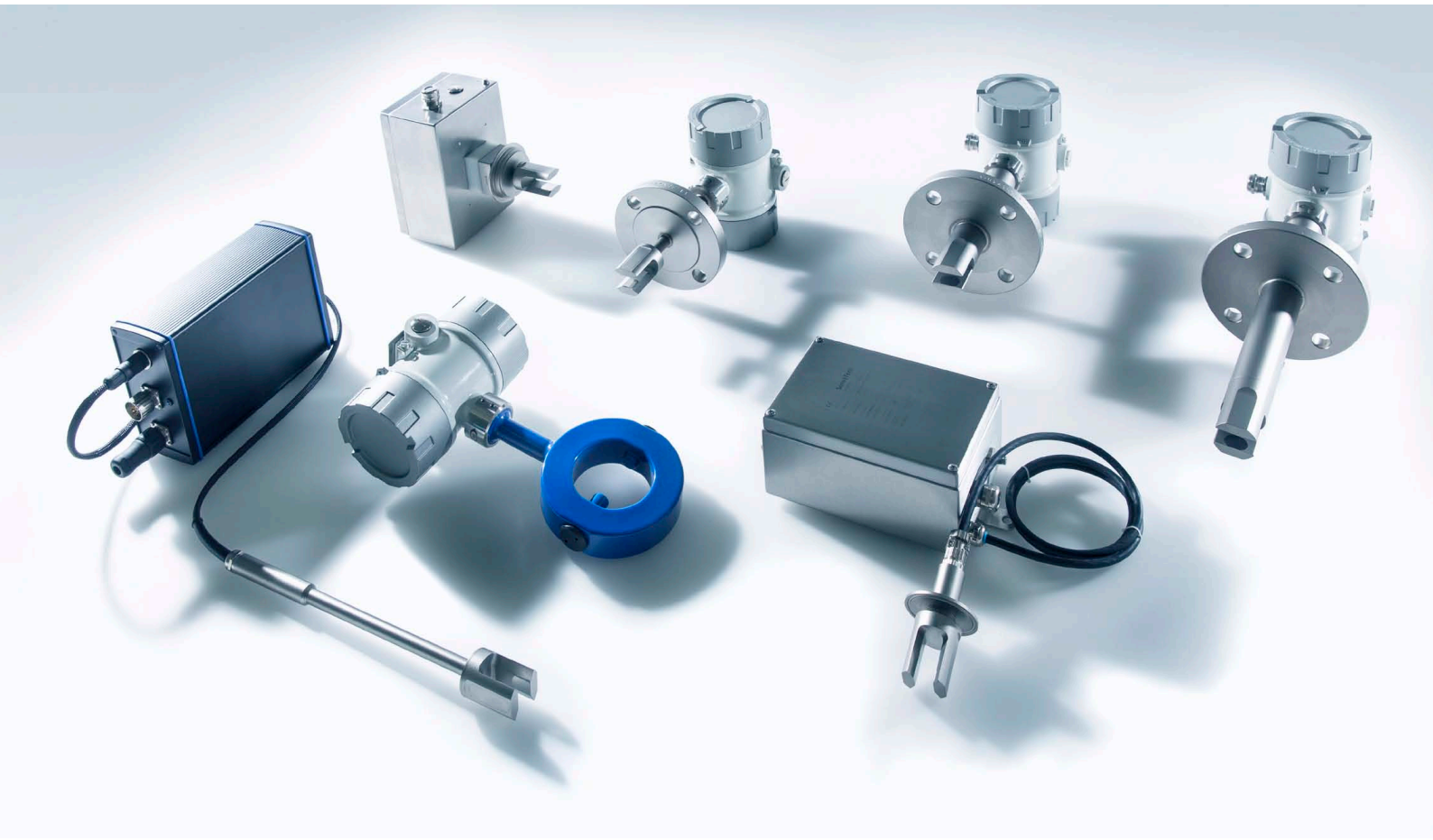
SensoTech



Application reports

In liquids, we set the measure.

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Content

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Chemical industry

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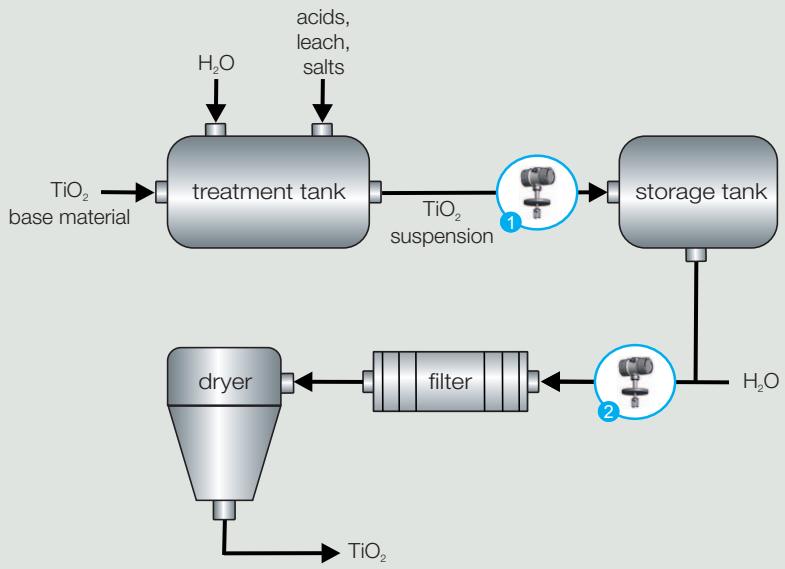


Measuring point	Installation	Measuring task
1	pipeline after treatment tank	process monitoring of TiO2 treatment
2	pipeline to filter	density-adjustment for optimal filtration

TiO_2 post-treatment

Introduction

Titanium Dioxide (TiO_2, titanium(IV) oxide) is used as white pigment in paints and lacquers, as well as UV blocker for sunscreen products.
The production of TiO_2 involves two processes: either the sulfate process or the chloride process. After this processing, the TiO_2 has to be refined to optimize the surface structure for better gloss and extended shelf life. Subsequently, the TiO_2 suspension has to be filtered and dryed.
In this posttreatment a continous process monitoring by TiO_2 suspension density measurement is needed to guarantee high product quality and to make up optimum use of the plant capacity.

LiquiSonic® is ideally equipped for this complex measuring task. The robust, maintenance free inline measuring technology convinces customers, mainly with an attractive price-performance ratio.

Application

The refined TiO_2 suspension is collected in a storage tank and afterwards filtered. To determine the suspension density, LiquiSonic® immersion sensors are installed before storage tank (1) or filtration unit (2). By using LiquiSonic®, the TiO_2 post-treatment is permanently monitored and can be regulated in a matter of seconds. This helps to save process costs and increase the product quality.

The LiquiSonic® measuring technology convinces customers, compared to Coriolis flowmeters, with an attractive price-performance ratio, even in pipelines with bigger diameters. Furthermore the LiquiSonic® analyzer operates maintenance free and with high precision for a long time.

Customer value

LiquiSonic® analyzer with numerous advantages:

- attractive price-performance ratio, even for nominal pipeline diameter DN 25 and bigger
- no abrasion by usage of titanium sensor
- robust and maintenance free function
- easy installation by individual choise of process connection
- durable use

SensoTech enables with LiquiSonic® a stable, user-friendly measuring technology, perfectly suitable to determine the TiO_2 suspension density.

Installation

The LiquiSonic® sensor is easily installed into TiO_2-pipelines (DN 25 or bigger). The process connection can be chosen individually.

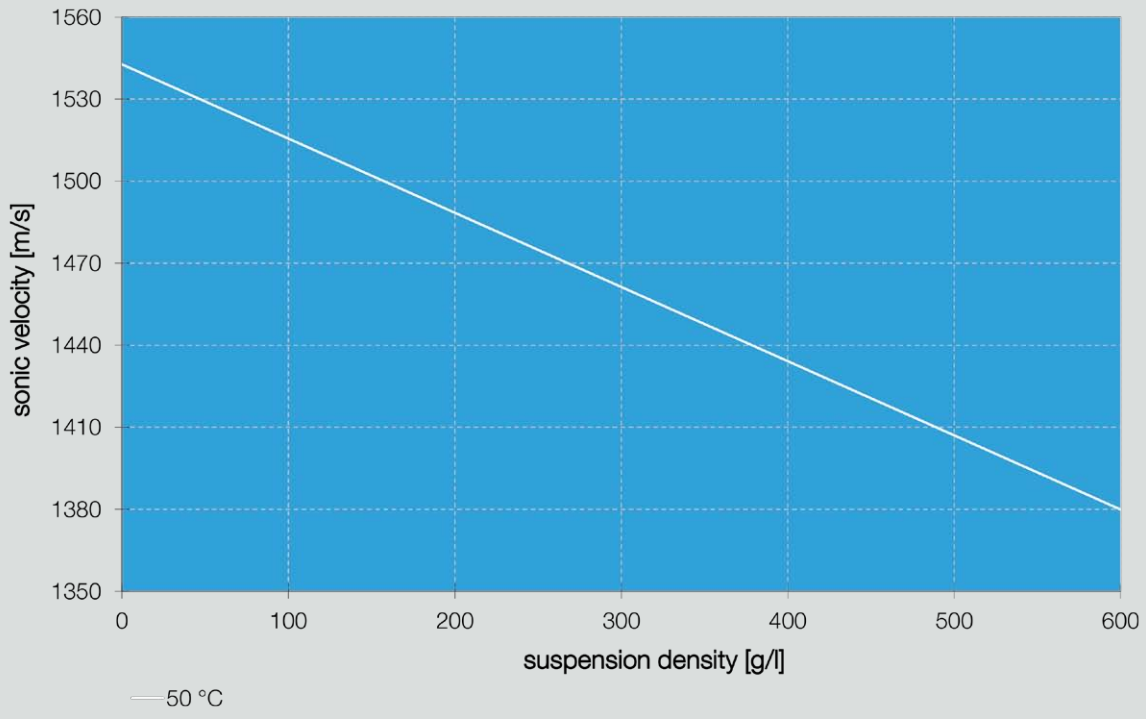
By using the LiquiSonic® controller 30, up to four sensors can be connected, allowing the simultaneous monitoring of several measuring points. This allows optimal process control, either before the collection tank or before filtration.

Typical measuring range:
concentration range: 0 to 600 g/l
temperature range: 10 to 80 °C

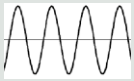
References

The LiquiSonic® analyzers are successfully implemented in TiO_2-plants, e.g. at KRONOS Titan GmbH (Leverkusen, Germany).

LiquiSonic® sonic velocity measurement in titanium dioxid suspension



LiquiSonic® 30

	21001311 LiquiSonic® Controller 30 V10
	21010112 Immersion sensor V10 40-14, DIN DN50, L092
	21005020 Material extra charge titanium
BUS	21004435 BUS connection: Profibus DP
	21004449 Network integration
	21004110 High power sensor electronic
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	21007846 Factory acceptance test (FAT) certificate

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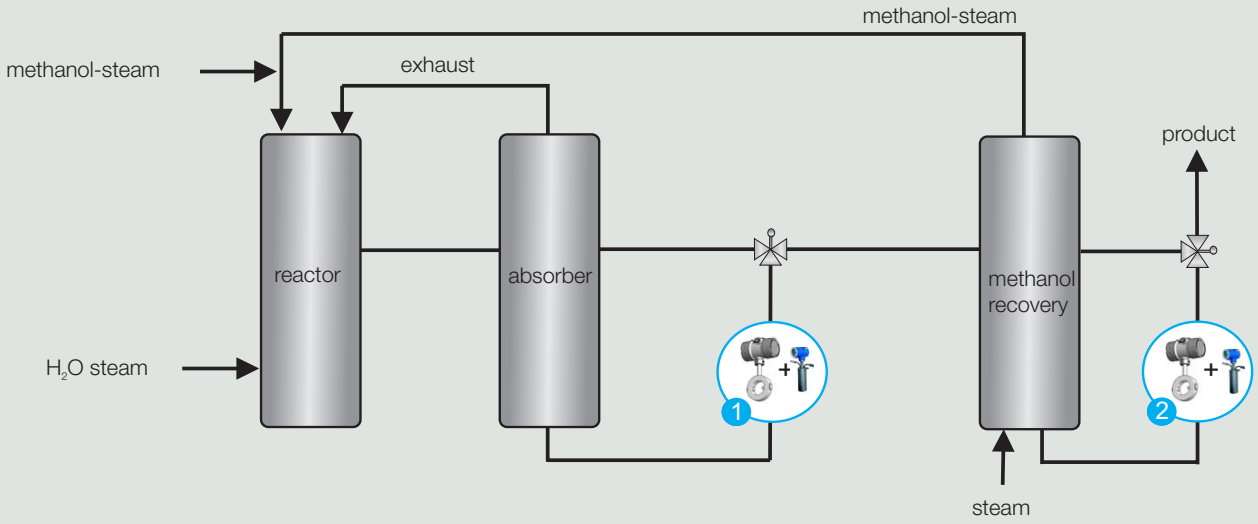


Measuring point	Installation	Measuring task
1	pipeline	discharging of the semi-finished product
2	pipeline	quality assurance for the final product

Formaldehyde Synthesis

Introduction

Formaldehyde is an organic base material for numerous applications to synthesize diverse end products. In this way formaldehyde is frequently used in chemical and pharmaceutical industry. Typical synthesis products are resins, dyes, fertilizers, disinfectants, pesticides and medicines.

Formaldehyde is produced by oxidation of methanol. The two most important production methods offer different advantages and disadvantages. Because of the higher efficiency and the lower residual methanol content, the silver catalyzed process has now replaced the metal oxide catalyzed process. However, the silver catalyst plant requires a more frequent catalyst regeneration.

By a continuous measurement directly in the process, an optimum concentration management can be assured. With the robust LiquiSonic® system, the synthesis can be inline monitored and the methanol and formaldehyde content is precisely determined.

Application

Formaldehyde is industrially produced in the silver catalyzed process. Methanol gas is mixed with air and passed through silver electrodes, which act catalytically. The result is a formaldehyde gas, which precipitates and is collected as liquid in storage tanks. The excess methanol is recovered and fed back into the process, leaving a residual value of < 1 wt% methanol in the formaldehyde to stabilize it.

The LiquiSonic® 40 analyzer is used to circulate the semi-finished product and to ensure the quality of the final product. Extensive laboratory measurements, providing analytical results with time delay, are omitted. The process efficiency can be derived by the precise inline determined formaldehyde and methanol value.

Customer value

LiquiSonic® 40 provides a precise inline concentration measurement of 3-component mixtures with real-time monitoring. Using sonic velocity and density, methanol and formaldehyde can be monitored directly in the process.

The robust sensor construction promotes long process life. All measured data are saved in a long term data memory, so that they can be used in audits and for analysis of process disturbances.

Additional advantages are:

- optimum line control and reliable process data
- precise methanol value of the final product
- early recognition of process malfunctions in a matter of seconds
- reduced material and energy (steam) costs
- reduced sampling and lab analyze

Investment: approx. 20.000 € (28,000 $)

Amortization: < 1 year

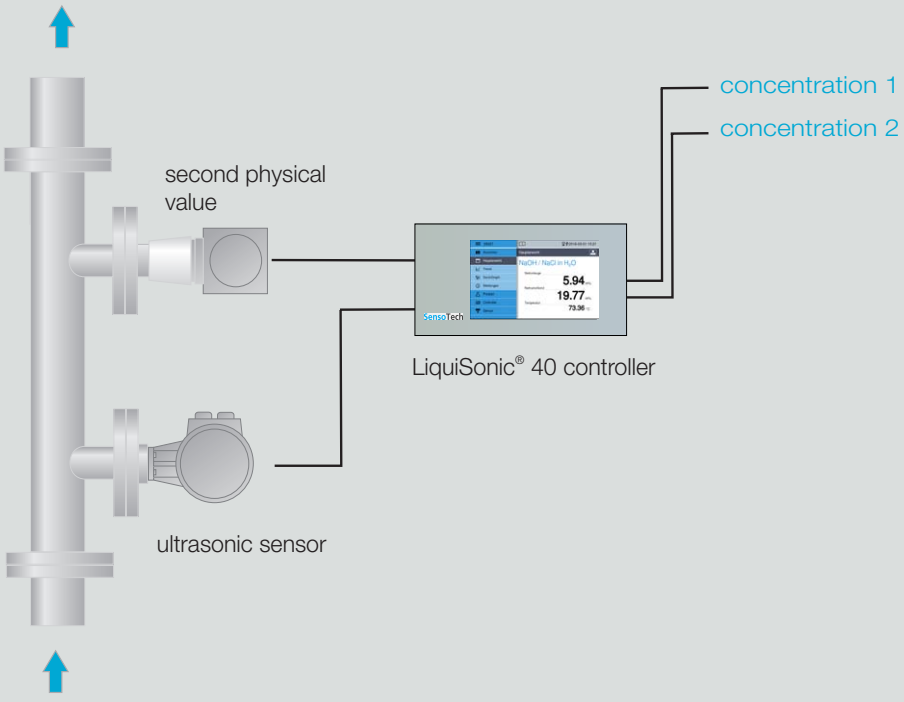
Installation

The LiquiSonic® 40 sensors are easily installed in the pipelines to determine the concentration level of the semi-finished and final product.

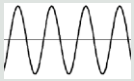
The LiquiSonic® controller 40 is connected to the LiquiSonic® immersion sensor and the device for the second physical value (density). The controller displays the concentration levels of methanol and formaldehyd.

Typical measuring range:
concentration methanol: 0 - 5 wt%
concentration formaldehyde: 40 - 60 wt%
temperature: 60 - 80 °C (140 - 180 °F)

LiquiSonic® 40 process analysis by sonic velocity and density



LiquiSonic® 40

	21001411 LiquiSonic® Controller 40 V10
	21010102 Immersion sensor V10 40-40 Ex FM, ANSI 2“, L150
	21006020 Density sensor BR, DN15, PN40, Ex i, 1.4571, T_{max}=150°C
BUS	21004435 BUS connection: Profibus DP
	21004449 Network integration
	21004110 High power sensor electronic
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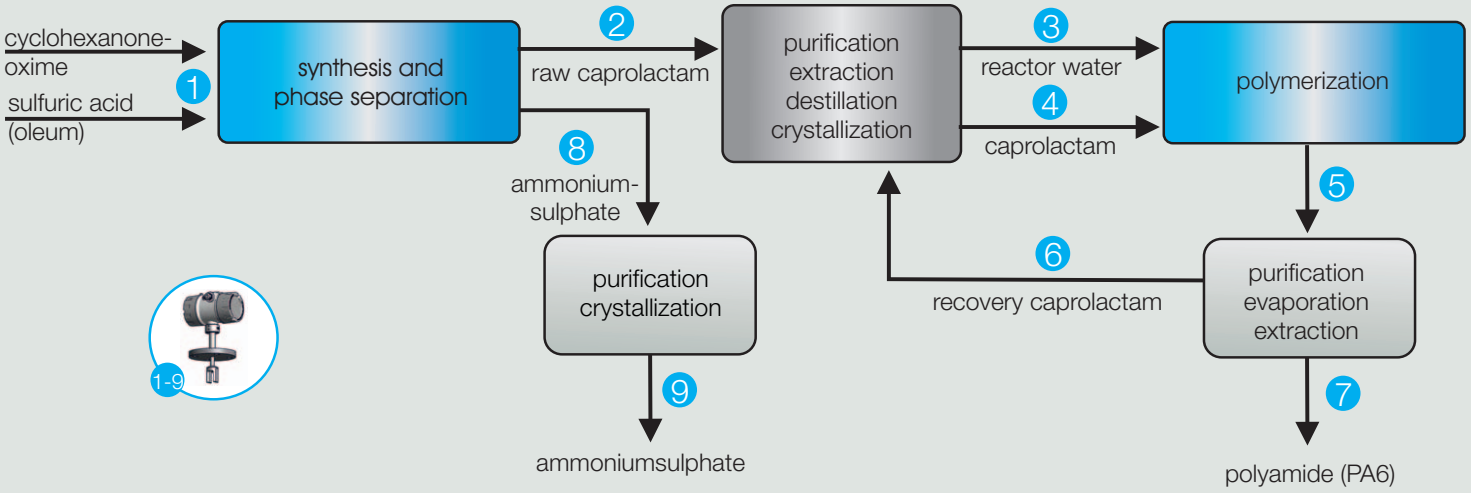


Measuring point	Installation	Measuring task
1, 2, 3, 4, 5, 6, 7	feed and transport pipeline	concentration and quality control (incoming goods and caprolactam)
8, 9	transport pipeline	phase detection and separation
9	crystallization unit	monitoring and control of ammoniumsulphate crystallization

Caprolactam Processing

Introduction

Polyamides are among the most common thermoplastic synthetic materials. Caprolactam (CPL) is the main raw material for these polymers, especially for PA6 (nylon 6). The monomer caprolactam is produced in a complex process, consisting of 4 main parts:

- synthesis of raw caprolactam
- separation and crystallization of ammoniumsulphate
- purification and preparation of raw caprolactam
- polymerisation of polycaprolactam (PA6)

The raw caprolactam production is based on the key intermediate cyclohexanone oxime, which is usually made by cyclohexanone, hydroxylamine and H_2SO_4. By adding of ammonia and oleum, the raw caprolactam is synthesized and separated of the ammonium sulphate phase. The following steps for the monomer caprolactam are the purification and concentrating (extraction, destillation and crystallization) and the polymerization step. Finally, residual monomers are separated from the polymer (recovery CPL).

Application

The robust inline analyzer LiquiSonic® offers several advantages within quality monitoring and optimal process control at several measuring tasks:

- incoming goods control
- Beckmann rearrangement: H_2SO_4 / oleum
- phase separation of CPL and ammonium sulphate
- crystallization monitoring of ammonium sulphate
- extraction: concentration CPL in solvent
- destillation: concentration CPL in water
- reaktor water: water in caprolactam

LiquiSonic® is used for high-precision concentration value determination (incoming goods, caprolactam), phase detection / separation and process monitoring (crystallization). The internal limit value monitoring signals exceeding or falling below thresholds and transfers the real-time information via analog or digital outputs, serial interfaces, or fielbus (Profibus DP, Modbus) to the process control system.

