar factory a series of pH measurements

are made in order to be able to optimize the production flow. After arrival at the sugar factory, the beet is first cleaned of dirt. Cleaning in the flume and washing plant is carried out using circulating water (flume water). During cleaning, small amounts of sugar can already dissolve in the flume water. Through microbial processes (conversion of sugar to acids), the quality of this water can be impaired, resulting in acid corrosion of the piping. pH measurement is carried out to control the dosage of lime milk to the flume water to keep the pH value within a defined range.

### **pH measurement during extraction**

When the beet has been perfectly cleaned, it is passed on to the slicer machine. The



**METTLER TOLEDO**

beet chips (cosettes) are then watered and prewarmed before the sugar is extracted from the beet cells in large extraction vessels at approx. 70 °C. The pH value and hardness of the water are both highly important factors in this procedure. The pH value should lie between 5.2 and 5.8 and the water hardness at 100° dH/German Hardness. Here too, a pH measurement system is used for controlling acid and lime milk dosage to ensure an optimal pH range. In this processing stage, raw juice with a sugar content of approx. 12-14% is produced

### pH measurement during carbonatation

The desugared beet chips are dried and returned to the farmers as cattle food. The raw juice contains, alongside the desired sugar, other soluble substances such as phosphate and magnesium, or citric and malic acid, as well as proteins. These organic and inorganic substances have to be removed from the raw juice in a further process stage. Purification, i.e. separation of sugar from nonsugar substances, involves the addition of lime milk and the introduction of carbon dioxide

gas. The nonsugars become bound to the calcium which subsequently precipitates as carbonate. Specialists call this carbonatation. After repeating this procedure followed by filtration, a clear, light golden solution called thin juice remains. In the carbonatation process, the pH value range is also a decisive control parameter for the overall process flow.

### Significantly reduced maintenance

Due to the elevated temperatures and high lime concentrations, pH measurement is an extremely challenging proposition, particularly during carbonatation. On the one hand the high temperature affects the service life of the membrane glasses, and on the other, the lime milk caters for a stubborn deposit on the electrode surface. In this application, use of an automatically controlled pH electrode via

a retractable housing has proved to be extremely worthwhile. A METTLER TOLEDO pH Transmitter M 700 in conjunction with the cleaning and calibration system EasyClean 400 was adapted to meet requirements and allow full automation of the continuous pH measurement. At defined intervals, the electrode is withdrawn from the process, cleaned and once a day calibrated. This led to a distinct reduction in manual maintenance effort. Particularly suitable for universal use in the various applications in the sugar factory under partly drastic conditions is the electrode InPro 4260 with integrated temperature sensor.

▶ [www.mt.com/easyclean400](http://www.mt.com/easyclean400)

▶ [www.mt.com/m700](http://www.mt.com/m700)

▶ [www.mt.com/Inpro4260](http://www.mt.com/Inpro4260)

#### Publisher/Production

Mettler-Toledo AG  
Process Analytics  
Im Hackacker 15  
CH-8902 Urdorf  
Switzerland

#### Illustrations

Archive MarCom  
CH-8902 Urdorf  
Switzerland  
Archive Südzucker  
Germany  
Archive US sugar Corp.

Subject to technical changes.  
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Printed in Switzerland.



pH electrode InPro 4260.



pH transmitter M 700.



automatic pH measurement, cleaning and calibration system EasyClean 400.

# Optimized Energy Cogeneration in the Sugar and Alcohol Industry

**The cogeneration techniques can be optimized by inline controlling of the measuring parameters pH, DO and conductivity in different, sensitive process steps. This leads to higher efficiency, improved energy yield and finally to less maintenance and repair costs.**

## Market general overview

The investments in Sugar and Alcohol Industry have been increasing in Brazil in the last years for two major reasons: the outlook of alcohol and sugar exports and the increase in home consumption due to more flex-fuel cars being sold. Brazil is nowadays the world leader in alcohol production. The demand of energy in sugar mills combined with the high amount of cane bagasse generated in the process, which can be used as bio-fuel for boilers, led many companies to work with cogeneration, trying to achieve self-sufficiency in energy consumption and to sell the exceeded energy. The boiler feed water to produce steam must be treated. The water treatment control assures the quality of the water and the high efficiency of the process.

## Background

The water treatment and thermal cycle for cogeneration in sugar mills consists of several steps: Through the injection of fuel (cane bagasse in the case of sugar mills), the water injected in the boiler is heated until it produces steam used to produce energy demanded by the process. Due to the high pressure of the produced steam, in order to allow the turbine movement, the water treatment and its quality must be strictly controlled. After been used, the steam is condensed and mixed with water coming from treatment (deionization or reverse osmosis). As the water coming from treatment is contaminated with oxy-

gen, it goes through the de-aeration process where oxygen is removed through mechanical or chemical reactions (hydrazine or sodium sulphide). After this process, dissolved oxygen is measured before being injected in the boiler.