Customer value

The LiquiSonic® analyzer provides a precise caprolactam concentration measurement with real-time monitoring. The devise is successfully implemented for phase separation between caprolactam and ammonium sulphate.

The robust sensor construction and the optional special materials, like HC 2000 oder PFA, promote long process life. In addition, SensoTech offers sensors approved by ATEX, IECEx and FM.

LiquiSonic® enables a reduction of labor cost through the elimination of manual process steps:
time saving: 1 h per day
cost per hour: 50 € (60 $)
total cost savings: 10.000 € (12,000 $) per year

Trough precise LiquiSonic® monitoring, the concentration of residual CPL monomers can be reduced to a minimum, which increases the plant productivity.

Investment: approx. 12.000 € (15,000 $)
Amortization: < 1 year

Installation

The LiquiSonic® immersion sensor is easily installed into the feed and transport pipelines. Installing the LiquiSonic® sensor eliminates dead space and avoids high installation costs for bypasses.

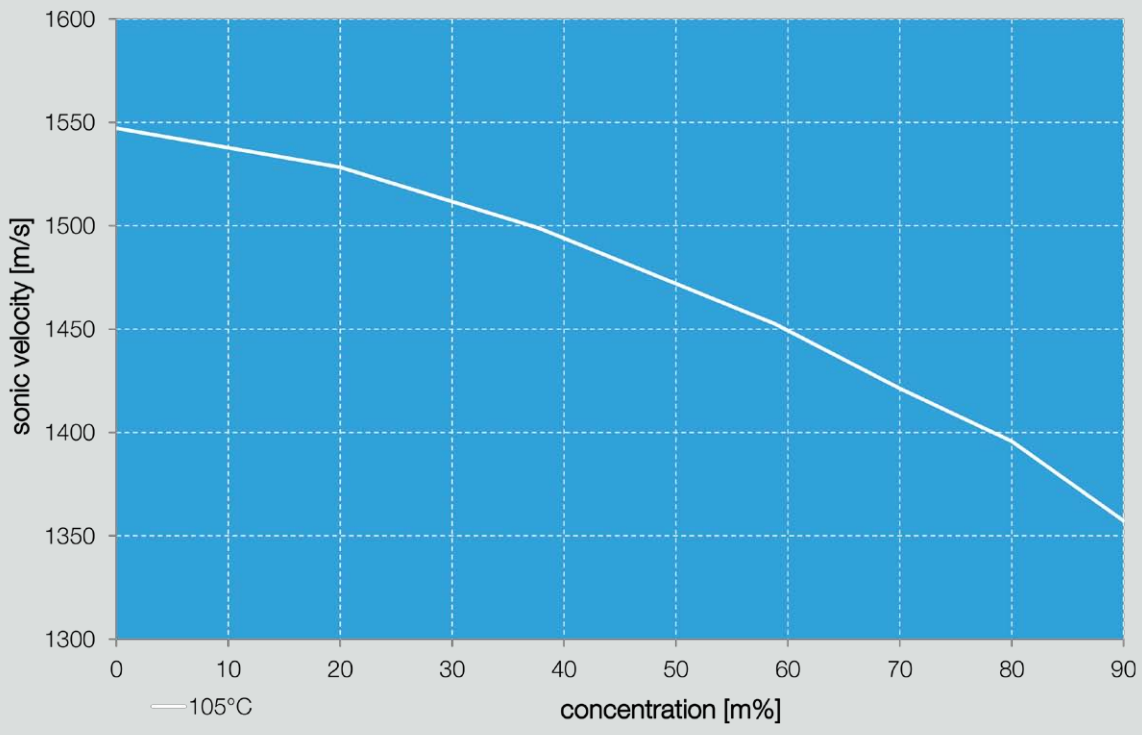
By using the LiquiSonic® controller 30, up to four sensors can be connected, allowing the simultaneous monitoring of several measuring points.

Typical measuring ranges:
concentration range caprolactam: 70 - 100 wt%
temperature range: 80 - 130 °C (175 - 265 °F)

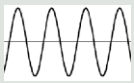
concentration range caprolactam: 0 - 10 wt%
temperature range: 20 - 70 °C (70 - 160 °F)

Incoming goods control:
concentration range oleum : 0 - 30 wt%
temperature range: 10 - 60 °C (50 - 140 °F)

LiquiSonic® sonic velocity measurement in caprolactam



LiquiSonic® 30

	21001311 LiquiSonic® Controller 30 V10
	21010112 Immersion sensor V10 40-14, DIN DN50, L092
	21005215 Maximum rated sensor temperature: 150 °C
BUS	21004435 BUS connection: Profibus DP
	21004449 Network integration
	21004110 High power sensor electronic
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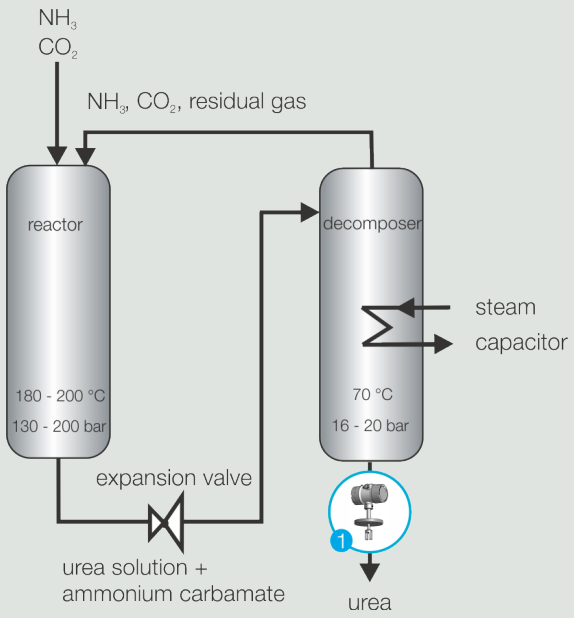


Measuring point	Installation	Measuring task
1	pipeline	monitoring of the urea concentration for quality control

Urea production

Introduction

Urea is an important raw material for many different industries. Due to its high nitrogen content, urea is used as a fertilizer and as a feed additive in agriculture. Urea plays also an important role in the chemical and pharmaceutical industry. Applications include for example the production of resins and melamine as well as the production of personal care products.

The production of urea is performed directly in conjunction with the ammonia synthesis because the base materials are liquid ammonia and carbon dioxide. The combination of both methods allows a resource-saving production.

The inline measuring method LiquiSonic® allows the urea concentration measurement at any time and guarantees an optimal efficiency of the urea production.

Application

Urea is prepared by numerous methods. A technical possibility to synthesise urea is the thermal conversion of ammonium carbamate, which is obtained from ammonia (NH_3) and carbon dioxide (CO_2) at a temperature of 200 °C and a pressure of 130 to 200 bar.

The reaction mixture (ammonium carbamate and urea) is expanded to atmospheric pressure and seperated from ammonium carbamate in distillation columns at 70 ° C. The reaction does not proceed completely. Therefore the residual ammonium carbamate is decomposed by stripping CO_2 in the base materials of NH_3 and CO_2 which are then returned to the reactor. The urea solution is evaporated and the urea is crystallized under vacuum. For further processing, the crystallized urea is centrifuged and dried.

Customer value

The quality control of the urea is of enormous importance for further processing. LiquiSonic® allows the determination of urea concentration at any time for complete documentation and consistent product quality. This enables immediate intervention, in case of malfunctions and deviations.

LiquiSonic® enables a reduction of labor cost through the elimination of manual process steps:

- time saving: 1 h per day
- cost per hour: 50 € (60 $)
- total cost savings: 10.000 € (12,000 $) per year

LiquiSonic® ensures an optimal and resource-saving production and increase the productivity:

- productivity increase: at least 0.1 %
- urea production: 1000 t per day (220 € / 240 $ per ton, 200 production days per year)
- benefit: 44.000 € / 48,000 $

Investment: approx. 13.000 € (16,000 $)
Amortization: < 6 month

Installation

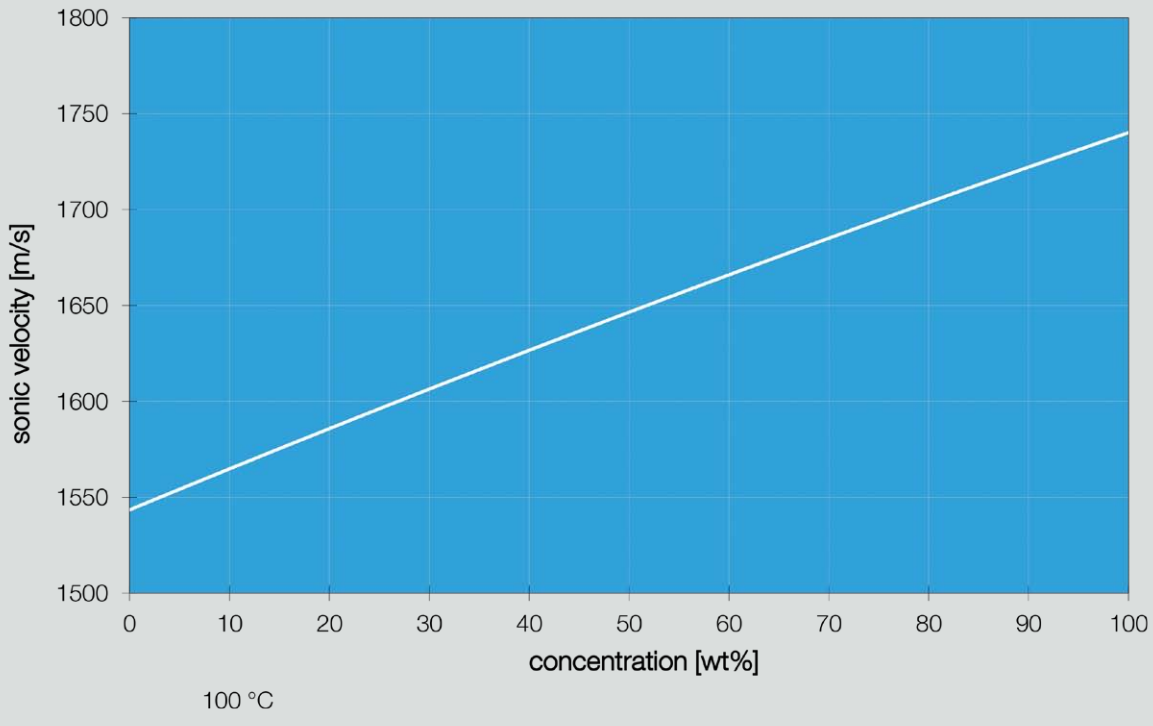
The LiquiSonic® immersion sensor is easily installed into the transport pipeline (typically DN80) after the decomposer.

The robust sensor construction and the optional special materials, like HC 2000, promote long process life.

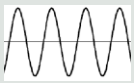
By using the LiquiSonic® controller 30, up to four sensors can be connected, allowing the simultaneous monitoring of several measuring points.

Typical measuring range:
concentration range: 0 to 100 wt%
temperature range: -10 to 140 °C

LiquiSonic® sonic velocity measurement in Urea



LiquiSonic® 30

	21001311 LiquiSonic® Controller 30 V10
	21010112 Immersion sensor V10 40-14, DIN DN50, L092
	21004352 T-adapter for immersion sensor DN80-50-80 PN16
BUS	21004435 BUS connection: Profibus DP
	21004449 Network integration
	21004110 High power sensor electronic
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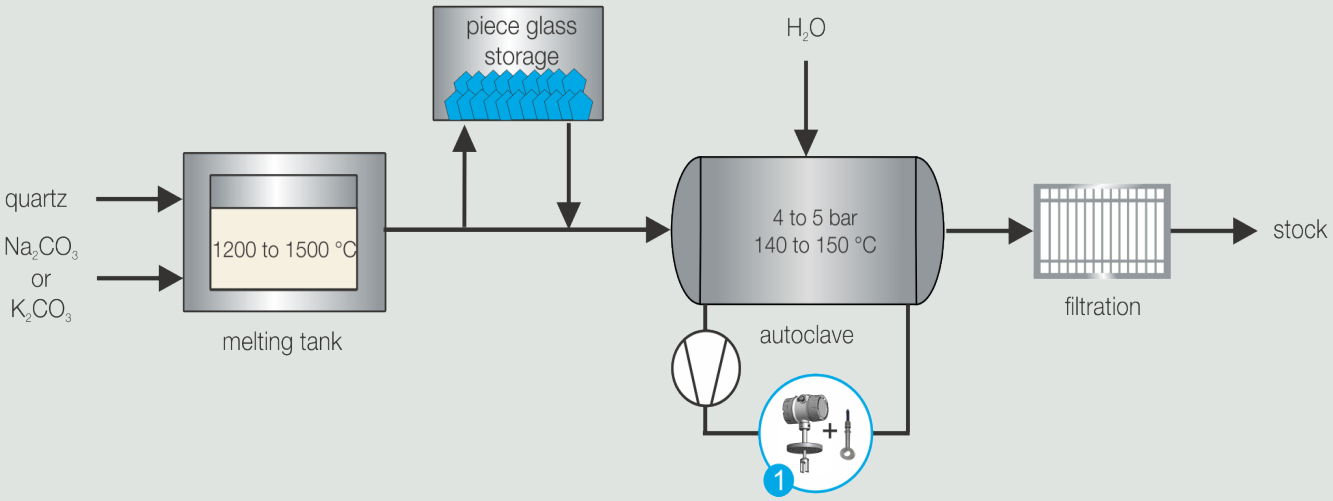


Measuring point	Installation	Measuring task
1	Bypass	Monitoring of SiO_2 and Na_2O or K_2O concentration in the autoclave

Water glass

Introduction

Base materials to produce water glass are quartz sand and different alkali carbonates. Soda (Na_2CO_3) is used for the production of sodium silicate, potash (K_2CO_3) for potassium water glass.

Depending on the alkali silicate type, the raw materials are mixed in the desired proportion (ratio) and used for alkali silicate synthesis. The purity of the raw material is of enormous importance, because they effect the melting process and the product properties.

The LiquiSonic® analyzer guarantees accurate and rapid determination of process concentrations (Na_2O/K_2O and SiO_2) and the process temperature. Through permanent data logging, process parameters can be controlled during quality inspection.

Application

Water glass is produced by melting of highly purified silica sand (SiO_2) with alkali carbonate (Na_2CO_3 or K_2CO_3). The raw material mix is continuously melted at a temperature of 1200 °C - 1500 °C in the melting tank.

The molten alkali silicate is water-cooled till transport on a chain conveyor. The cooled fragments are dissolved in an autoclave at 4 - 5 bar and 140 - 150 °C, until the desired density and viscosity is reached. Even the finest impurities are removed by filtration. The filtered solution is adjusted with water to the desired moisture content.

LiquiSonic® analyzers determine the process concentrations inline and continuously and allow precise process control, to avoid quality fluctuations.

Customer value

The LiquiSonic® analyzer provides a precise inline concentration measurement with real-time monitoring and exact control of the required Na_2O / SiO_2 molar ratio. Thus providing optimal product parameters, like stability and resilience.

LiquiSonic® enables a reduction of labor cost through the elimination of manual process steps:

- time saving: 1 h per day
- cost per hour: 50 € (60 $)
- total cost savings: 10.000 € (12,000 $) per year

LiquiSonic® provides an optimal dissolving speed of the water glass fragments and reduces steam costs:

- steam savings: 0.2 t per hour
- steam costs: 30 € per t (40 $)
- operating hour: 6000 h per year
- total cost savings: 36.000 € per year (48,000 $)

Investment: approx. 25.000 €
Amortization: approx. 6 month

Installation

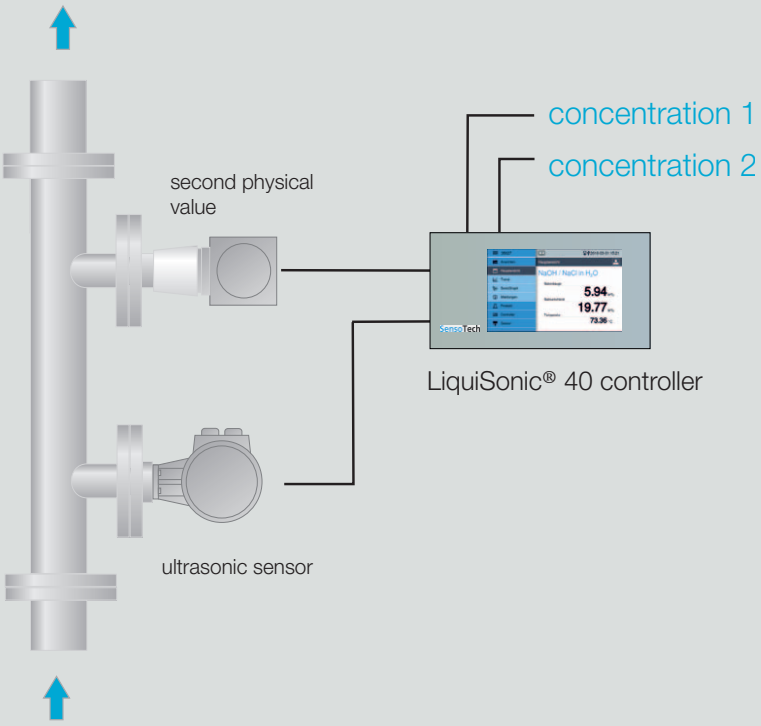
The LiquiSonic® 40 sensors are easily installed in the pipeline from the bypass line of the autoclave. The robust sensor construction and the optional special materials, like HC2000, promote long process life.

The LiquiSonic® controller 40 is connected to the LiquiSonic® immersion sensor and the device for the second physical value. The controller displays the Na_2O or K_2O concentration and SiO_2 content. Further process parameters, like temperature or sonic velocity, are monitored via trend view.

Typical measuring ranges:
concentration range Na_2O: 6 to 9 wt%
concentration range SiO_2: 20 to 30 wt%
temperature range: 40 to 95 °C (105 - 205 °F)

concentration range K_2O: 19 to 24 wt%
concentration range SiO_2: 30 to 35 wt%
temperature range: 40 to 70 °C (105 - 165 °F)

Sonic velocity measurement with LiquiSonic® 40



LiquiSonic® 40

	21001411 LiquiSonic® Controller 40 V10
	21010112 Immersion sensor V10 40-14, DIN DN50, L092
	21006123 Inductive conductivity sensor CM42/CLS50 DN 50
	21005215 Maximum rated sensor temperature: 150 °C
	21004449 Network integration
BUS	21004435 BUS connection: Profibus DP
	21004202 Bus cable indoor (100m)
	21007846 Factory acceptance test (FAT) certificate

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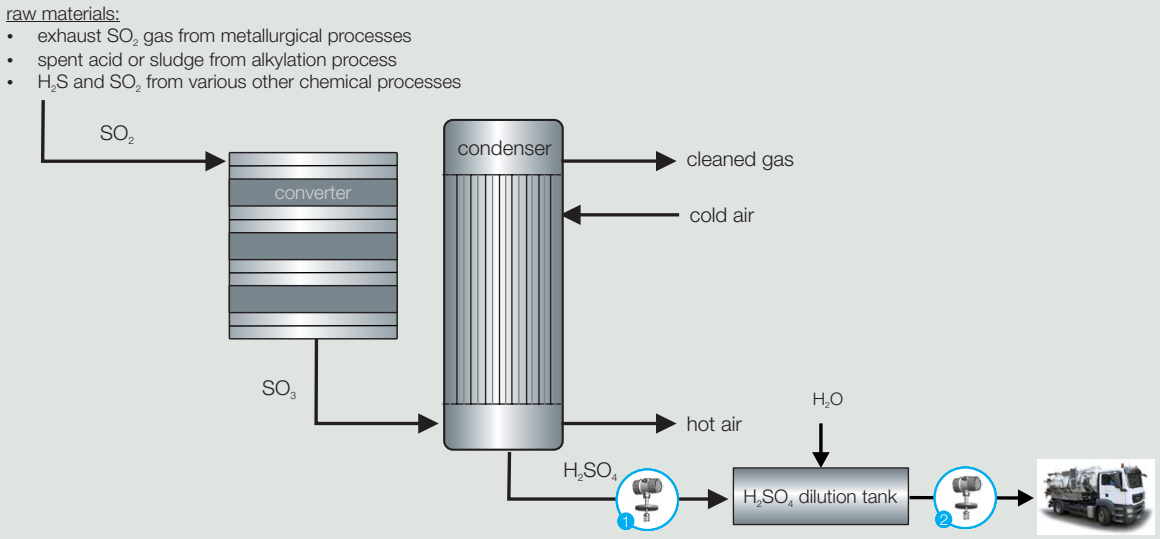


Measuring point	Installation	Measuring task
1	pipeline	monitoring of the sulfuric acid concentration
2	pipeline	control and monitoring the blending to the desired concentration

WSA Process (H_2SO_4)

Introduction

The WSA process (wet gas sulphuric acid) combines compliance with emission regulations and profitable handling of sulfurous exhaust gases. Actually, the wet catalytic sulfuric acid process is one of the most important gas cleaning processes. As it ensures ecological safety and economical benefit in the form of saleable sulphuric acid.

The WSA process is common in the petrochemical industry, especially for:

- Treatment of H_2S from the amine regenerator (MDEA scrubber)
- Regeneration of spent sulfuric acid from alkylation
- Purification of exhaust gases from the Claus plant
- Cleaning of flue gases from the combustion of highly sulfurous fuels, e.g. petroleum coke

Application

In the first step of the wet catalytic process, the sulfur component H_2S from the exhaust gases is catalytically converted to SO_2. In a subsequent step at 400°C, the conversion to SO_3 takes place, which then reacts with the atmospheric moisture to produce sulfuric acid. By using the heat of the reaction and the exhaust gases, this process can be operated without additional thermal energy even at low exhaust gas concentrations (S-components < 0.2 Vol%).

LiquiSonic® ensures an accurate concentration measurement of sulfuric acid, even at high acid concentrations. Each process step can be both monitored continuously with the inline LiquiSonic® analyzer and be optimally set. Sonic velocity changes significantly with minor changes in sulfuric acid concentration, allowing the LiquiSonic measurement to reach an accuracy of +/- 0.05 wt%.

Customer value

The LiquiSonic® analyzer provides a precise inline H_2SO_4 and oleum concentration measurement with real-time monitoring.

The robust sensor construction and the optional special materials, like Hastelloy C2000, promote long process life.

LiquiSonic® enables a reduction of labor cost through the elimination of manual process steps:
time saving: 1 h per day
cost per hour: 50 € (60 $)
total cost savings: 10.000 € (12,000 $) per year

In comparison to conductivity and density measurement, LiquiSonic® generates a clear signal in the 80 to 100 wt% concentration range and provides reliable process information.

Investment: approx. 18.000 € (22,000 $)
Amortization: approx. 2 years

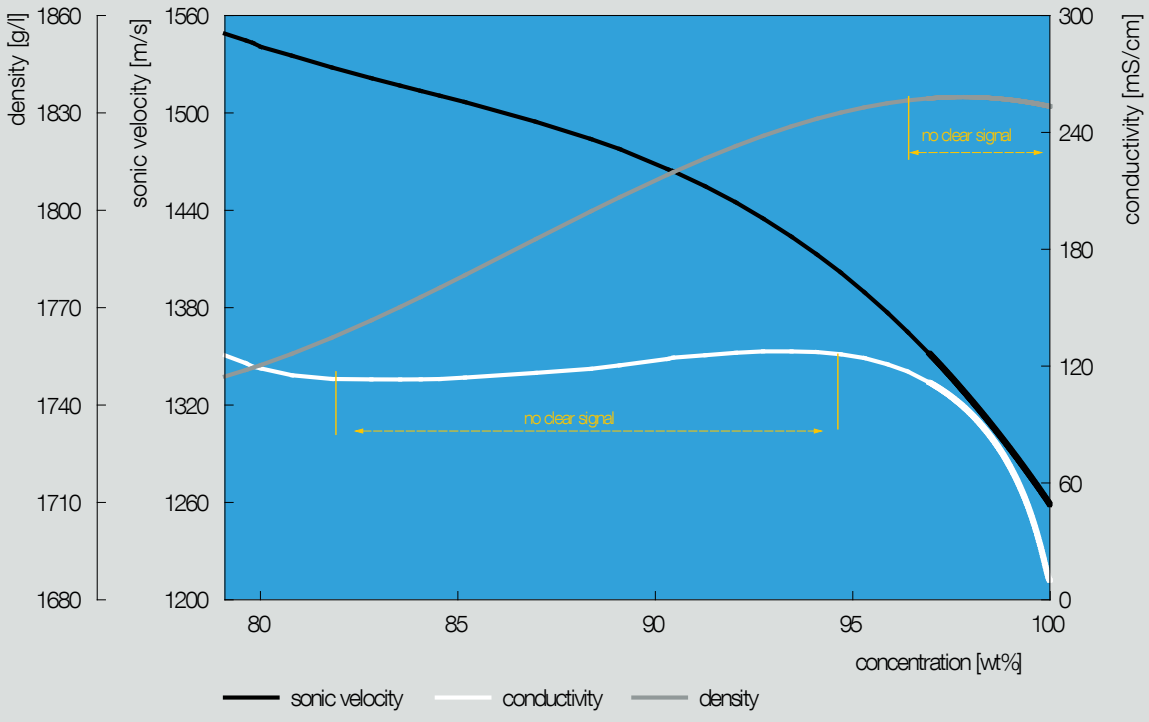
Installation

The LiquiSonic® immersion sensor is easily installed into pipelines after the condenser in sulfuric acid production as well as at the blending station.

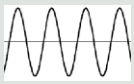
By using the LiquiSonic® controller 30, up to four sensors can be connected, allowing the simultaneous monitoring of several measuring points.

Typical measuring range:
concentration range from H_2SO_4: 80 to 100 wt%
temperature range: 20 to 90 °C

LiquiSonic® sonic velocity measurement



LiquiSonic® 30

	21001311 LiquiSonic® Controller 30 V10
	21010109 Immersion sensor V10 40-14, ANSI 2“, L092, HC2000
BUS	21004435 BUS connection: Profibus DP
	21004449 Network integration
	21004110 High power sensor electronic
	21004202 Bus cable indoor (100m)
	21007846 Factory acceptance test (FAT) certificate

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Scrubbing

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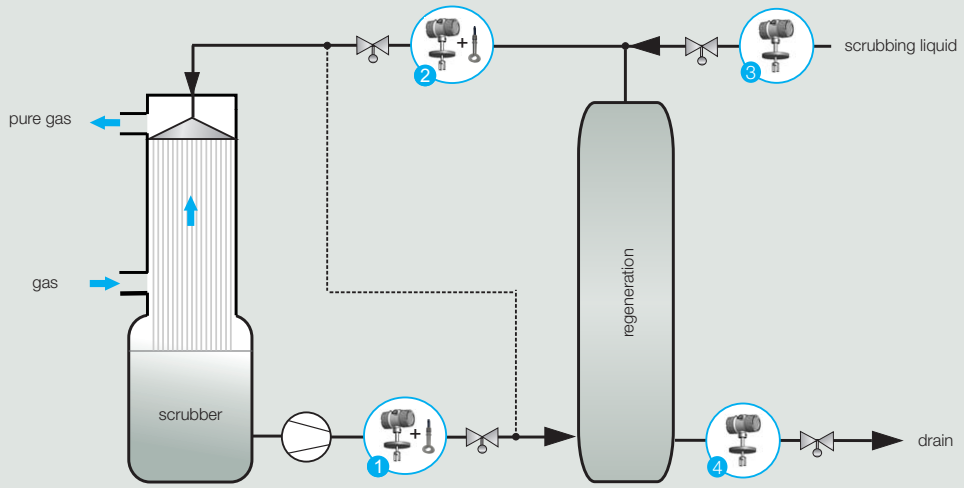


Measuring point	Installation	Measuring task
1,2	pipeline	control and monitoring of the concentration of scrubbing liquid and salt
3	pipeline	control and monitoring of the concentration of fresh srubbing liquid
4	pipeline	monitoring on breakthroughs in the treatment of salts

Phosgene Gas Scrubbing

Introduction

Two different monomers are linked for the production of polyurethanes: polyisocyanates and polyols. This process is also referred to as polyaddition. Thereby two most significant monomers are polyether polyol and the toluene-2,4-diisocyanate (TDI).
The production process is divided into 3 parts:

- preparation of polyether polyol
- production of toluene diisocyanate
- polyaddition.

The TDI is produced from toluylendiamin (TDA) by phosgenation. In emergency cases, the unreacted phosgene must be absorbed, because the gas is highly toxic. In the chemical industry, it is only used in hermetically closed circuits. The neutralization of the gas to sodium chloride (NaCl) and sodium carbonate (Na_2CO_3) takes place with sodium hydroxide (NaOH).

Application

In a gas scrubber, the scrubbing liquid absorbs certain gaseous, liquid or solid components from the gas stream. The circulating scrubbing liquid must be kept in the range of the maximum absorption. In order to ensure an effective absorption of the phosgene in the gas scrubber, the concentration of NaOH, NaCl and of Na_2CO_3 must be monitored.

If the NaOH content is under limit, it must be re-dosed. If the content of the salt is too high, salt is removed from the circulation, since it would otherwise crystallize in the system.

The LiquiSonic® 40 analyzer allows the concentration measurement in 3-components-liquids. Due to the parallel detection of two physical quantities such as sonic velocity and conductivity, two concentration values can be determined simultaneously: the scrubbing liquid and the salts NaCl and Na_2CO_3. This allows a better response to concentration fluctuations in the srubbing liquid.

Customer value

The LiquiSonic® analyzer provides a precise inline concentration measurement with real-time monitoring. Due to automatic control, a sufficient level of scrubbing liquid is maintained, thus keeping the scrubber at its optimal absorption efficiency.

The robust sensor construction and the optional special materials, like HC2000, promote long process life.

LiquiSonic® enables a reduction of labor cost through the elimination of manual process steps:

- time saving: 1 h per day
- cost per hour: 50 € (60 $)
- total cost savings: 10.000 € (12,000 $) per year

The prevention of an over- and underdosing leads to the reduction of material input for the scrubbing liquid:

- 1 % NaOH overdosing in the circulation flow corresponds to: approx. 27.000 € per year

Investment: approx. 25.000 € (30,000 $)
Amortization: approx. 8 month

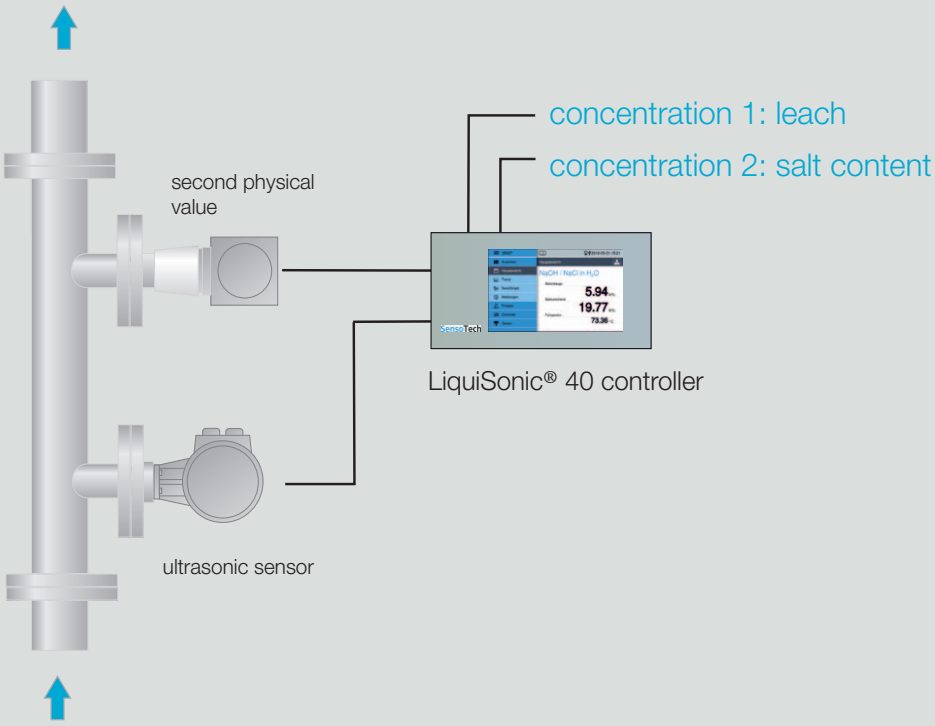
Installation

The LiquiSonic® immersion sensor can easily be installed directly into pipelines. A typical installation point, combined with a conductivity meter, are DN 80 pipelines from the scrubber to the regeneration tank

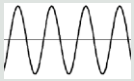
The LiquiSonic® controller 40 is connected to the LiquiSonic® immersion sensor and device for the second physical value. The controller displays NaOH concentration and salt content.

Typical measuring range:
NaOH concentration range: 5 to 20 wt%,
Na_2CO_3/NaCl concentration range: 5 to 30 wt%
temperature range: 30 to 60 °C

Sonic velocity measurement with LiquiSonic® 40



LiquiSonic® 40

	21001411 LiquiSonic® Controller 40 V10
	21010138 Immersion sensor V10 40-40 Ex FM, ANSI 2“, L150, HC2000
	21006123 Inductive conductivity sensor CM42/CLS50 DN 50
BUS	21004435 BUS connection: Profibus DP
	21004449 Network integration
	21004110 High power sensor electronic
	21004202 Bus cable indoor (100m)
	21007846 Factory acceptance test (FAT) certificate

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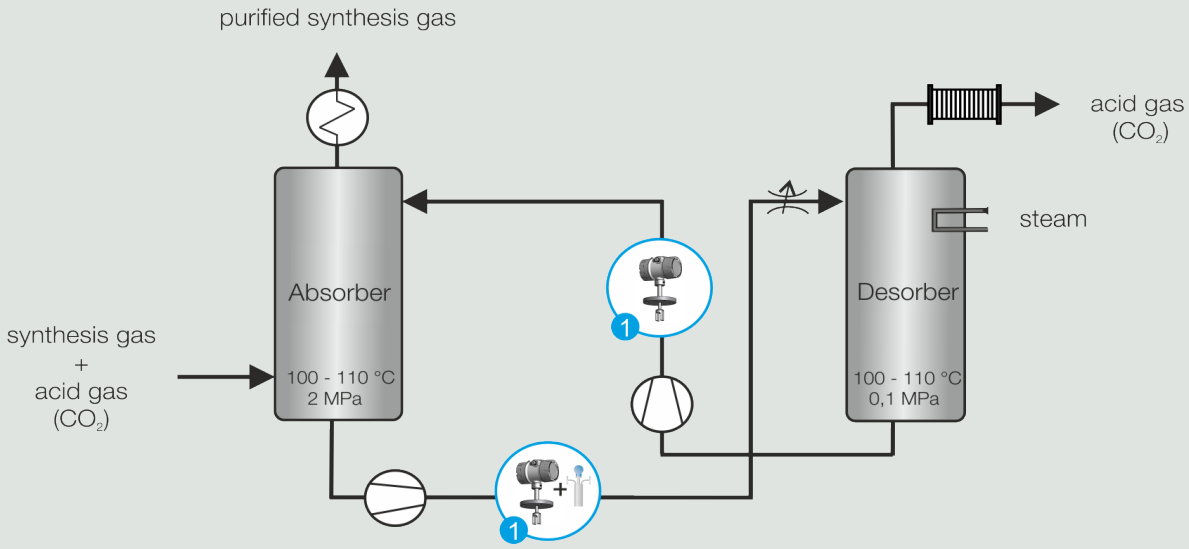


Measuring point	Installation	Measuring task
1	pipeline	monitoring of scrubbing liquid K_2CO_3 and the salt $KHCO_3$
2	pipeline	real time control of regenerated K_2CO_3 solution

Benfield Process Scrubber

Introduction

In many industrial plants, contaminated gas accrues for example in the ammonia synthesis or in an ethylene oxide plant. For quality reasons, the CO_2 enriched gas has to be cleaned. Therefore a well-known approach in the chemical industry is the Benfield synthesis gas scrubber where the acidic components in the gas stream (such as CO_2) are absorbed by means of a scrubbing liquid.

In the purification of the gas stream, the focus is to prevent an under- or overdosing of the scrubbing liquid. Inline analyzer are used to prevent insufficient gas cleaning and in case of overdosage the higher material usage and associated costs.

By a continuous measurement directly in the process, an optimum concentration management can be assured.

Application

A hot potassium carbonate (K_2CO_3) solution is used in the Benfield process as a scrubbing liquid. The gas to be cleaned is passed under high pressure in a counterflow through the K_2CO_3 solution in the absorber. The scrubbing solution K_2CO_3 is enriched with CO_2 and reacts partially to potassium bicarbonate $KHCO_3$. The purified gas leaves the absorber at the upper end. The temperature range in the absorption process is between 100 °C and 110 °C.

The desorption is carried out by steam and under pressure loss, whereby the captured CO_2 is emitted into the scrubbing liquid. The regenerated K_2CO_3 is then fed back to the absorption cycle.

The LiquiSonic® 40 analyzer allows the optimal response to concentration fluctuations in the scrubbing liquid. Too high $KHCO_3$ concentration results in foam formation and lesser CO_2 absorption performance. At too low K_2CO_3 concentration, sufficient absorption is not ensured.

Customer value

LiquiSonic® 40 provides a precise inline concentration measurement of 3-component mixtures with real-time monitoring. This allows an automatic control of the K_2CO_3 concentration in the range of the maximum absorption or the maximum efficiency of the scrubber.

LiquiSonic® enables a reduction of labor cost through the elimination of manual process steps:

- time saving: 1 h per day
- cost per hour: 50 € (60 $)
- total cost savings: 10.000 € (12,000 $) per year

Through prevention of under- or overdosing, the operational costs related to their consumption at absorber (K_2CO_3) and desorber (steam) are saved:

- steam savings: 0.3 t per hour
- steam costs: 30 € per t (40 $)
- operating hour: 6000 h per year
- total cost savings: 54.000 € per year (72,000 $)

Investment: approx. 25.000 € (30,000 $)
Amortization: approx. 6 month

Installation

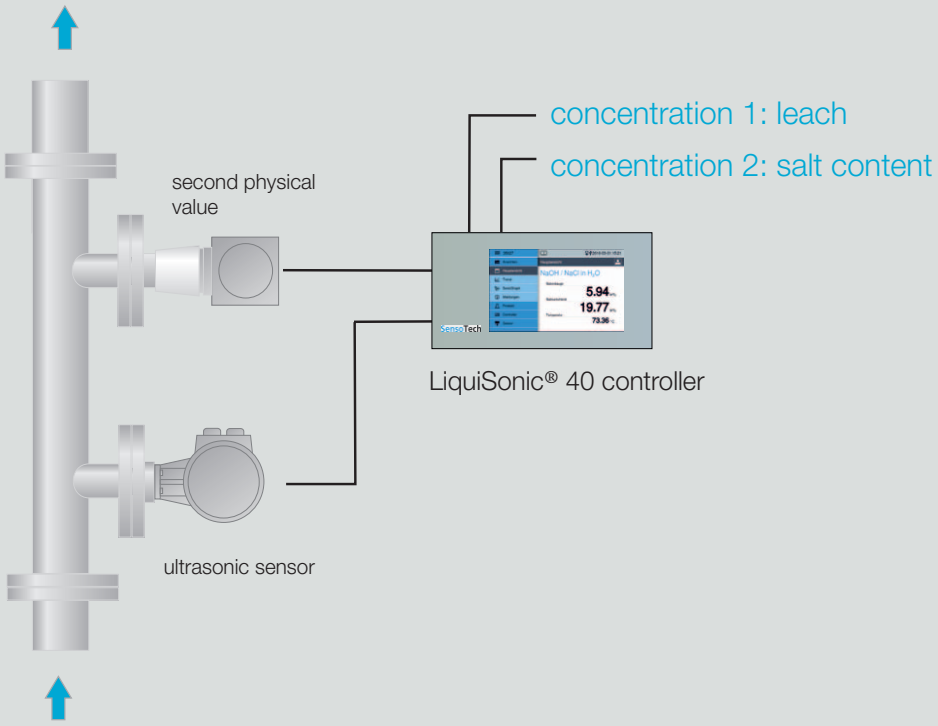
The LiquiSonic® 40 sensors are easily installed in the pipeline (typically DN 80) from the absorber to the desorber and the recirculation.

The robust sensor construction and the optional special materials, like HC2000, promote long process life.

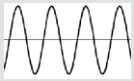
The LiquiSonic® controller 40 is connected to the LiquiSonic® immersion sensor and the device for the second physical value. The controller displays the K_2CO_3 concentration and $KHCO_3$ - salt content.

Typical measuring range:
concentration range K_2CO_3: 0 to 25 wt%
concentration range $KHCO_3$: 0 to 25 wt%
temperature range: 80 to 110 °C

Sonic velocity measurement with LiquiSonic® 40



LiquiSonic® 40

	21001411 LiquiSonic® Controller 40 V10
	21010138 Immersion sensor V10 40-40 Ex FM, ANSI 2“, L150, HC2000
	21006020 Density sensor BR, DN15, PN40, Ex i, 1.4571, T_{max}=150°C
BUS	21004435 BUS connection: Profibus DP
	21004449 Network integration
	21004110 High power sensor electronic
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	21007846 Factory acceptance test (FAT) certificate

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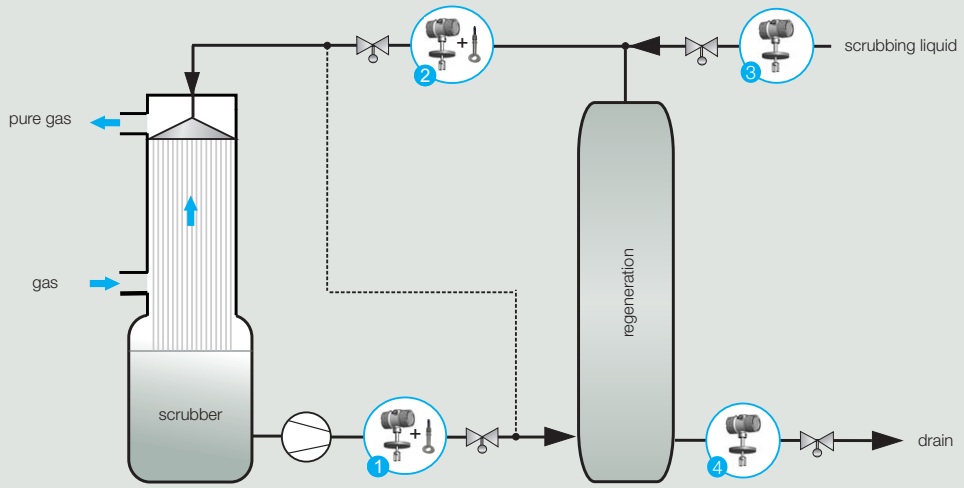


Measuring point	Installation	Measuring task
1,2	pipeline	control and monitoring of the concentration of scrubbing liquid and salt
3	pipeline	control and monitoring of the concentration of fresh srubbing liquid
4	pipeline	monitoring on breakthroughs in the treatment of salts

Emergency Vent Scrubber

Introduction

In the chemical industry, emergency vent scrubbers (EVS) are used to absorb toxic or environmentally hazardous gases and vapors.
In addition to traditional process gas scrubbers, the EVS provides continuous assurance of process and plant safety. Even in the event of an emergency, there is enough scrubbing liquid on hand to completely chemically bind the hazardous or toxic gases.
Typical applications of emergency vent scrubbers in chemical processes are to absorb emissions, such as chlorine, bromine, phosgene, sulfur dioxide, NO_x, HF and ammonia. For the neutralization of these gases, caustic soda and caustic potash solutions are used. The gas flow passes the scrubbing liquid and in case of emergency, the release of toxic or critical gases is prevented.
SensoTech inline analyzers are often used to monitor the scrubbing liquid, which improves the system stability and quality.

Application

The scrubbing liquid of an emergency vent scrubber circulates and is continually in contact with the gas stream to be cleaned. If toxic or environmentally hazardous chemicals are included in this stream, they will be absorbed. Even during standard operation (without emergency), certain components, e.g. CO_2, are chemically bound and the NaOH concentration decreases. In order to ensure an effective absorption in the event of an emergency and a sufficient volume of scrubbing liquid, the concentration of NaOH and salts (NaCl and Na_2CO_3) must be monitored.
If the NaOH content is under limit, it must be re-dosed. In case of too high salt content, the salt must be removed from the circulation stream, to prevent crystallization in the system and blocked nozzles.
The LiquiSonic® 40 analyzer allows the concentration measurement of 3-components-liquids, due to the parallel detection of two physical quantities such as sonic velocity and conductivity.