## The need to control boiler water

The water used in the boiler should be controlled through analytical measurements. If certain levels of contaminating agents are in the water, the boiler can be mechanically damaged and the system can lose its efficiency. The measurement, however, is difficult due to certain process conditions. Therefore, the sensors used must be resistant and reliable to meet customers' needs. Sampling systems are generally used to measure dissolved oxygen and pH.

The analytical measurement loops are commonly installed at:

- the condenser,
- the purification system, consisting of the deionization or reverse osmosis, and
- after the de-aeration process.

## DO measurements prevent oxidation

The dissolved oxygen measurement is used to prevent oxidation. The de-aeration is made by adding sodium sulphide or hydrazine. One of the major problems found in the measurement is the low levels of dissolved oxygen in the water (around

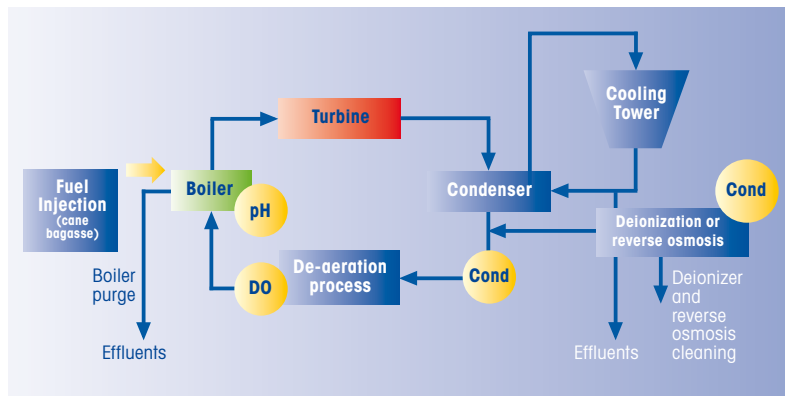
5ppb). Therefore, most commonly, the InPro 6900 is used with the O<sub>2</sub> 4100ppb transmitter. This system measures levels of DO up to 1ppb, due to its bigger cathode and its special electrolyte.

## pH measurements prevent incrustation and corrosion

The pH is another analytical variable that must be controlled. Its monitoring prevents incrustations and avoids carbon dioxide contamination and consequent boiler corrosion. Commonly the InPro 3250 is used, a low maintenance pH sensor for demanding applications with precise measurements. Most of the time, measurement must be made using sampling, according to the ASTM 5128 standard test method that drives how to measure pH at low conductivity.

## Conductivity measurements prevent ion contamination

The conductivity is not only controlled due to the final product quality, identifying contamination by ions, but also to control the cleaning and regenerating solution (in deionization) in the treatment system. The conductivity measurement is also used to control the quality of the condensed that returns to the thermal cycle. Due to the low levels of conductivity measured in cogeneration process, the InPro 7001 of 2-electrode design is used.



### Benefits from implementation

Analytical measurement in treated water for cogeneration assures that the quality parameters are being followed, indicating when a corrective action is needed either in the water treatment system itself or in the production process. The pH monitoring is important to prevent incrustation and carbon dioxide contamination. The corrosion can be prevented not only by

controlling carbon dioxide with pH but also measuring the dissolved oxygen in the water injected in the boiler. Conductivity measurement prevents contamination by ions. The whole analytical measuring system helps the water treatment and thermal cycle to work in a high level of efficiency, bringing cost saves and high energy yield.

► [www.mt.com/pro-ph](http://www.mt.com/pro-ph)

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## pH Measurement Critical to Quality Assurance

**The METTLER TOLEDO InPro 3250 SG electrode met stringent pH accuracy requirements and ousted a competitor's system. As a result, high reliability was obtained paired with reduced maintenance and extended sensor life.**

### A challenging situation

A world leading refiner of corn-based products approached Mettler-Toledo Ingold with a challenging application. The final pH measurement of high fructose corn syrup is made at 80 °C (176 °F), has low conductivity and has a very high viscosity. pH measurement and control prior to shipment is critical in documenting product quality. At this North American operation, a competitor's pH offering was only able to meet the stringent accuracy requirement through frequent, labor intensive calibrations. Further, the pH readings were

sluggish and the harsh conditions of the application resulted in short sensor life. Could METTLER TOLEDO improve this situation?

### METTLER TOLEDO's recommendation

An InPro 3250 SG pH-electrode was selected for this application due to the pressurized liquid electrolyte design preventing reference junction fouling from the sticky sugar product, and the solution ground capability eliminates the possibility of ground loop problems and permits expanded sensor di-

agnostics. The sensor was mounted into an InFlow housing and wired to a pH 2100e transmitter.