Customer value

The LiquiSonic® analyzer provides a precise inline concentration measurement with real-time monitoring. Due to automatic control, a sufficient level of scrubbing liquid is maintained, thus keeping the scrubber at its optimal absorption efficiency.

LiquiSonic® enables a reduction of labor cost through the elimination of manual process steps:

- time saving: 1 h per day
- cost per hour: 50 € (60 $)
- total cost savings: 10.000 € (12,000 $) per year

The prevention of an over- and underdosing leads to the reduction of material input for the scrubbing liquid:

- 1 % NaOH overdosing in the circulation flow corresponds to: approx. 27.000 € per year

The LiquiSonic® system ensures consistent plant and system safety, even in emergency case.

Investment: approx. 25.000 € (30,000 $)
Amortization: approx. 8 month

Installation

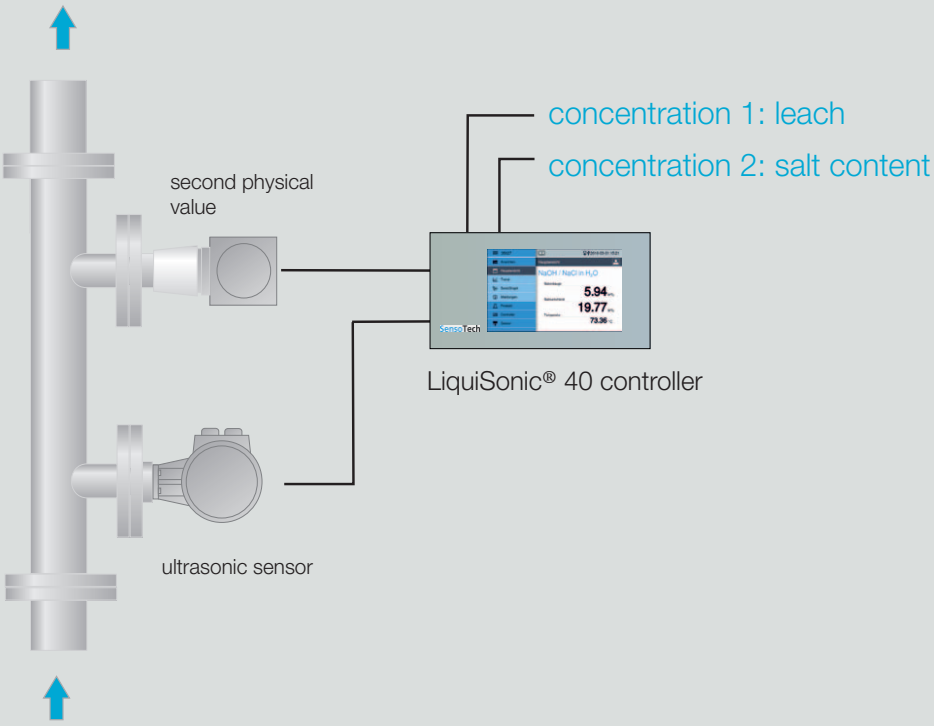
The LiquiSonic® immersion sensor is easily installed directly into pipelines. A typical installation point, combined with a conductivity meter, are DN 80 pipelines from the scrubber to the regeneration tank

The robust sensor construction and the optional special materials, like HC2000, promote long process life.

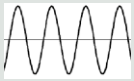
The LiquiSonic® controller 40 is connected to the LiquiSonic® ultrasonic sensor and the device for the second physical value (conductivity meter). The controller displays NaOH concentration and salt content.

Typical measuring range:
NaOH concentration range: 5 to 20 wt%,
Na_2CO_3/NaCl concentration range: 5 to 30 wt%
temperature range: 30 to 60 °C

Sonic velocity measurement with LiquiSonic® 40



LiquiSonic® 40

	21001411 LiquiSonic® Controller 40 V10
	21010138 Immersion sensor V10 40-40 Ex FM, ANSI 2“, L150, HC2000
	21006123 Inductive conductivity sensor CM42/CLS50 DN 50
BUS	21004435 BUS connection: Profibus DP
	21004449 Network integration
	21004110 High power sensor electronic
	21004202 Bus cable indoor (100m)
	21007846 Factory acceptance test (FAT) certificate

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Electronics & Photovoltaics

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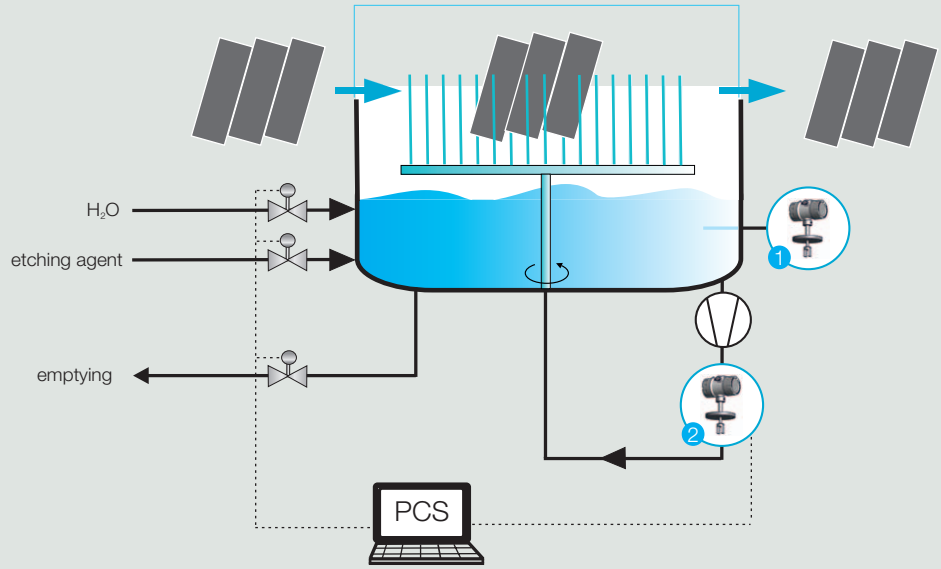


Measuring point	Installation	Measuring task
1,2	pipeline, bath	concentration monitoring of etching agent, e.g. KOH

Texturing & Etching Bath

Introduction

The base material to manufacture photovoltaic cells are monocrystalline or multicrystalline silicon blocks. These blocks (ingots) are sawed to silicon discs or wafers of defined size. Then surface damages and impurities are removed by wet chemical etching. Special etching and texturing agents are used to optimize the wafer surface, reduce crystal damages and increase the wafer life span.
Additionally, the etching and texturing process has an advantage regarding energy input. The roughened, optimized structure is able to absorb more light and increase the efficiency of the photovoltaic cell. Various texturing chemicals can be used depending on the wafer type and desired outcome of the process. Typical alkaline etching agents are caustic soda and caustic potash solutions. Acidic etching of wafers and silicon is done with sulphuric acid, nitric acid and hydrofluoric acid. The completion steps are neutralization and the removal of residues.

Application

Alkaline or acidic etching agents remove the surface damage induced by the sawing process and texture the surface of the wafer. Acidic etching agents, like HF and HNO_3 are used for isotropic etching. Typical alkaline etching agents are caustic soda (NaOH), caustic potash (KOH) and tetramethylammonium hydroxide (TMAH) solutions. Wafer surface texturing is important to improve the light trapping into the cell and the energy absorption capacity. The major factors of influence in this process are the current bath concentration and residence time. Because of the consumption and discharge of etching chemicals during the texturing process, it is necessary to measure the concentration and temperature continuously. This insures consistant product quality and, if needed, more etching agents can be added. LiquiSonic® inline analyzers monitor the current texturing and etching bath concentration. This enables an automatic additional dosing through the incorporation in to existing process control systems.

Customer value

The LiquiSonic® analyzer provides a precise inline bath concentration measurement with real-time monitoring. This allows the process to be automatically controlled in the optimal concentration range with the maximum efficiency. LiquiSonic® is used to avoid a underdosage or overdosage of etching solution.

The robust sensor construction and the optional special materials, like Halar oder PFA, promote long process life.

LiquiSonic® enables a reduction of labor cost through the elimination of manual process steps:
time saving: 1 h per day
cost per hour: 50 € (60 $)
total cost savings: 10.000 € (12,000 $) per year

The avoidance of insufficient dosages saves material costs and secures constant process quality.

Investment: approx. 12.000 € (15,000 $)
Amortization: approx. 12 month

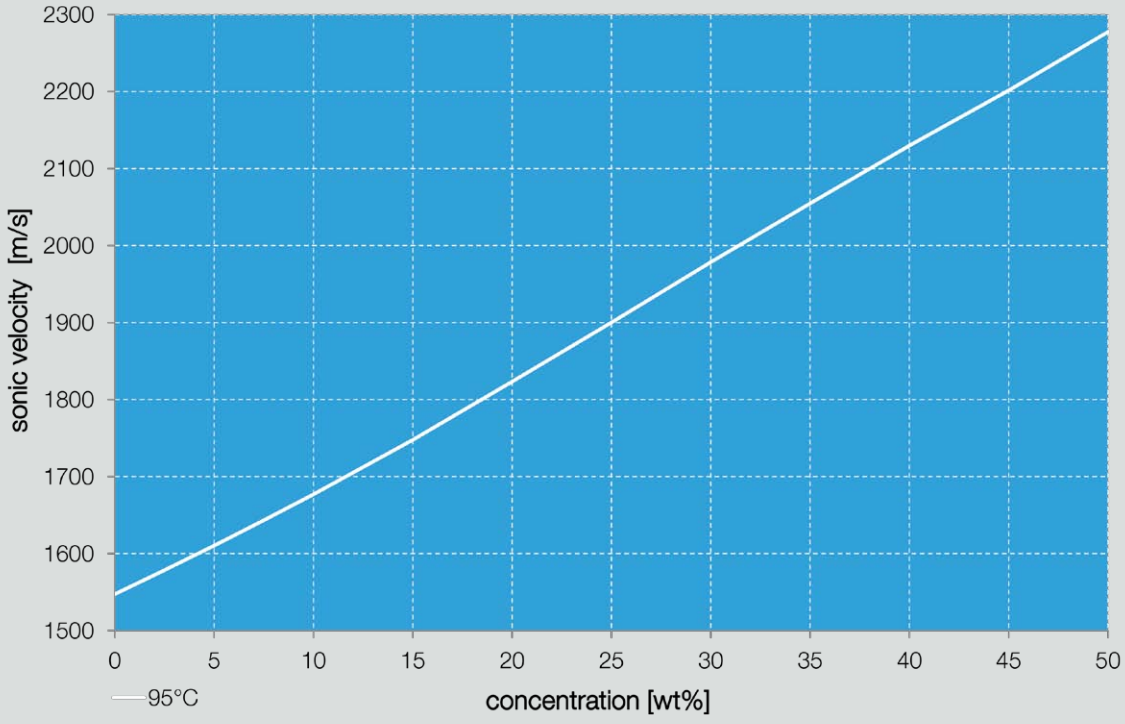
Installation

The LiquiSonic® immersion sensor is easily installed into the bath circulation pipeline or directly in the texturing or etching bath.

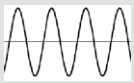
By using the LiquiSonic® controller 30, up to four sensors can be connected, allowing the simultaneous monitoring of several measuring points.

Typical measuring range:
concentration range: 0 to 55 wt%
temperature range: 80 to 120 °C (170°F to 250°F)

LiquiSonic® sonic velocity measurement in KOH solution



LiquiSonic® 30

	21001311 LiquiSonic® Controller 30 V10
	21010112 Immersion sensor V10 40-14, DIN DN50, L092
	21004350 T-adapter for immersion sensor DN50-50-50 PN16
BUS	21004435 BUS connection: Profibus DP
	21004449 Network integration
	21004110 High power sensor electronic
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	21007846 Factory acceptance test (FAT) certificate

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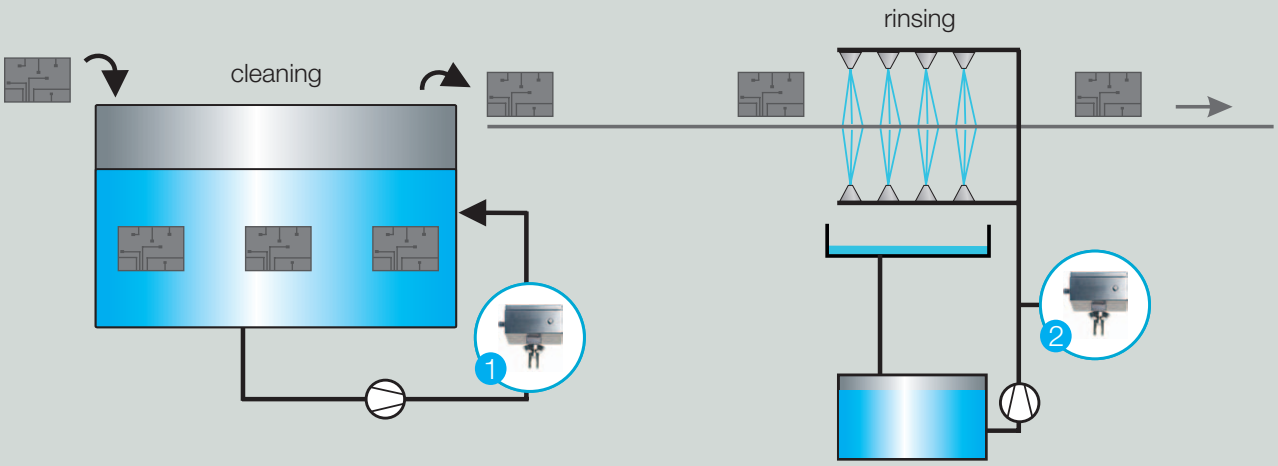


Measuring point	Installation	Measuring task
1	bypass pipe	Monitoring of cleaning agent concentration or contamination degree
2	circulation pipe	Rinsing process monitoring and cleaning liquid carryover control

PCB Cleaning

Introduction

In the manufacture of printed circuit boards, fiber-reinforced plastics are coated with copper layers. Subsequently, the conductor tracks are etched from the flat copper layers and the respective components are soldered to the circuit board.

The cleaning of printed circuit boards is an essential process step to remove impurities such as film-like or particulate residues from flux, resin or soldering paste. The impurities may cause electrical failures and corrosion of the circuit boards or assemblies. Often, single-chamber, multi-chamber and continuous flow cleaning systems are used for this purpose.

The purification process significantly influences the product lifetime and increases their reliability. As electrical parameters of the electronic components are being improved by purification, continious bath control is of enormous importance.

Application

The cleaning process of printed circuit boards consists of a cleaning step, followed by one or more aqueous rinsing steps. Often this is done in a spray cleaning system. Thereby, the precise dosed cleaning liquid is sprayed through nozzles on the assemblies.

Aqueous cleaners, such as Vigon and Atron, and anhydrous cleaner, such as Zestron are common. An aqueous cleaning process basically offers the advantages that the cleaners have no flash point and only a very low VOC-content.

Through many years of experience, the LiquiSonic® analyzer is a reliable partner in bath control and convinces with precise concentration determination of different types of cleaners. LiquiSonic® provides real-time data and permanent data recording, which is essential for high product quality and to avoid rejects.

Customer value

The inline LiquiSonic® analyzer enables the detection of the bath composition. The measured values are available online and will be forwarded directly to the process control system. Thus an immediate reaction to deviations of the measured value is possible, such as follow-on filling or bath replacement. Quality fluctuations are reliably prevented.

LiquiSonic® reduces extensive lab measurement:
time saving: 2 x 0.5 h per day
cost per hour: 50 € (60 $)
total cost savings: 10.000 € (12,000 $) per year

LiquiSonic® optimize processes:

- Rapid detection of quality changes
- Internal data storage for quality management
- Optimizing the lifetime of the cleaning baths
- Avoid overdosing or early bath changes
- Optimal cleaning performance (process safety)
- Avoid over- and underdosing to save material costs

Installation

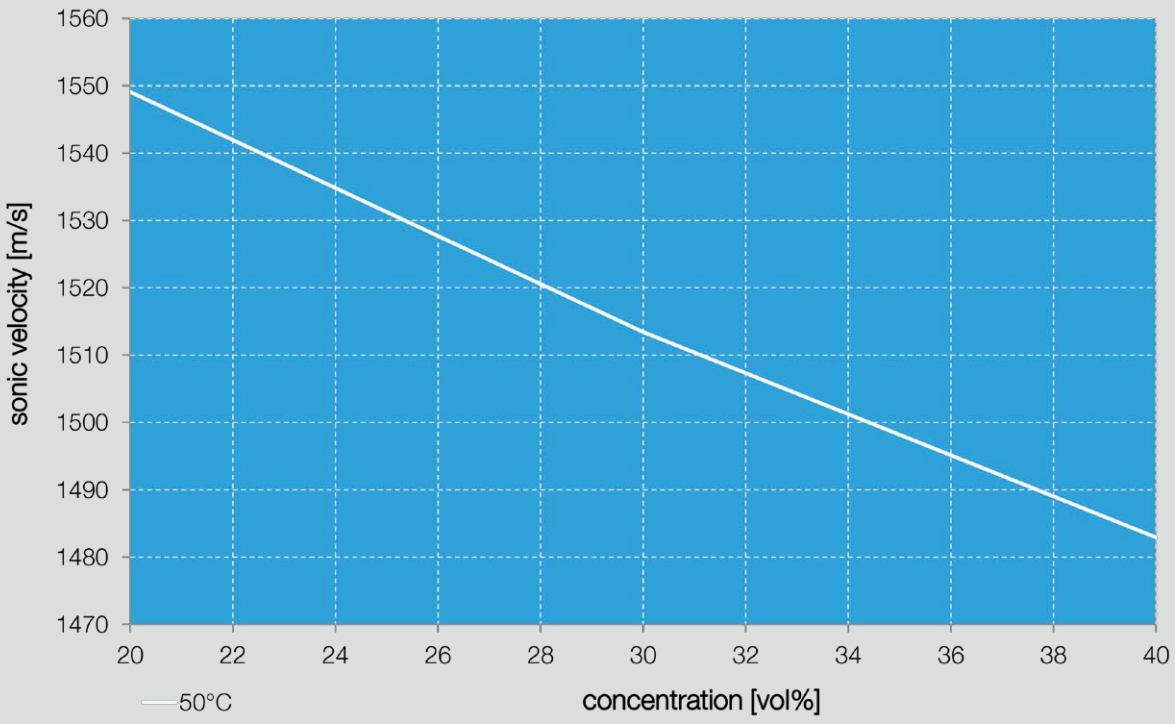
The LiquiSonic® sensors are preferably installed in the circulation circuit after the pump or directly into the cleaning or rinsing bath.

By using the LiquiSonic® Bath Monitor, up to four sensors can be connected, allowing the simultaneous monitoring of several measuring points.

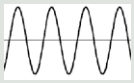
The sensor electronics is mounted in closed stainless steel housing with IP68 degree of protection, ideally suited for the process system cleaning with high-pressure washers. Bath monitoring in hazardous areas (non-aqueous cleaners) is made possible by sensors approved by ATEX, IECEx and FM.

Typical measuring range (e.g. Vigon A200):
concentration range: 20 to 40 vol%
temperature range: 30 to 60 °C

LiquiSonic® sonic velocity measurement in Vigon A200



LiquiSonic® Bath monitoring

	21007262 LiquiSonic® Bath Monitor V10
	21010119 LiquiSonic® Cleaning bath sensor V10 with seperated housing
	21004463 Field housing (stainless steel) for LiquiSonic Controller
BUS	21004435 BUS connection: Profibus DP
	21004449 Network integration
	21004110 High power sensor electronic
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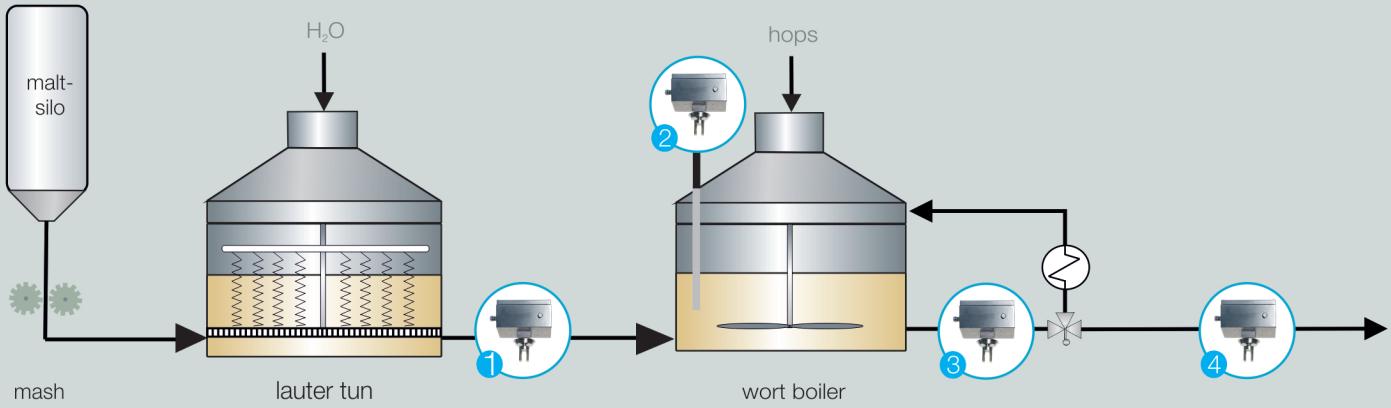


Measuring point	Installation	Measuring task
1	pipeline	concentration monitoring of lautering wort and initial extract in the wort boiler; recognition of the sparge water point
2	wort boiler	concentration monitoring of wort in the internal boiler
3	pipeline	concentration monitoring of wort in the external boiler
4	pipeline	concentration monitoring of cast wort

Wort boiler

Introduction

The wort boiling takes place either in the wort pan or externally with an external boiler, which can be designed as a shell or plate heat exchangers. The boiling time per brew is between 50 and 75 minutes.

Objectives of wort boiling:

- adjustment of the desired wort concentration
- destruction of malt enzyme
- fixation of the wort composition
- sterilization of the wort
- protein coagulation
- hop isomerization
- flavor formation
- evaporation of undesirable flavors

For quality and efficiency reasons, the wort concentration must be controlled continuously in the brewhouse.

Application

The LiquiSonic® Plato system determines the wort at different points of the brewing process. In the wort pan, the LiquiSonic® Plato system is used for:

- control of the boiling process
- accurate monitoring of the cast wort concentration

The immersion sensor is fully made of stainless steel, and due to the robust construction the sensor works maintenance-free and drift-free with long life time. The LiquiSonic® high-power technology provides a stable measurement even with gas bubbles in the liquid.

The LiquiSonic® controller enables an automatic product switching. The internal limit value monitoring signals exceeding or falling below thresholds and transfers the real-time information via analog or digital outputs, serial interfaces, or fielbus (Profibus DP, Modbus) to the process control system.

Customer value

The LiquiSonic® analyzer provides a precise inline concentration measurement with real-time monitoring. The system is used in the indoor as well as in the outdoor boiler. Thus, no expensive bypass solutions are required.

LiquiSonic® enables a reduction of labor cost and eliminates complex manual sampling:
time saving: 2 h per day
cost per hour: 100 € (120 $)
total cost savings: 20.000 € (24,000 $) per year

Through the continuous determination of the cast wort, the boiling time can be shortened.
Example for 1,700 brews per year with 560 hl cast wort per brew and heating oil price of 0.86 € per liter:

- saving of 1 kWh/hl corresponds to a cost saving of 85,000 € per year (106,000 $)

Investment: 12.000 € (15,000 $)
Amortization: 1 month

Installation

For the internal boiler, the LiquiSonic® sensor is installed directly into the wort pan. The immersion length is variable and can reach up to 3 m. A special design of the sensor keeps the influence of deposits low. Additionally, the sensor in the internal boiler can be equipped with a cleaning head, in order to avoid encrustation by foam.

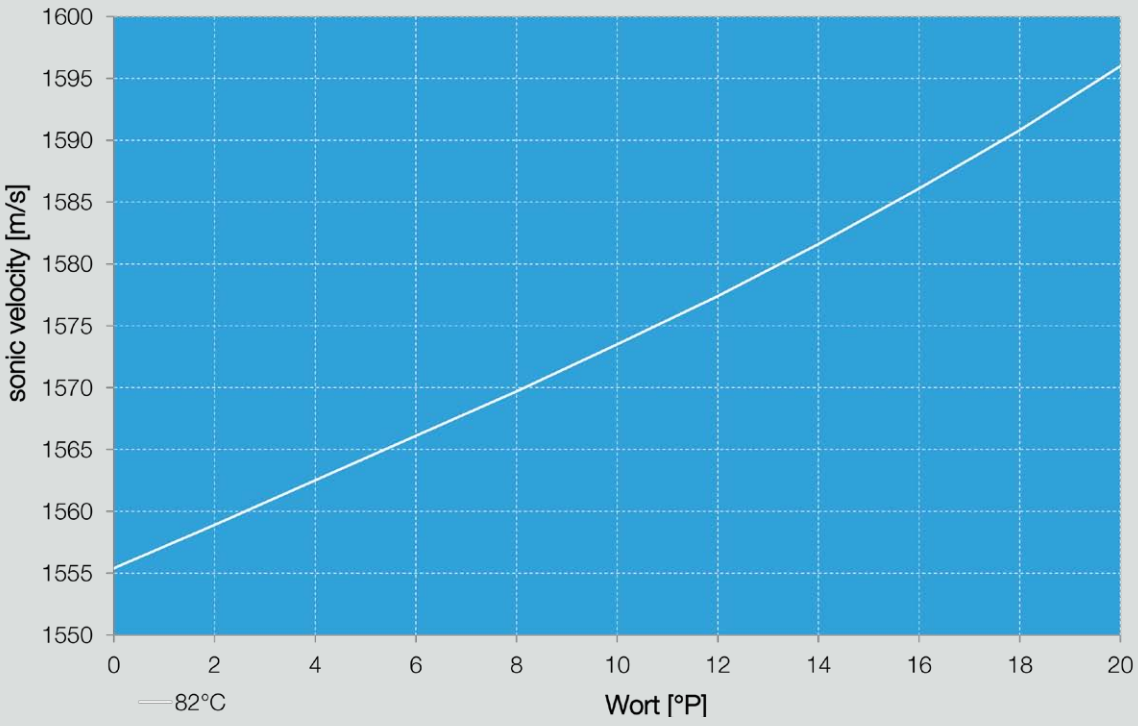
If the LiquiSonic® sensor is used in an outdoor boiler, it is mounted directly into the circulating pipe between wort the supply pump and heat exchanger.

Installing the LiquiSonic® sensor eliminates dead space and avoids high installation costs for bypasses.

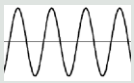
By using the LiquiSonic® Plato controller 30, up to four sensors can be connected, allowing the simultaneous monitoring of several measuring points. Furthermore, up to 99 beer types with specific calculation models can be stored in the controller.

concentration range: 0 °P to 20 °P
temperature range: 40 °C to 120 °C

LiquiSonic® sonic velocity measurement in wort boiler



LiquiSonic® Plato

	21007232 LiquiSonic® Plato Controller 30 V10
	21010116 Immersion sensor V10 Food, Varivent, L061
	21004463 Field housing (stainless steel) for LiquiSonic Controller V10
BUS	21004435 BUS connection: Profibus DP
	21004449 Network integration
	21004110 High power sensor electronic
	21004202 Bus cable indoor (100m)
	21007846 Factory acceptance test (FAT) certificate

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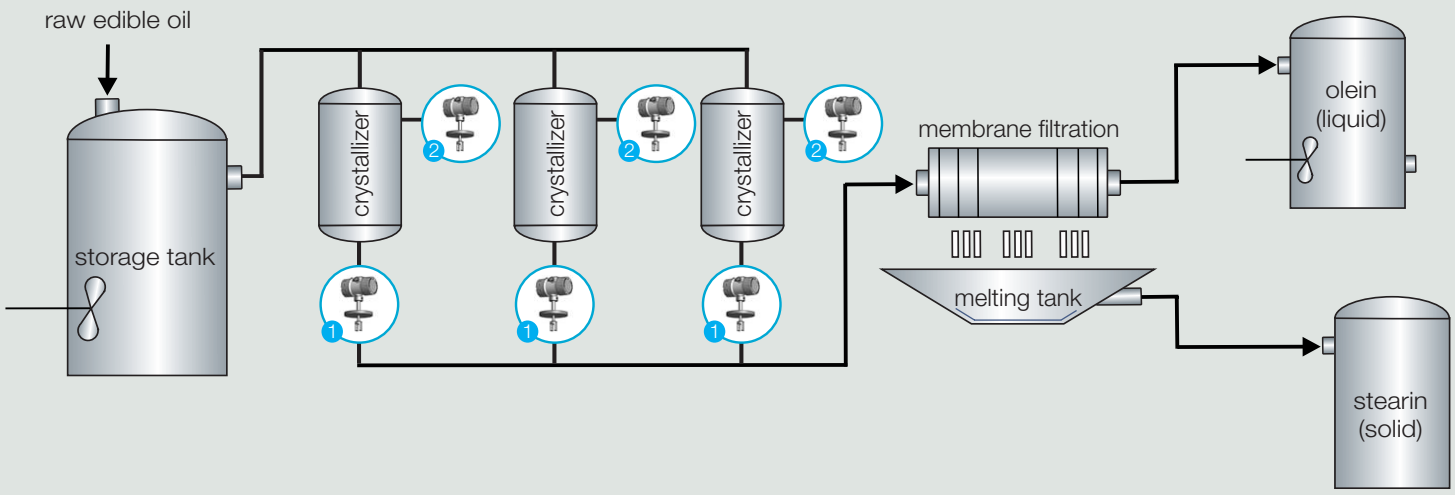


Measuring point	Installation	Measuring task
1	Outlet crystallizer	Determination of solid fat content (SFC)
2	Crystallizer vessel	Inline process monitoring of dry fractionation and crystallization

Oil dry fractionation

Introduction

In their native type, numerous edible oils are not usable for food purposes. To optimize their texture and structural properties, the food industry uses various chemical and physical modifications. Edible oils with a modified texture are most suitable for a consistent final product quality and a stable processing chain.

Dry fractionation is one of the first and most prominent texture-improving processes. It is mostly used for edible oils with high solid fat content (SFC), e.g.:

- palm oil or palm kernel oil
- coconut oil
- soybean oil

The inline LiquiSonic® system provides an optimized dry fractionation process control and precise solid fat content determination.

Application

Dry fractionation is based upon the principle of separation according to the varying melting points for the fat fractions within the edible oil. The method works without solvents. Caused by temperature changes, valuable fatty acids with a higher melting point are separated from the low melting liquid fat fraction. In case of palm kernel oil, solid fat is used as cocoa butter substitute.

In a crystallization unit, the temperature is slowly lowered until semisolid palm oil forms crystals. The resulting solid fat consists of high melting fat crystals (Stearins). The liquid fat fraction (Oleins) is separated by high-pressure membrane filtration.

The maintenance-free LiquiSonic® analyzers provide a real-time dry fractionation monitoring, based on sonic velocity and attenuation. Once the target SFC is reached, the edible oil fractions will be filtered and a consistent product quality is obtained.

Customer value

LiquiSonic® convinces customers with precise inline solid fat content determination and real-time process monitoring, based on sonic velocity and attenuation.

The robust sensor construction without moving parts enables a long-time use in process. The crystallization time is reduced by optimal monitoring of nucleation, cooling rate and SFC. That increases the dry fractionation efficiency.

Additional advantages are:

- optimum line control and reliable process data
- quality check and SFC determination
- stable product properties and texture
- early recognition of nucleation or malfunctions in a matter of seconds
- reduced material, maintenance and energy costs
- reduced sampling and lab analyze

Investment: approx. 15.000 € (18.000 $)

Amortization: approx. 1 year

Installation

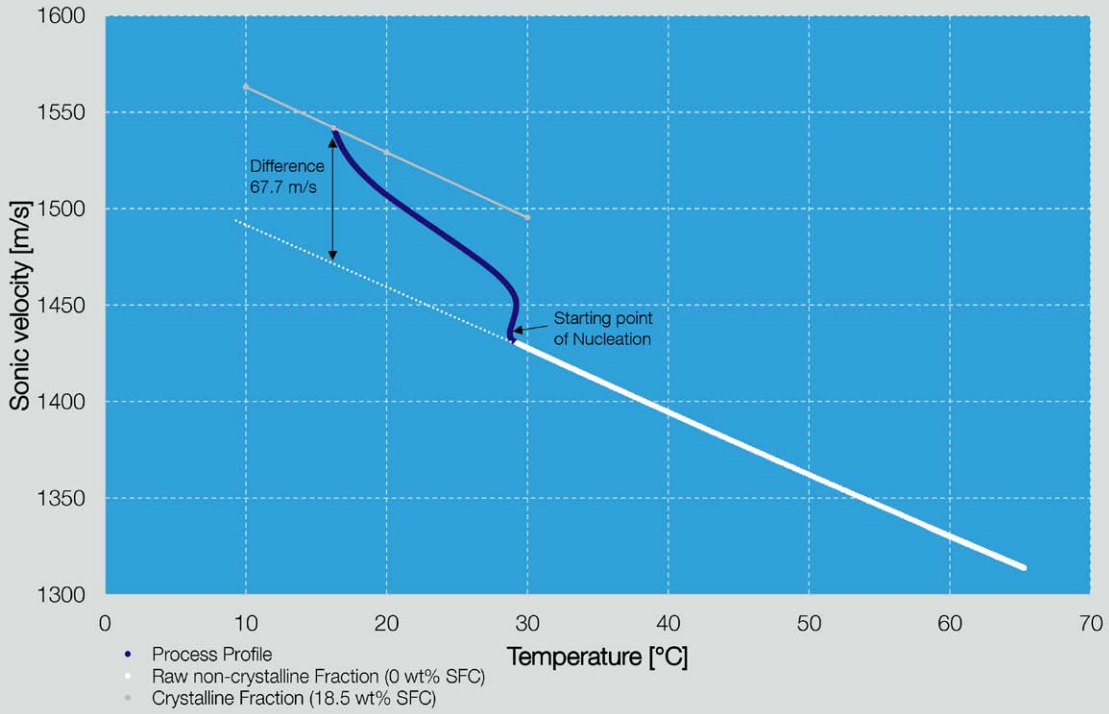
The LiquiSonic® immersion sensor can easily be installed directly into the crystallizer or into pipelines. Based by high power electronics, it is well-equipped for measurements in highly viscous suspensions.

By using the LiquiSonic® controller 30, up to four sensors can be connected, allowing the process at several crystallizers to be monitored.

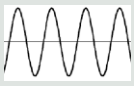
A typical application is the crystallization process control and SFC calculation, based on sonic velocity, attenuation and temperature. LiquiSonic® parameter can be easily implemented into the process control system.

Typical measuring range:
concentration: 0 to 20 wt% SFC - Palm oil (RBDPO)
temperature: 10 to 70 °C (50 to 160 °F)

LiquiSonic® sonic velocity profile of RBDPO dry fractionation



LiquiSonic® 30

	21001311 LiquiSonic® Controller 30 V10
	21010114 Immersion sensor V10 40-14, DIN DN50, L150
BUS	21004435 BUS connection: Profibus DP
	21004449 Network integration
	21004110 High power sensor electronic
	21004402 Attenuation measurement
	21004202 Bus cable indoor (100m)

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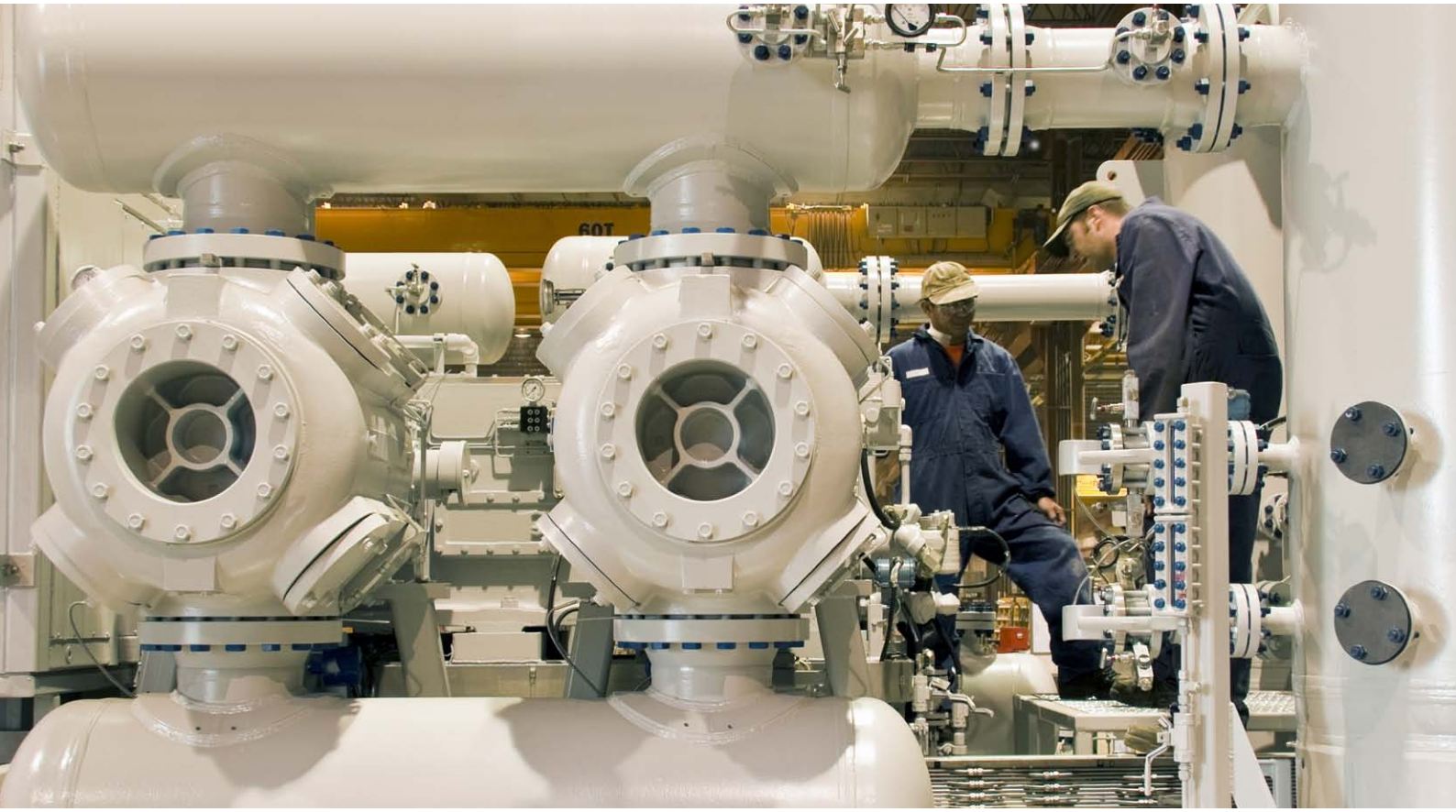

Pulp and Paper

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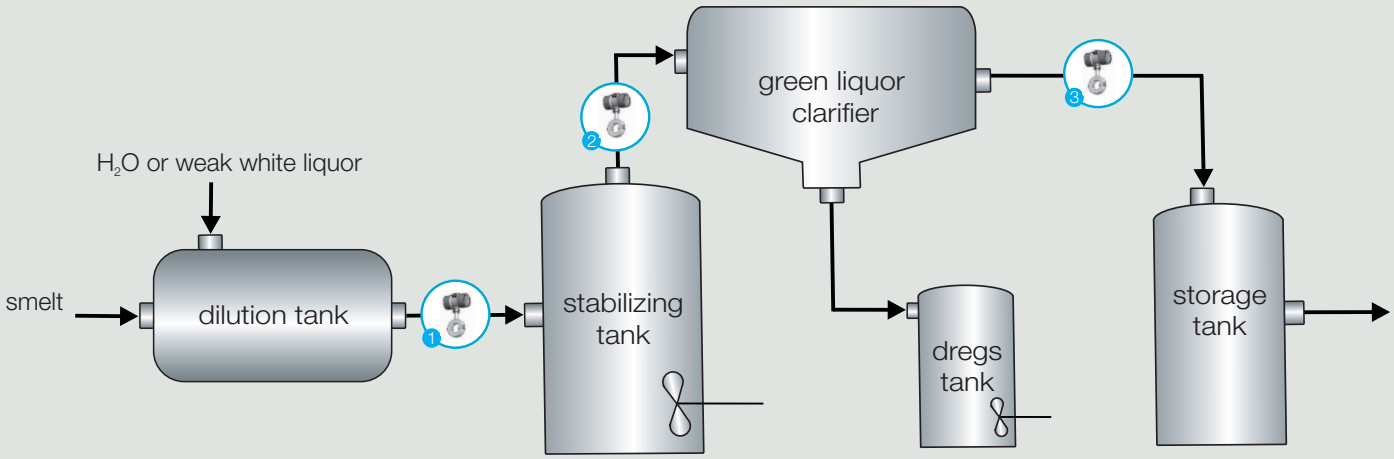


Measuring point	Installation	Measuring task
1	pipe after dilution	process monitoring of recycling process
2	pipe to clarifier	determination of green liquor concentration
3	pipe after clarifier	concentration measurement for subsequent causticizing

Green liquor treatment

Introduction

One of the most important processes in the pulp and paper industry is the alkaline sulphate process where lignin is separated from the fibrous material.
Due to economic and environmental reasons, the chemicals used in this process need to be recycled.

In the recycling process the black liquor will be concentrated and burned to remove organic materials like lignin. This recovery process generates - in addition to energy - a smelt with high salt content, the base material for green liquor. Through causticizing with lime, the sodium carbonate in green liquor is converted to sodium hydroxide, re-used in white liquor for the next pulping process.

By using LiquiSonic® analyzers, each process step can be inline monitored and set in an optimal way. The LiquiSonic® system provides an optimized quality control and productivity increase, especially through fast process monitoring while liquor recycling.

Application

The base material in the liquor recycling process is black liquor. While burning an inorganic salt-rich smelt is formed, sediments on the ground of the recovery boiler and has to be diluted by water or weak white liquor. The result of this process is green liquor, rich in Na_2S and Na_2CO_3. The green liquor is often collected in a separate stabilizing tank before it is clarified. While clarification of green liquor, dregs have to be removed. The clarified green liquor is used for the following causticizing to regenerate NaOH.

The LiquiSonic® measuring technology provides a precise inline concentration determination, based on sonic velocity measurement. Through this real-time monitoring each process step (green liquor generation, storage and clarification) can be permanently monitored, regulated and optimized.
LiquiSonic® convinces customers with quality improvement and economic advantages, like optimally regulated lime dosage in causticizing.

Customer value

The LiquiSonic® technology offers customers in the pulp and paper industry, numerous advantages:

- robust and maintenance free even with high coating of green liquor
- easy to clean, no cleaning adapter necessary
- highly accurate inline concentration measurement of green, black and white liquor
- ideal lime dosage
- enhancement of operational safety

Cost and time savings:

- reduced laboratory costs: 1 hour per day or 50 € (60$)
- mounting and dismounting of common measuring technology for maintenance and cleaning: 1 day per month or 800 € (900$)
- ideal lime dosage

Investment: approx. 20.000 € (23.000 $)
Amortization: approx. 1 year

Installation

The LiquiSonic® flange sensor is easily installed into pipelines transporting green liquor. The PFA-coating guarantees minimal maintenance and highly accurate measurement over years, even for alkaline, hot liquids with highly coating tendencies.