### Side-by-side with the competitor's installation

The METTLER TOLEDO system was installed side-by-side to the competitive system for trial comparison purposes.

The original competitive system would undergo routine calibration (one-point calibration vs. grab sample) every 3 days while the METTLER TOLEDO system would be



left untouched throughout the evaluation period to determine an overall deviation.

### INGOLD technology ousted the competitor

The stability of the measurement over time was incredible! In fact, after four months in operation, the METTLER TOLEDO system that was left untouched, read within 0.1 pH units of the system that had undergone nearly 40 routine calibrations over this period and read within 0.05 pH of the grab sample result.

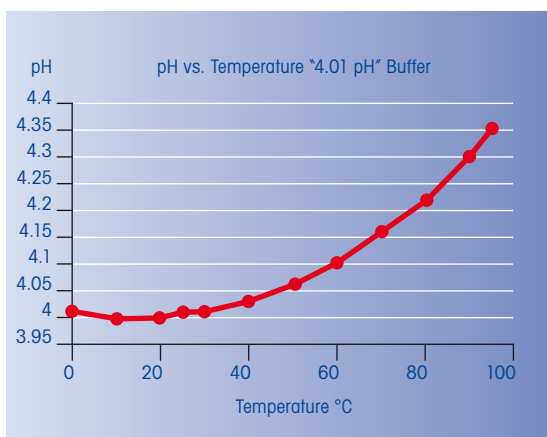
### Portable pH meter 1120 for immediate samples at site

Note that obtaining meaningful, representative pH grab sample readings is a challenge itself. Sample cooling and exposure to atmosphere can impact the accuracy of the sample when taken to a central laboratory. This situation led to the use of the METTLER TOLEDO Model 1120 portable pH meter. The portable unit permits immediate sample measurement at site, and accepts the identical pH sensor as used in the process, thereby minimizing any discrepancies. (See separate box)

### Customer satisfaction paid off in further orders

The pH measurement has now been in operation for over two years, and the customer is very pleased with the reliability and accuracy of the system. Significant cost savings have resulted from reduced routine electrode maintenance and extended sensor life. This success has resulted in replacement of 16 additional pH applications.

► [www.mt.com/pro-ph](http://www.mt.com/pro-ph)



#### What you have to know!

#### The importance of temperature when comparing in-line versus off-line pH measurements

One point of clarification is that electrodes with integral temperature elements only compensate for changes in electrode millivolt output with temperature according to the Nernst equation. Temperature compensated electrodes do not compensate for actual solution pH changes with temperature. This change in solution pH with temperature is real and should be measured. As shown in the figure below, the impact of temperature can be significant and may be very non-linear. Comparison of a cold "lab" sample to a hot process reading can introduce error.

#### Timing is everything

"Grab samples" can change pH with time for various reasons. Acidic carbon dioxide uptake from air can lower pH. Biologically

active solutions can continue to react as microbes metabolize nutrients. Solutions can off-gas volatile elements causing a pH shift especially for higher pressure processes. Low conductivity samples such as pure water or pure sugar solutions, are particularly impacted since they contain very little buffering capacity. Measuring samples immediately and minimizing atmospheric exposure will assure a representative measurement.

The Model 1120 portable pH meter is ideal for both above situations, and accepts the same electrode as used in the process, eliminating yet another source of error. Having a thorough understanding of the pH measurement processes, and paying attention to details of calibration, sampling, and measurement, will minimize off-line analysis requirements and deliver an in-line pH measurement you can rely on.

# Open Fieldbus Protocols support Asset Management and Plant Maintenance

Open fieldbus technology like HART®, FOUNDATION™ Fieldbus and PROFIBUS® enables the full use of METTLER TOLEDO functional advantages on digital communication:

- improved resolution of measured values,
- intelligent sensor diagnostics and instrument parameter settings
- comfortable instrument configuration out of a central station,
- higher level of process data to improve the plant conditions,
- availability of additional process values to be easily integrated into the control system

Our intelligent analytical instruments are equipped with electronic device descriptions (DD) for various process instrument configuration software tools.

► [www.mt.com/pro-service](http://www.mt.com/pro-service)

## METTLER TOLEDO recommends

- Transmitters for pH/ORP, dissolved oxygen and conductivity

Two transmitter lines for integration in HART®, FOUNDATION™ Fieldbus and PROFIBUS® PA networks.

- EasyClean 400

The cleaning and calibration system EC 400 for an easy integration in FOUNDATION™ Fieldbus and PROFIBUS® PA networks.

- ISM technology

Integration of sensor diagnostic information into the process control environment  
– “sensor wear monitor” and “adaptive calibration timer” for optimal maintenance planning.



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