By using the LiquiSonic® controller 30, up to four sensors can be connected, allowing the simultaneous monitoring of several measuring points:

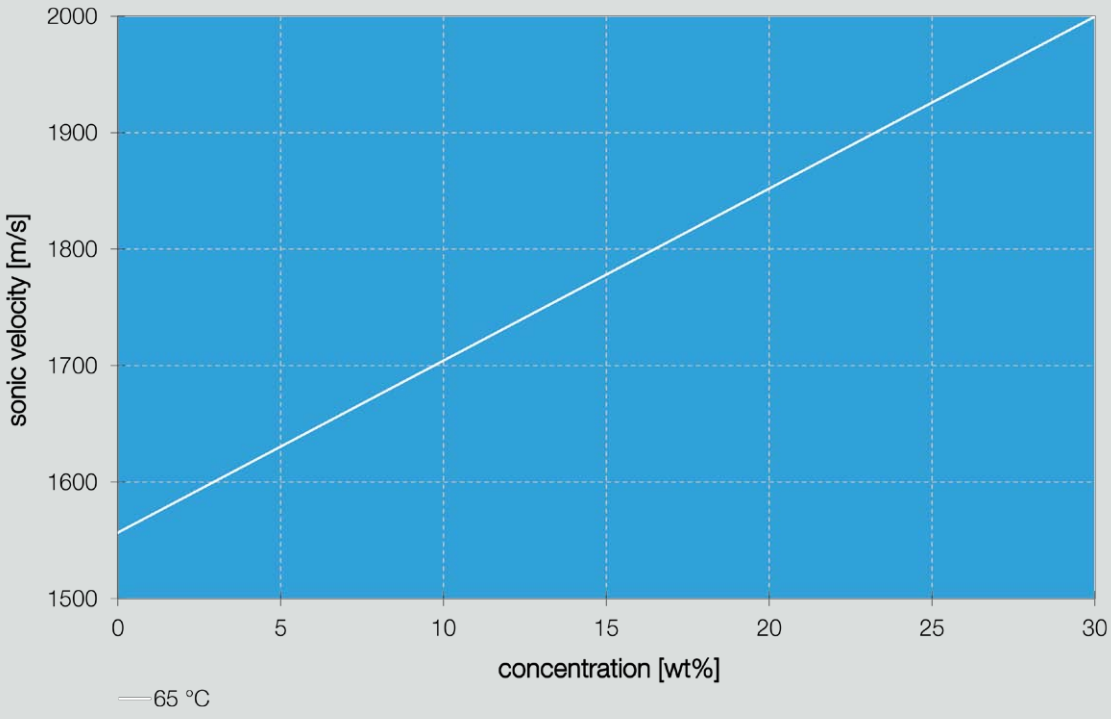
- after dilution tank
- after stabilizing tank
- after clarifier

Typical measuring range:
concentration range: 0 to 30 wt% or 950 - 1200 g/l
temperature range: 5 to 95 °C (40°F to 200°F)

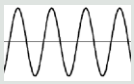
References

The LiquiSonic® analyzer is successfully implemented in pulp and paper plants, e.g. by „Metsä Group“ (Metsä, Finland).

LiquiSonic® sonic velocity measurement in green liquor



LiquiSonic® 30

	21001311 LiquiSonic® Controller 30 V10
	21010123 Flange sensor V10 DN80 (3“), PFA coating
BUS	21004435 BUS connection: Profibus DP
	21004449 Network integration
	21004110 High power sensor electronic
	21004202 Bus cable indoor (100m)
	21007846 Factory acceptance test (FAT) certificate

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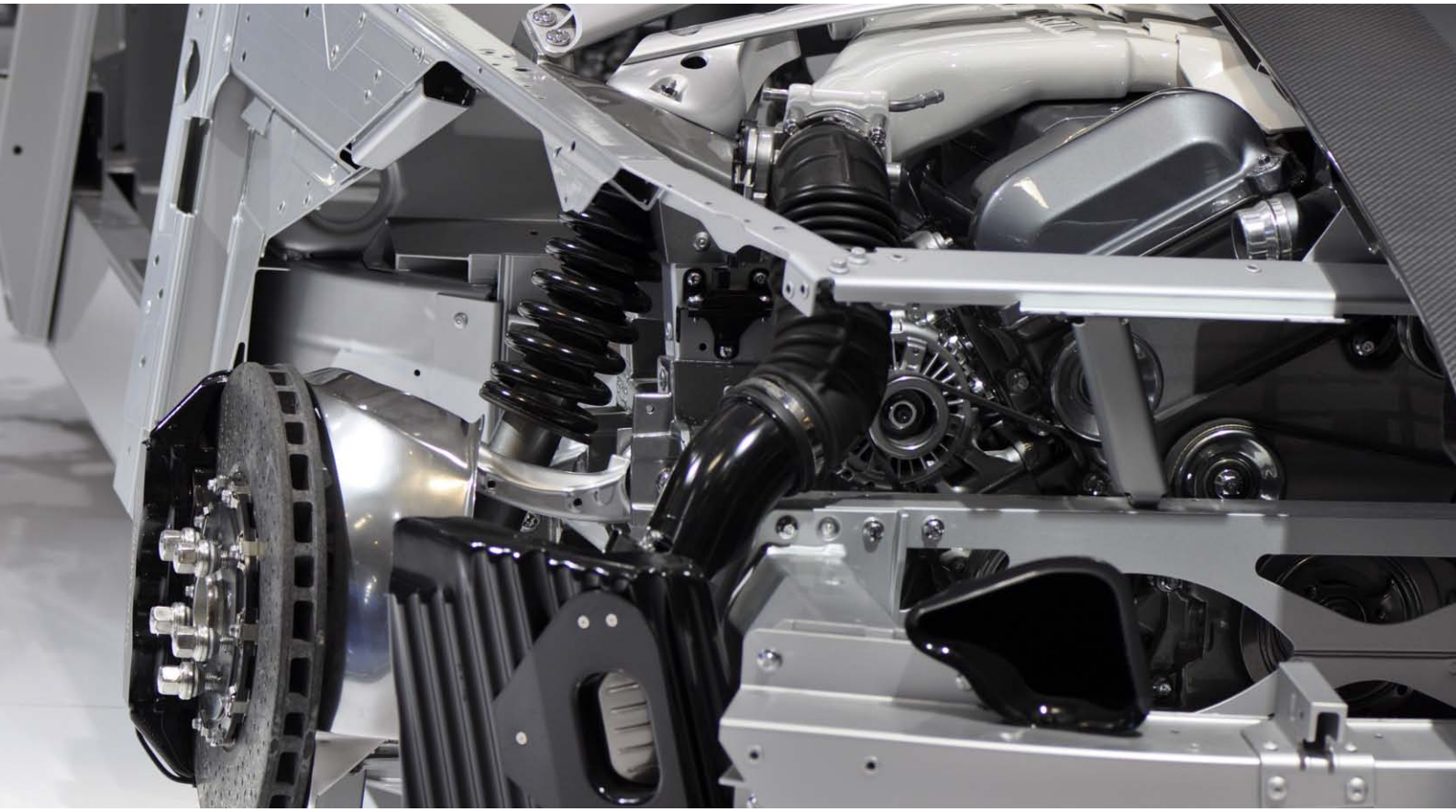

Automotive

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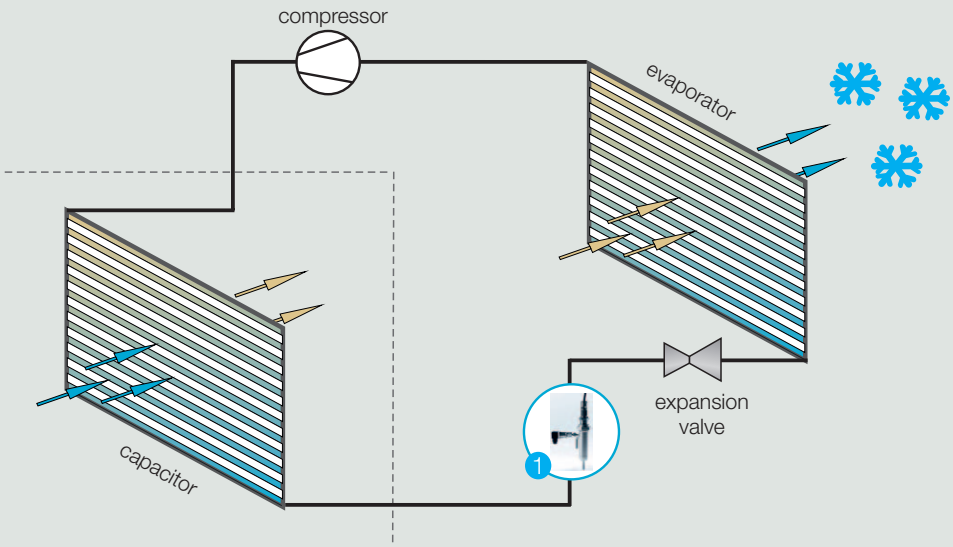


Measuring point	Installation	Measuring task
1	pipeline	monitoring of cooling circuit

Oil circulation ratio

Introduction

Compressor-based cooling systems are often used in air-conditioning. Within these systems, there are circulating refrigerants such as R134a, R1234yf or CO_2 that are ideal as a heat transfer medium due to their thermodynamic properties. In addition, to the refrigerants, refrigerator oils can also be found in the cooling circuit to lubricate the compressor.

Depending on the type and use of the cooling system, there are a variety of combinations of oils and refrigerants. Whereas a high percentage of oil is for a good lubrication, it also reduces the efficiency of the cooling system. Therefore, the aim is a perfect mixture of oil and refrigerant.

The LiquiSonic® measuring technology monitors the concentration of the oil in the cooling circuit. Moreover, the measurement include temperature and pressure to provide a compensated measuring result.

Application

Cooling systems consist of four main components:

- expansion valve
- evaporator
- compressor
- capacitor

In the cooling circuit, the gaseous refrigerant (R134a or R1234yf) is compressed and condensed by a compressor. The pressure and the temperature increase strongly. The heated refrigerant is then passed through the capacitor, where the heat is extracted. The capacitor is outside the passenger compartment.

The expansion valve reduces the high-pressure of the liquid. Thereby, the refrigerant is evaporated completely and releases the cold in the evaporator to the environment. For example, in the car the evaporator is located in the passenger compartment. On the low pressure side, the gaseous refrigerant regresses to the compressor where the circuit starts all over again.

Customer benefits

Based on the sonic velocity measurement, the LiquiSonic® 30 analyzer enables a highly precise determination of the oil concentration in the cooling circuit and of the temperature as well. This affects the following aspects positively:

- optimum heat transfer in the evaporator and capacitor
- maximum enthalpy of vaporization of the refrigerant
- prevention of unintended increase in temperature at the compressor caused by viscosity increasing

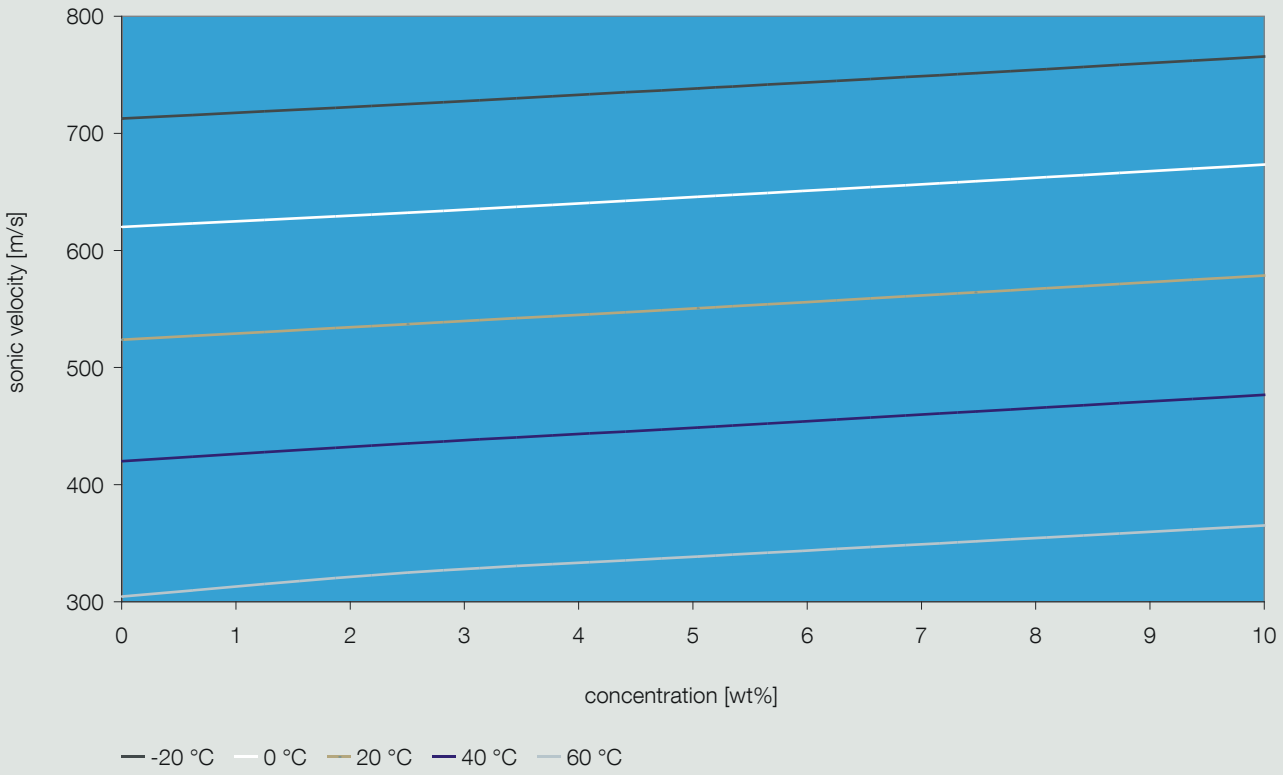
The continuous monitoring of the oil content in the refrigerant places high demands on the analysis. Since the refrigerant is gaseous at ambient pressure gaseous, manual sampling and offline analysis is almost impossible.

The inline measurement of temperature-compensated and pressure-compensated oil concentration guarantuees process safety and makes an resource-efficient handling of the expensive refrigerant oil and a high qualtity assurance with complete documentation of the measuring results possible.

Specifications

concentration range of refrigerant	0 to 20 wt%
temperature range	-30 to 90 °C
sensor installation	in a DN10 pipeline upstream of the expansion valve
refrigerator oil	Plantelf PAG 244 ND8, ND11, ND12, PAG, POE, RB74, RFL-100x, DH-PS, HD100, 4GS
refrigerant	R22 R32 R125 R134a R143 R245fa R407C R410A R744 (CO_2) R1234yf

Oil (ND11) in refrigerant R134a



LiquiSonic® 30 OCR analyzer

	21001311 LiquiSonic® Controller 30 V10
BUS	21004435 BUS connection: Profibus DP
	21010139 Immersion sensor V10 24-08, NPT 1“, PN40, V150, separated housing
	21004725 pressure transmitter 0 - 25 bar abs.
	21004704 T-adapter for refrigerant measurement NPT 1“ PN40
	21004202 bus cable indoor (100 m)
	21004449 Network integration
	21007841 Calibration certificate

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Mining

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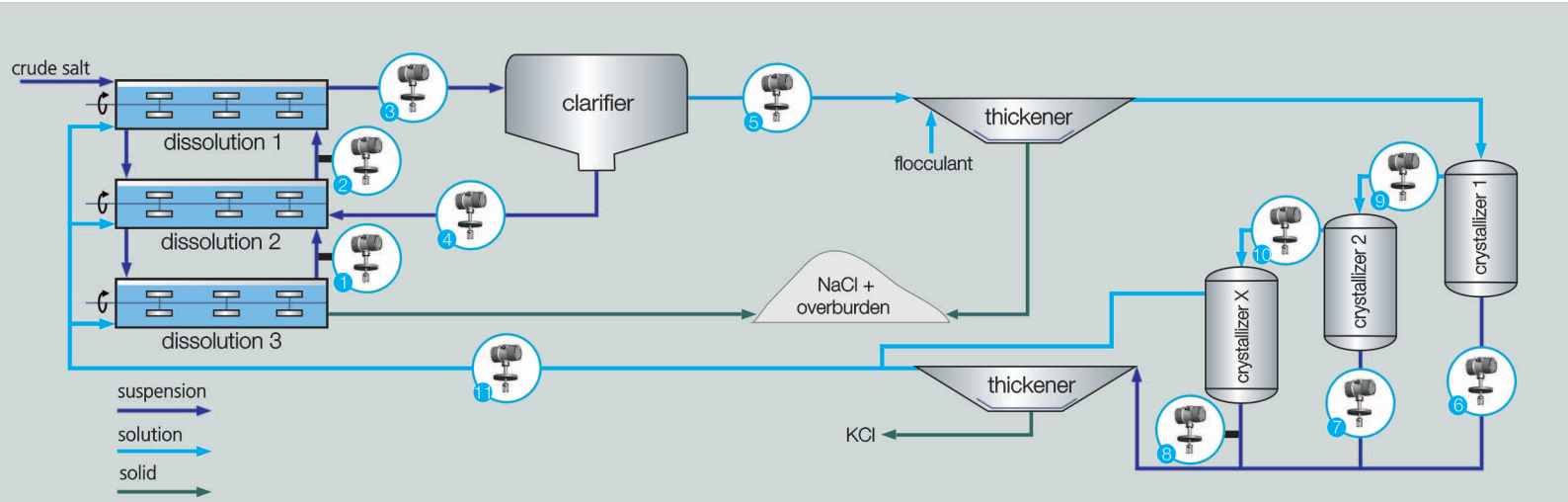


Measuring point	Installation	Measuring task
1, 2, 3	crude salt dissolution	saturation monitoring of potassium chloride (KCl)
5, 9, 10, 11	clarifier / crystallizer outlet 1	concentration measurement of mother liquor
4, 6, 7, 8	clarifier / crystallizer outlet 2	process monitoring of suspension density

Hot dissolution process

Introduction

The mixture of potassium chloride (KCl) and sodium chloride (NaCl) is the base material for many mineral fertilizers and high purity salts, often used in chemcical and pharmaceutical industries.

Typical separation processes for NaCl and KCl are:

- flotation
- electrostatic separation
- hot dissolution process

While NaCl exhibits good solubility in water regardless of temperature, the solubility of KCl increases with rising temperature. Thus, in large scale commercial plants, KCl is separated from NaCl in a hot dissolution process.

The LiquiSonic® measuring technology provides an optimized quality control and productivity increase, especially trough fast process monitoring while hot dissolution process.

Application

On account of the different dissolving properties of KCl and NaCl, the base material in the hot dissolution process is a saturated solution (mother liquor).
After heating to ~ 120°C, crude salt (NaCl and KCl) is added. As the mother liquor is already saturated with NaCl, the NaCl does not pass into the solution and can be drawn off in the clarifier.
In at least 3 successive crystallizers, the dissolved KCl is cooled down and precipitates. In the thickener, KCl is concentrated up to 97 wt% and separated from the mother liquor. The resulting saturated NaCl solution returned into the first process step as mother liquor.

The LiquiSonic® analyzer provides a precise inline concentration determination, based on sonic velocity measurement. Each process step (crude salt dissolution, clarification, crystallization, thickening) can be monitored, controlled and optimized in real-time. LiquiSonic® convinces customers with quality improvement and economic advantages, such as saving energy and materials.

Customer value

The LiquiSonic® analyzer provides a precise inline concentration measurement with real-time monitoring. An automatic concentration-regulated process control prevents the plant from being „blocked“ (process control is too slow) and increases the process yield and productivity.

The robust sensor construction and the optional special materials, like titanium, promote long process life.

Additional advantages are:

- optimum line control and reliable process data
- increasing the efficiency of clarifier and thickener
- drift free measurements over years
- early recognition of malfunctions in a matter of seconds
- reduced material and energy consumption and costs

Investment: approx. 17.000 € (19.000 $)
Amortization: approx. 1 year

Installation

The LiquiSonic® immersion sensor can easily be installed directly into the crystallizer or into pipelines and is well-equipped for measurements in solutions and suspensions.

Installation details:

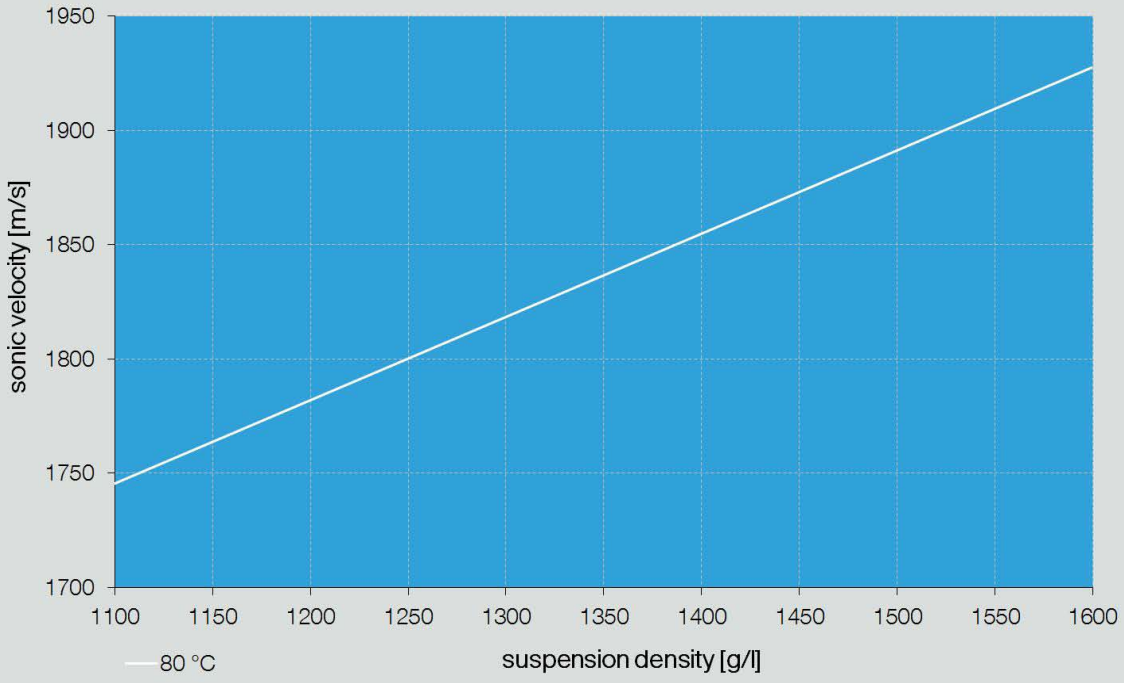
- crystallizer: sensor length 300 - 500 mm
- pipeline (typically DN 300 - DN 800): sensor length 250 mm
- installation from below by partially filled pipes

By using the LiquiSonic® controller 30, up to four sensors can be connected, allowing the whole process to be monitored at different measuring points including:

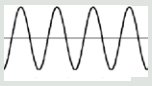
- crude salt dissolution
- clarification
- crystallization unit
- KCl thickening

Typical measuring range:
concentration range: 1100 to 1600 g/l
temperature range: 70 to 110 °C (160°F to 230°F)

Sonic velocity measurement in KCl-suspension



LiquiSonic® 30

	21001311 LiquiSonic® Controller 30 V10
	21010105 immersion sensor V10 40-40 Ex ATEX/IECEx, DIN DN50, L092, titanium
BUS	21004435 BUS connection: Profibus DP
	21004449 Network integration
	21004110 High power sensor electronic
	21004202 Bus cable indoor (100m)
	21007846 Factory acceptance test (FAT) certificate

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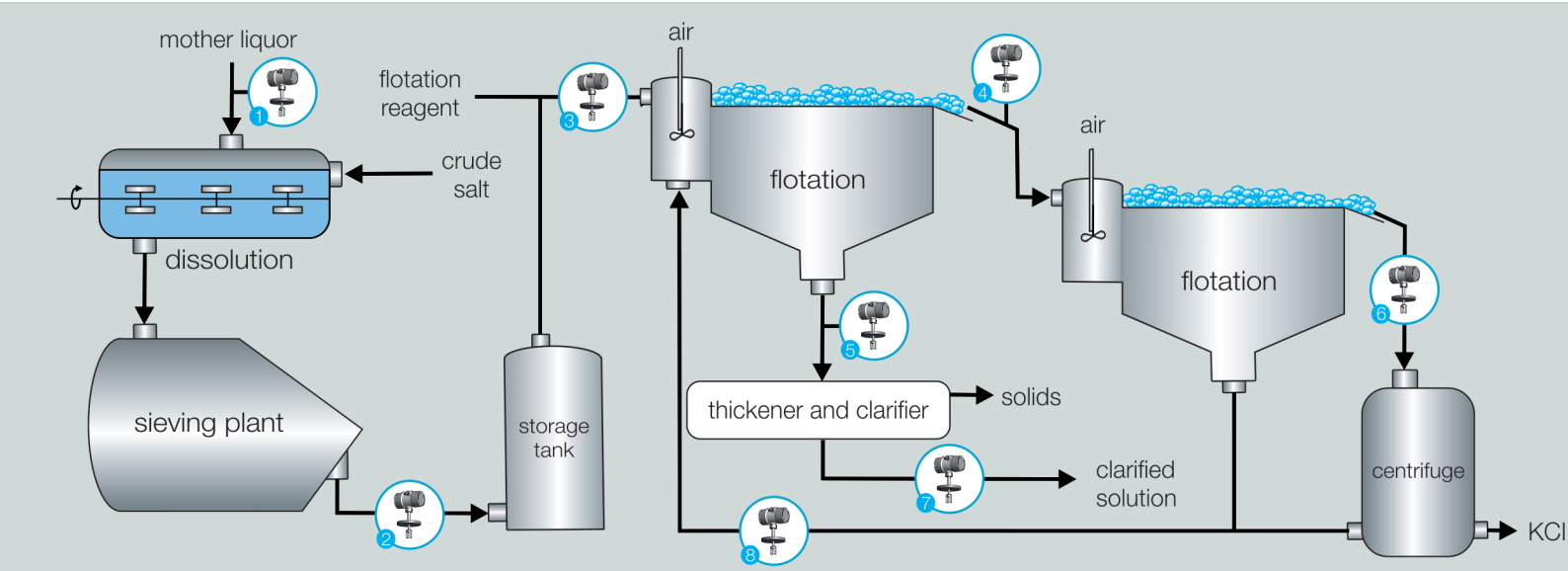


Measuring point	Installation	Measuring task
1, 8	pipeline	concentration monitoring of mother liquor
2, 3, 4, 6	KCl-stream	process monitoring of KCl concentration and saturation
5, 7	posttreatment	NaCl concentration measurement

KCl Flotation

Introduction

The mixture of potassium chloride (KCl) and sodium chloride (NaCl) is the base material for many mineral fertilizers and high purity salts, often used in chemcical and pharmaceutical industries.

Typical separation processes for NaCl and KCl are:

- flotation
- electrostatic separation
- hot dissolution process

During the flotation process, KCl crystals are covered by surface active substances. This allows gas bubbles to bind to the KCl. Thus, KCl is seperated by flotation, while the NaCl sedimentates.

The robust LiquiSonic® measuring technology provides an optimized quality control and productivity increase, especially trough fast process monitoring while flotation process.

Application

Crude salt (KCl and NaCl) is mixed with saturated solution (mother liquor) and is ground finely (crystal size ~ 1mm). During the optional purification stage impurities are separated and the pre-purified solution is stored temporarily.
In the flotation cell the KCl crystalls are covered by surface-active substances. Air bubbles are injected into the flotation cell which adhere to the KCl crystals. This generates a KCl foam, which is mechanically seperated. Meanwhile, the non-binding NaCl crystalls sedimentate and are posttreated in thickener and clarifier.
Frequently, more than one flotation step is needed. The purified KCl-suspension is drained by drying or centrifugation, whereby solid KCl and re-useable process water are produced.

Each process step ,e.g. the crude salt dissolution, can be real-time monitored, regulated and optimized. LiquiSonic® benefits customers by its robustness, with quality improvement and economic advantages.

Customer value

The LiquiSonic® analyzer provides a precise inline concentration measurement with real-time monitoring.

The robust sensor construction and the optional special materials, like titanium, promote long process life.

Additional advantages are:

- optimum line control and reliable process data
- increasing the efficiency of flotation
- drift free measurements over years
- early recognition of malfunctions in a matter of seconds
- reduced maintenance, materials and energy

Investment: approx. 17.000 € (19.000 $)
Amortization: approx. 1 year

Installation

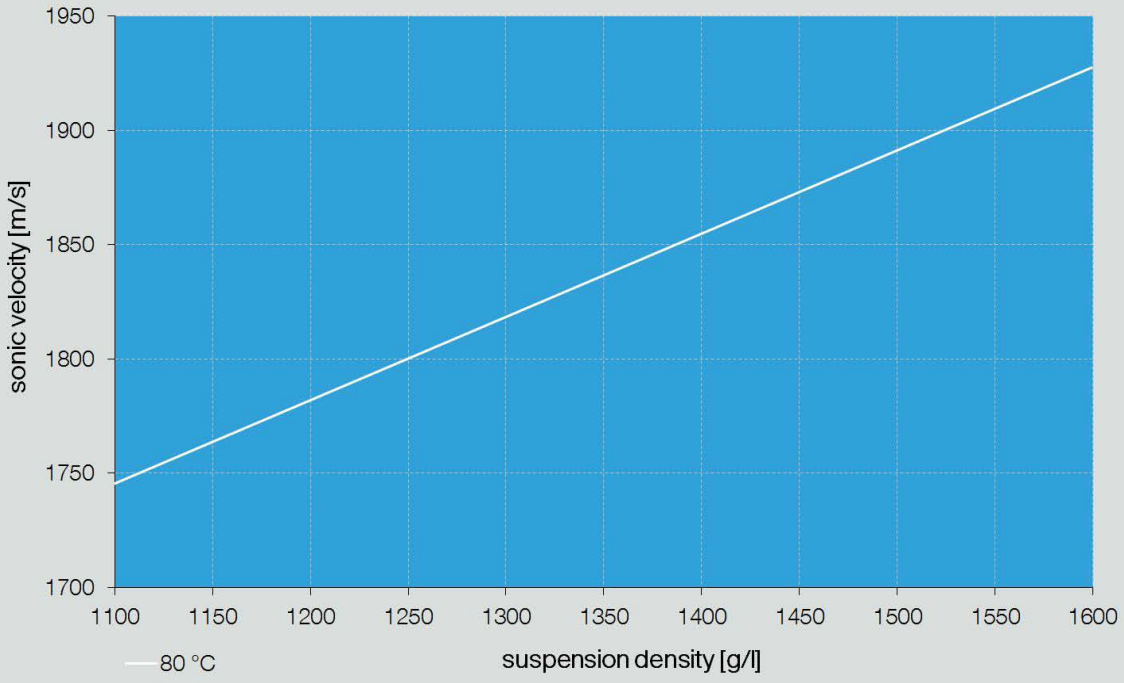
The LiquiSonic® immersion sensor can easily be installed directly into tanks or pipelines, and is well-equipped for measurements in solutions and suspensions. In partially filled pipes, installation from below is recommended.

By using the LiquiSonic® controller 30, up to four sensors can be connected, allowing the whole flotation process to be monitored at different measuring points including:

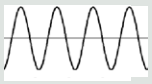
- mother liquor input
- crude salt dissolution
- clarification
- flotation unit
- KCl drainage

Typical measuring range:
concentration range: 1100 to 1600 g/l
temperature range: 10 to 40 °C (50°F to 100°F)

Sonic velocity measurement in KCl-suspension



LiquiSonic® 30

	21001311 LiquiSonic® Controller 30 V10
	21010105 immersion sensor V10 40-40 Ex ATEX/IECEx, DIN DN50, L092, titanium
BUS	21004435 BUS connection: Profibus DP
	21004449 Network integration
	21004110 High power sensor electronic
	21004202 Bus cable indoor (100m)
	21007846 Factory acceptance test (FAT) certificate

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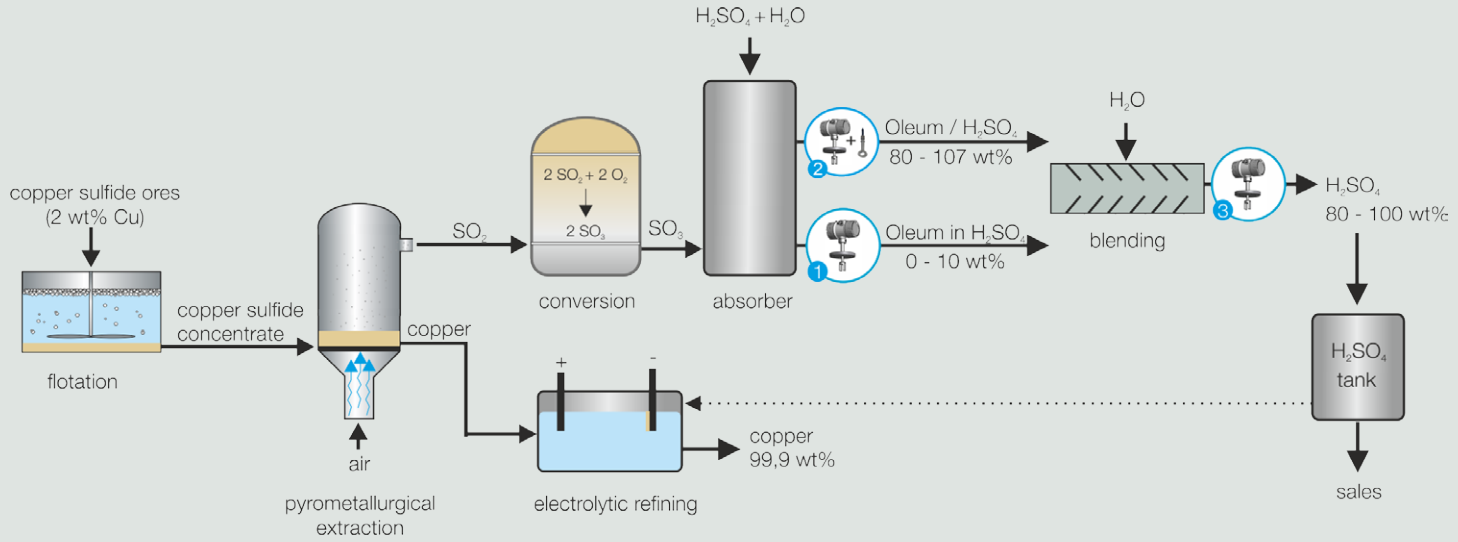


Measuring point	Installation	Measuring task
1	pipeline	determination of the oleum concentration
2	pipeline	monitoring of the sulfuric acid / oleum concentration
3	pipeline	control and monitoring the blending to the desired concentration

H_2SO_4 in Copper Mining

Introduction

Copper is obtained by the extraction of copper sulfide ores, which have a copper content of ~ 2 wt%. The raw metal production includes a wide variety of process steps.

The processing of copper sulfide ores is carried out by flotation. Thereby, crushed copper sulfide ores are enriched with water and a foaming agent, to skim quartz or silicates. The obtained copper concentrate has a copper content of 20 - 40 wt%.

In the pyrometallurgical extraction, SO_2 is generated which is oxidized with atmospheric oxygen to form sulfur trioxide SO_3 (contact process). What remains is a copper content of approx. 96-99 wt%. In order to reach a purity of 99.99 wt%, a electrolytic refining takes place subsequently. Otherwise, the impurities strongly influence the thermal and electrical conductivity and quality of copper.

Application

In the pyrometallurgical extraction, the copper concentrate is slagged by adding SiO_2 in the furnace at 1200 to 1400 °C. The melt of copper and iron sulfide is removed as the so-called copper matte from the slag phase. The liquid copper matte is poured into a converter and the iron sulfide reacts with air to sulfur dioxide SO_2.

Resulting SO_2 is oxidized to sulfur trioxide SO_3 (contact process), which SO_3 is directed into sulfuric acid (96 wt%). In the absorber, sulfuric acid in high concentrations by adding water or oleum is generated. In the blending process, the H_2SO_4 is diluted on desired target concentration.

Each process step can be both monitored continuously by the inline LiquiSonic® measurement technology and optimally set. The high dependency on sonic velocity enables an accuracy of +/- 0,05 wt% for sulfuric acid.

Customer value

The LiquiSonic® analyzer provides a precise inline H_2SO_4 and oleum concentration measurement with real-time monitoring.

The robust sensor construction and the optional special materials, like Hastelloy C2000, promote long process life.

LiquiSonic® enables a reduction of labor cost through the elimination of manual process steps:
time saving: 1 h per day
cost per hour: 50 € (60 $)
total cost savings: 10.000 € (12,000 $) per year

In comparison to conductivity and density measurement, LiquiSonic® generates a clear signal in the concentration range from 80 to 100 wt% and provides at every time reliable process information.

Investment: approx. 18.000 € (22,000 $)
Amortization: approx. 2 years

Installation

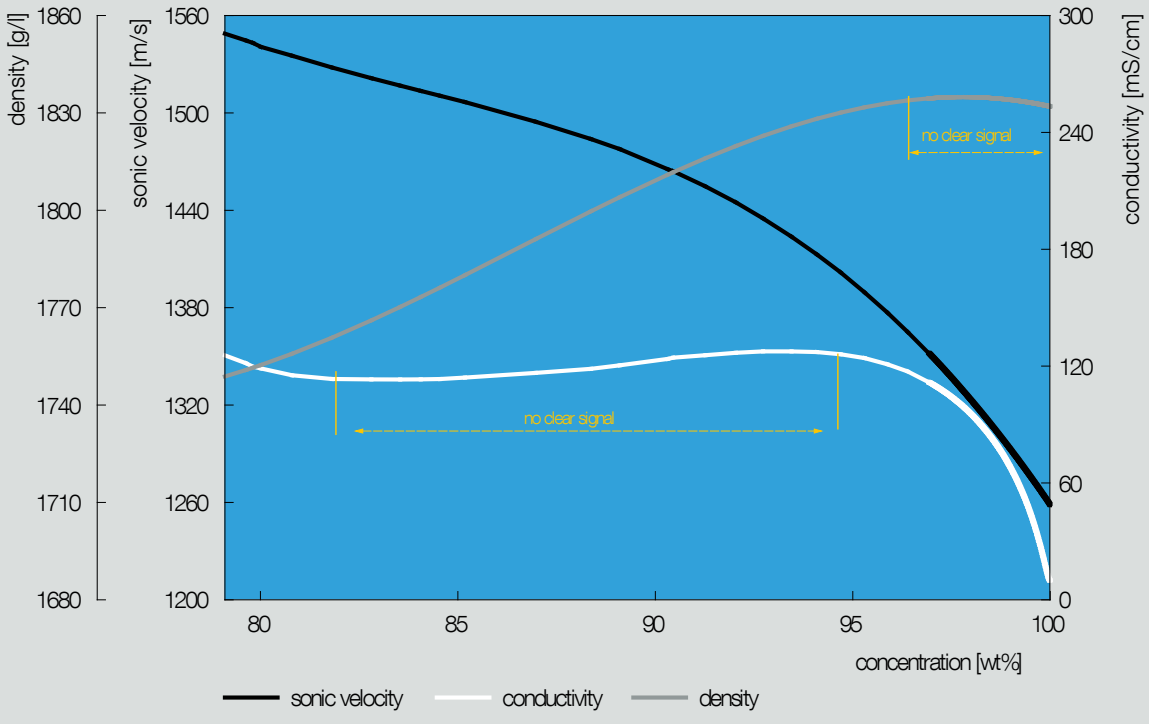
The LiquiSonic® immersion sensor is easily installed into pipelines after absorber or sulfuric acid production and blending.

By using the LiquiSonic® controller 30, up to four sensors can be connected, allowing the simultaneous monitoring of several measuring points.

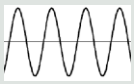
Typical measuring range:
concentration range from H_2SO_4: 80 to 100 wt%
temperature range: 20 to 90 °C

concentration range from oleum: 0 to 10 wt%
temperature range: 10 to 60 °C

LiquiSonic® sonic velocity measurement



LiquiSonic® 30

	21001311 LiquiSonic® Controller 30 V10
	21010109 Immersion sensor V10 40-14, ANSI 2“, L092, HC2000
BUS	21004435 BUS connection: Profibus DP
	21004449 Network integration
	21004110 High power sensor electronic
	21004202 Bus cable indoor (100m)
	21007846 Factory acceptance test (FAT) certificate

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Petrochemistry

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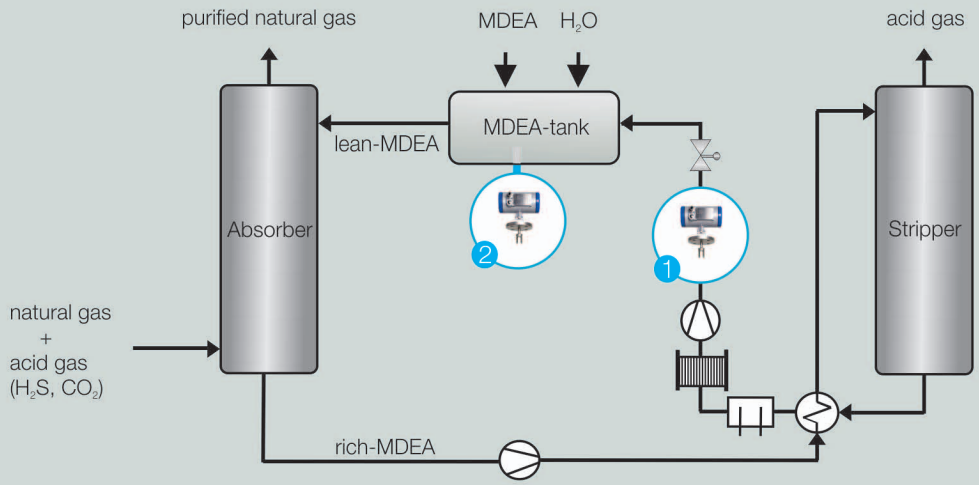


Measuring point	Installation	Measuring task
1	pipeline	real time control of the regenerated MDEA concentration
2	pipeline	monitoring the MDEA concentration directly in the MDEA tank

MDEA-scrubbing

Introduction

Amine scrubbing is a chemical process in which CO_2, H_2S and other acid gases are captured from natural gas. Thereby, a slightly alkaline aqueous solution of amines (mostly tertiary amines) is applied, which reversibly chemically absorbs the acid gases. Due to its high selectivity for H_2S and CO_2, the tertiary methyldiethanolamine (MDEA) is used as an absorber. The aim of the gas scrubbing is to prepare the sour natural gas for further transport in accordance with the pipeline requirements, so that corrosion damages can be avoided.

BASF is the licensee of the MDEA plants, as well as for two additional gas scrubbing plants: the ammonia and the synthesis gas plants. As a result of the successful cooperation; the LiquiSonic® analyzer is recommended by the BASF AG Ludwigshafen for MDEA-concentration measurement.

Application

The natural gas processing with scrubbing liquids, such as MDEA, is an industrial process to improve the quality of natural gas. The natural gas is led counter-current in the absorber through MDEA, which is enriched with disturbing components. At the upper end of the absorber, the purified natural gas escapes. The MDEA (rich amine) that is contaminated with H_2S and CO_2 is transferred after the scrubbing in the stripper.

In the stripping process, the scrubbing liquid is heated and the acid gases are desorbed. The regenerated MDEA (lean amine) is then cooled, filtered and lead back into the absorption cycle.

The LiquiSonic® 30 system allows a detailed analysis of the regenerated MDEA concentration. Through the inline LiquiSonic® sensors, the amine scrubbing is analyzable around the clock with precise real-time data storage. This enables the user to react in a flexible manner and the efficiency of the absorption can be optimized

Customer value

Through the continuous measurement of the concentration of the scrubbing liquid (MDEA) manual sampling can be omitted. This leads to a reduction of material and labor costs and improves plant safety:

- time saving: 1 h per day
- cost per hour: 50 €
- total cost saving: 10.000 € per year

Through the concentration measurement with LiquiSonic®, the purity of the regenerated scrubbing liquid is ensured for optimal efficiency of the absorption.

The prevention of overdosing of MDEA scrubbing liquid leads to the reduction of substance expenses for the scrubbing liquid.

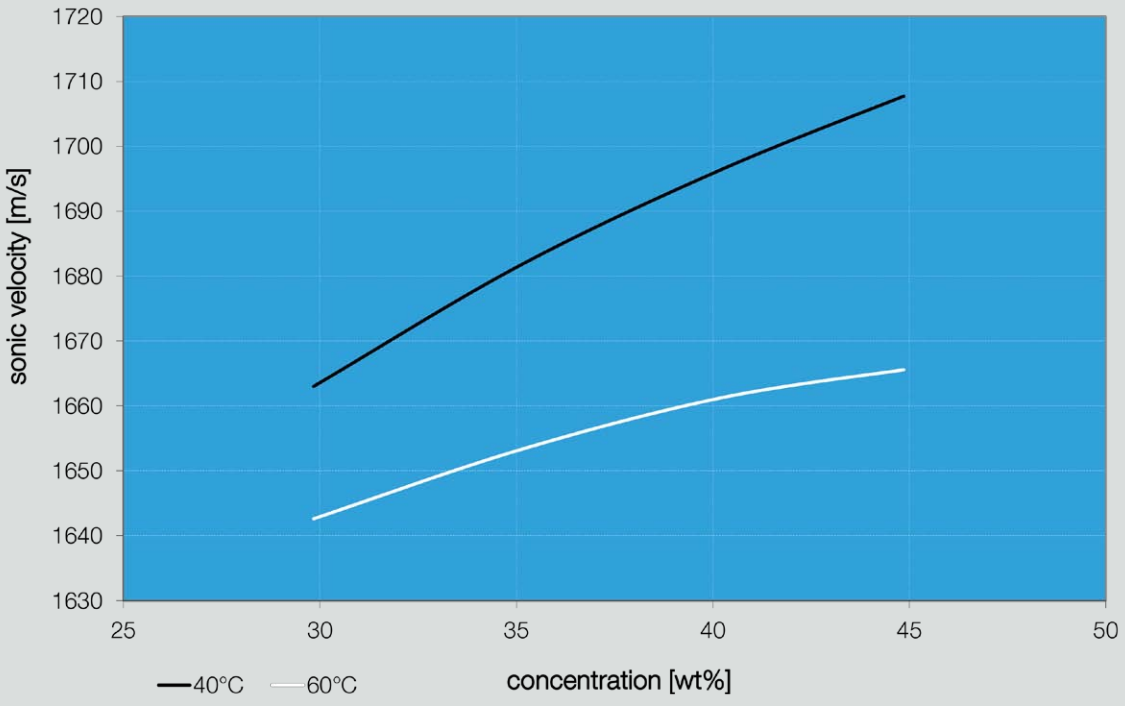
- 1 % MDEA scrubbing liquid to much in the cycle corresponds to: 40.000 € / 46.000 $ per year
- investment: 20.000 € / 24.000 $
- amortization: 6 months

Installation

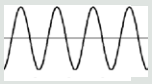
The LiquiSonic® sensor is installed in the DN 50 pipeline from the stripper to the absorber after the amine cooler and the filter. Another installation side is the MDEA-tank.

concentration range: 20 to 45 wt%
temperature range: 30 to 65 °C (85 - 150 °F)

Sonic velocity measurement in MDEA



LiquiSonic® 30

	21001311 LiquiSonic® Controller 30 V10
	21010106 immersion sensor V10 40-40 Ex ATEX/IECEx, DIN DN50, L150
BUS	21004435 BUS connection: Profibus DP
	21004449 Network integration
	21004110 High power sensor electronic
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	21007846 Factory acceptance test (FAT) certificate

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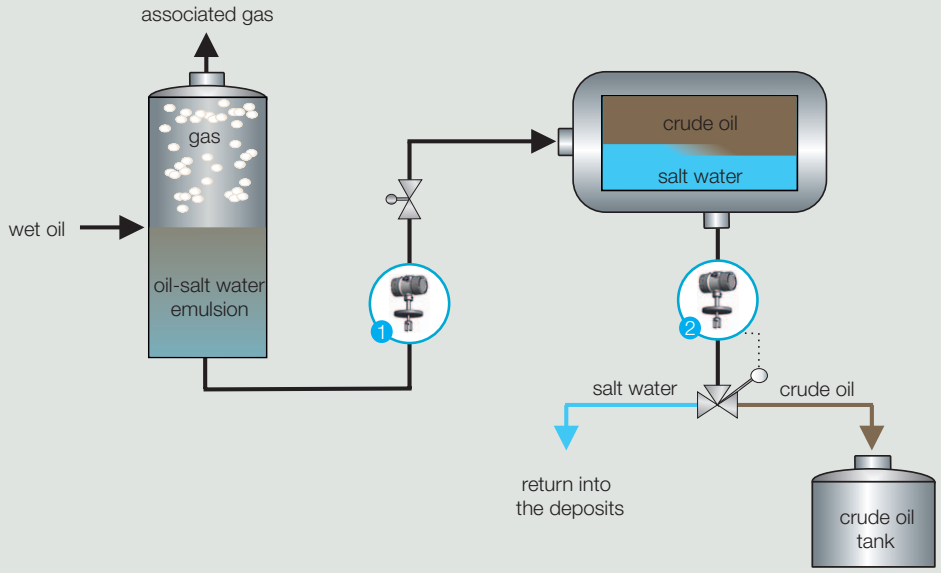


Measuring point	Installation	Measuring task
1	pipeline	monitoring the oil - salt water emulsion to check the production quantity
2	pipeline	phase separation between salt water and oil

Water Cut Analyzer

Introduction

One of the first steps in the crude oil production is the separation of associated gas and produced water from mined crude oil. Crude oil is a base material for numerous industries. It is used in pharmaceutical and food industry, as energy source and in the chemical industry. Typical application areas are the production of plastics, synthetic fibers, detergents, cleaning agents. Crude oil is a resource for numerous chemical applications.

The extracted wet oil is a mixture of crude oil, natural gas, salt water and contaminants. In order to reach the required quality for further processing in a refinery, the mixture needs to run through a purification phase. The purification takes place in special separation plants in several processing stages. During the first step of the purification, natural gas is extracted from the oil, followed by a separation of crude oil and salt water.

Application

The removal of the associated gas takes place in a gas separator by swirling the mixture at increased pressure (condensation). The gas escapes and is collected separately for further processing. By the use of the LiquiSonic® analyzer in the separator the product quantity of the oil - produced (salt) water - emulsion can be determined.

The processed oil-salt water emulsion is pumped into a separate „wet oil tank“. Due to the density difference between oil and salt water, the two phases can be separated. The salt water under the oil is pumped out.

Considering the characteristic sonic velocities of the respective phases, the separation of the salt water from the oil can be easily monitored with the LiquiSonic® measuring technology. This enables a phase separation in a matter of seconds.

Customer value

The LiquiSonic® measuring technology guarantees an exact identification of the different phases (oil / water) at all times with an extremely fast response time of less than 1s. This ensures the required quality for further processing in the refinery.

The LiquiSonic® analyzers increase the oil yield through a precise separation of salt water.
An example for an ROI calculation is shown below:

- Extracted oil per day: 500 t, which is equivalent to a crude oil revenue of about $ 200,000 ($ 400 per t)
- Increased crude oil content of 0.01% per day leads to an increase of the crude oil revenue of $ 73,000.00 per year
- Investment: 20.000 € ($ 25,000)
- Amortization: 4 month

Furthermore, the production volume per day can be determined through the monitoring of the oi - salt water emulsion concentration during gas separation.

Installation

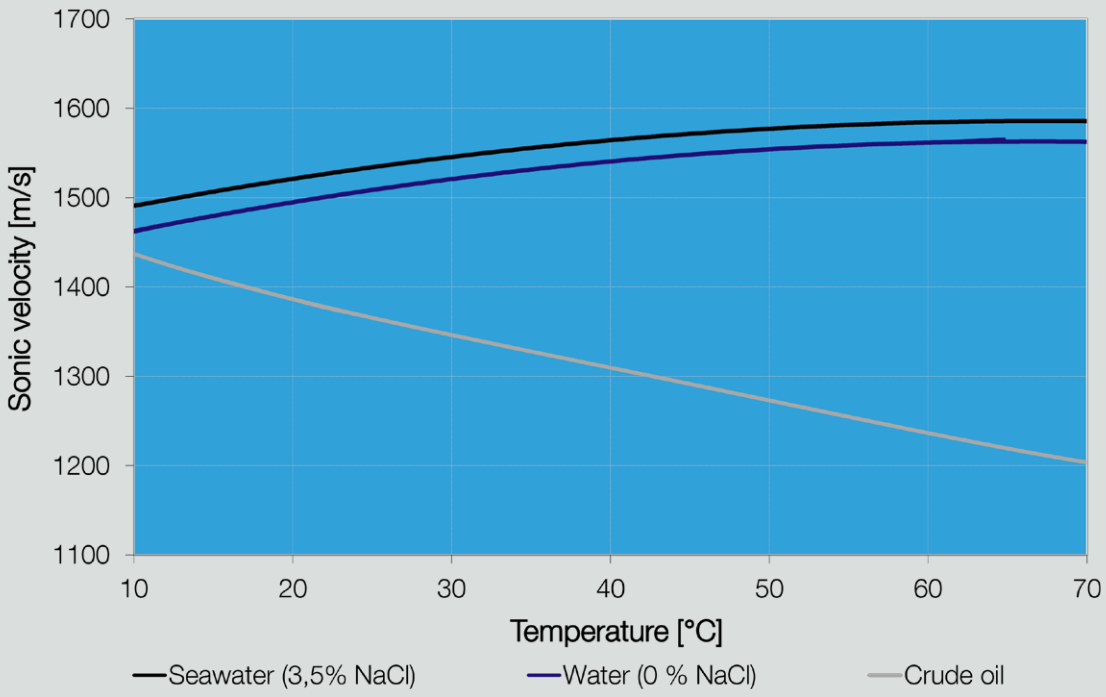
The LiquiSonic® immersion sensor can easily be installed into the transport pipe after gas separation. Another installation option is the phase separartion tank outlet. The LiquiSonic® sensor can be integrated to a bottom outlet valve for fast phase separation without cavities.

By using the LiquiSonic® controller 30, up to four sensors can be connected, allowing to monitor simultaneous at different measuring points:

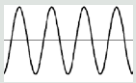
- concentration monitoring of crude oil - salt water emulsion (gas separation unit)
- phase detection and phase separation

Typical measuring range:
concentration range of crude oil: 0 to 100 wt%
temperature range: 10 bis 70 °C (50°F to 160°F)

Phase separation with LiquiSonic® analyzer



LiquiSonic® 30

	21001311 LiquiSonic® Controller 30 V10
	21010112 Immersion sensor V10 40-14, DIN DN50, L092
	21008110 Integration of sensor to SchuF valve
BUS	21004435 BUS connection: Profibus DP
	21004449 Network integration
	21004110 High power sensor electronic
	21004202 Bus cable indoor (100m)
	21007846 Factory acceptance test (FAT) certificate

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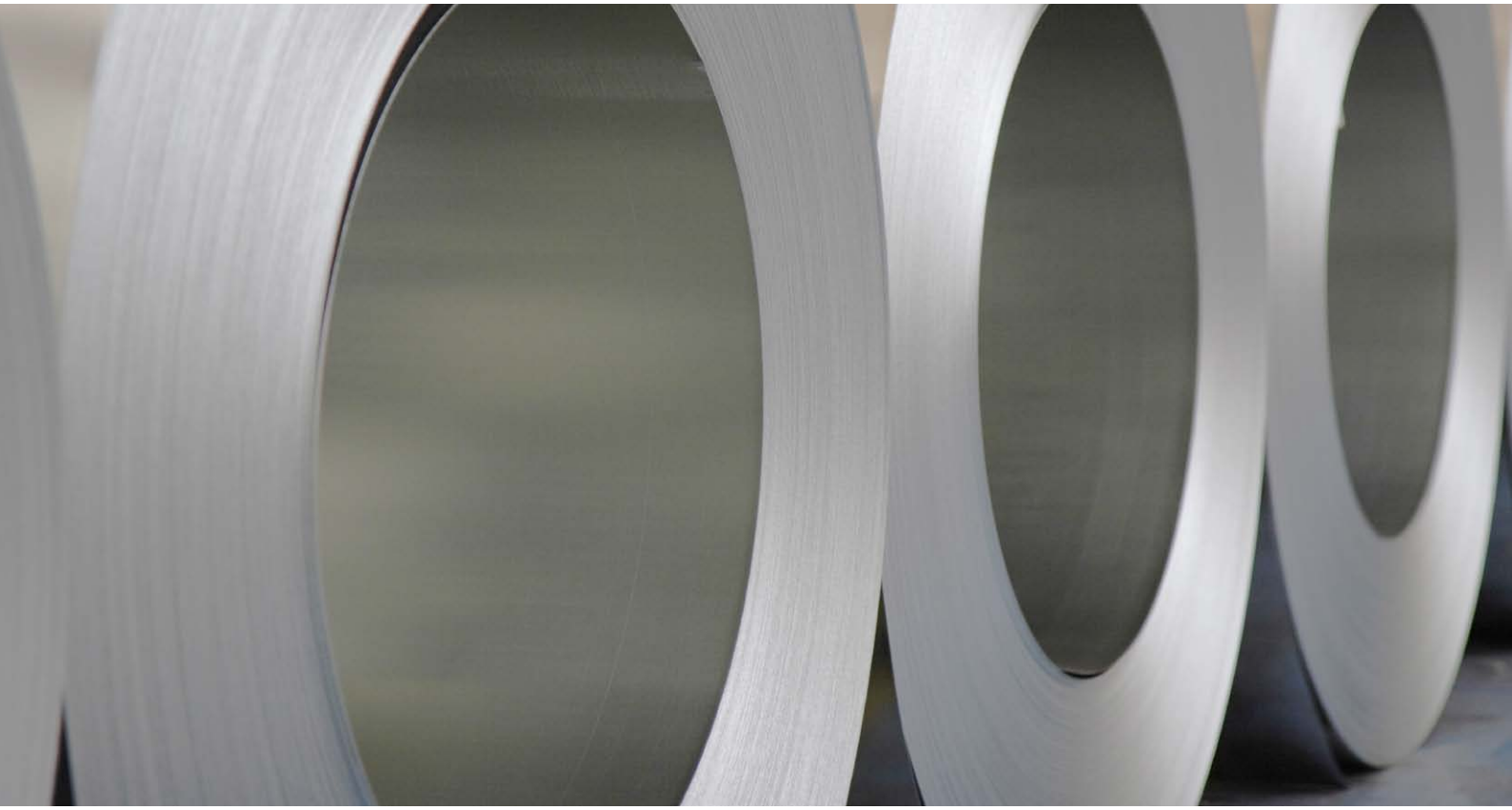

Metal Processing

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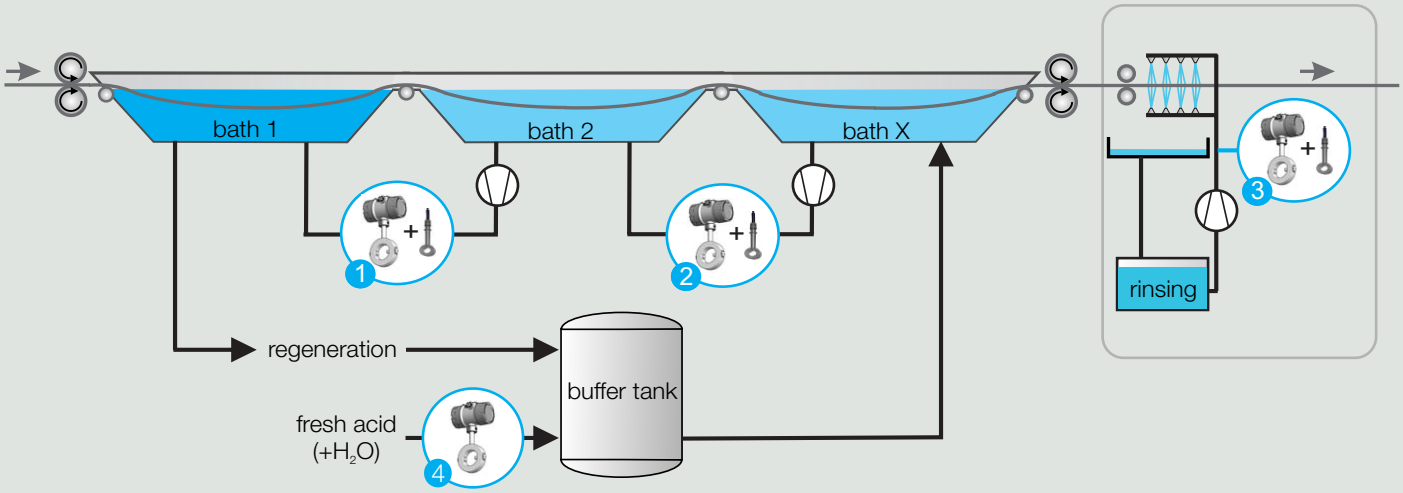


Measuring point	Installation	Measuring task
1, 2	transport pipe or bypass	monitoring of pickling bath
3	transport pipe	monitoring of rinsing bath
4	transport pipe	concentration measurment and fresh acid redosing control

Hydrochloric acid Pickling

Introduction

Pickling baths are used downstream of the hot rolling process, but also in many other fields of the metal-working industry to remove, modify, passivate or clean surfaces in a defined manner.

To this end, pickling solutions are employed, mainly consisting of mineral acids, like hydrochloric acid. The concentration of these acids decreases during the pickling process, whereas the degree of disturbing components such as contaminations and carry-over increases.

The LiquiSonic® measuring technology provides a solution for online measurements of pickling bath concentrations facilitating redosing of the required quantity of fresh acid. This ensures a continuous, optimum pickling bath quality. Delays in time as a result of sampling and lab analyses are avoided.

Application

Pickling removes impurities from the steel surface. However, the acid also attacks the iron oxide on the metal surface and ferrous salts are generated (e.g. iron (II)). It is therefore of great importance to precisely control all process-relevant parameters, such as dwell time, bath temperature and bath composition. Only in this way, pickling bathes can be operated in an economic and resource-saving manner.

The measuring system LiquiSonic® 40 allows the parallel detection of two physical quantities, such as sonic velocity and conductivity, and therefore the determination of the HCl concentration in the pickling bath as well as the iron content. This leads to the elimination of expensive laboratory analysis.

The inline LiquiSonic® sensors enable the user to monitor the process concentrations precise in real time and make pickling bath control automatable. Fluctuations can be seen and corrected immediately and very flexibly.

Customer value

The LiquiSonic® analyzer provides a precise inline bath concentration measurement with real-time monitoring and permanent data logging. This allows the process to be automatically controlled in the optimal concentration range with stable, sufficient pickling results. LiquiSonic® is used to avoid a underdosage or overdosage of HCl.

LiquiSonic® reduces extensive lab measurements and replaces the time-consuming sampling process:

- time saving: 1 h per day
- cost per hour: 50 € (60 $)
- total cost savings: 10.000 € (12,000 $) per year

LiquiSonic® saves costs by reduction of hydrochloric acid consumption (ROI for 30 m^3 plant: 7,5 m^3/h acid consumption):

- 10 % HCl savings or 20.000 € (24,000 $) per year

Investment: approx. 25.000 € (30,000 $)
Amortization: approx. 12 month

Installation

The LiquiSonic® 40 analyzer is installed into the transport pipelines (mostly DN80, 3“) or the bypass of the pickling bath. Even for installation either in the transport line of the rinsing bath or in the fresh acid feed, SensoTech offers proven solutions for decades.

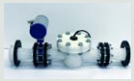
The robust sensor construction and the optional special materials, like Halar oder PFA, promote long process life.

The installation of the LiquiSonic® flange type sensor DN80 and the corresponding conductivity sensor in a piping system DN80 is simplified through the use of the installation adapter DN80. The total length of the measuring distance can be shortened by the adapter, to 0.70 m.

Typical measuring range:
concentration of free HCl: 0 - 120 g/l; 180 - 250 g/l
concentration range of Fe: 20 - 140 g/l
temperature range: 60 - 95 °C (140 - 200 °F)

LiquiSonic® 40 installation adapter for pickling bath

LiquiSonic® 40

	21001411 LiquiSonic® Controller 40 V10
	21010122 Flange sensor V10 DN80 (3“), Halar coating
	21006125 Inductive conductivity sensor 226/1066
BUS	21004435 BUS connection: Profibus DP
	21004449 Network integration
	21004660 Installation adapter for pickling bath DN80
	21004202 Bus cable indoor (100m)
	21007846 Factory acceptance test (FAT) certificate

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Other processes

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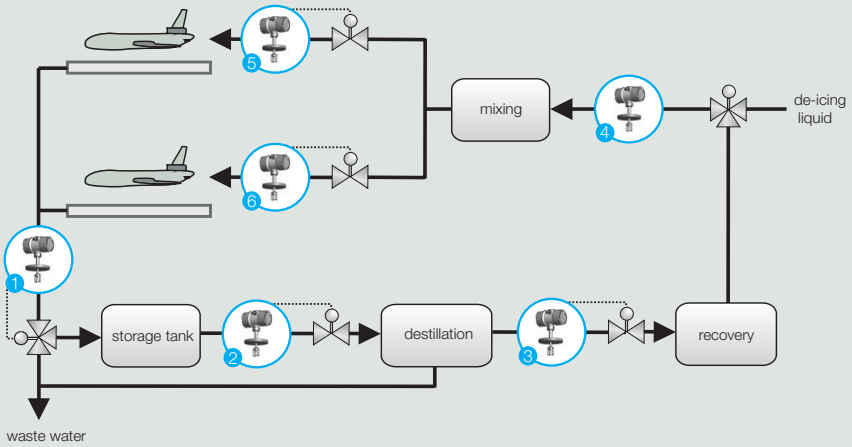


Measuring point	Installation	Measuring task
1	pipeline	monitoring of used aircraft deicing liquid
2	pipeline	concentration monitoring of collected deicing liquid
3	pipeline	quality control of distillation process (recycling)
4	pipeline	incoming goods control for the delivered deicing liquid
5,6	pipeline	control of the required deicing liquid concentration

Aircraft Deicing

Introduction

In frost, the aircraft, runway and pavement must be kept free of snow and ice before the start. Aircraft deicing reduces the aircraft weight and prevent unfavorable aerodynamics, which is reflected in a price reduction and ensures high standards of quality and safety. At special deicing areas of the airfield, the ADL (aircraft deicing liquid) is sprayed on the aircraft. ADL is a mixture of propylene glycol or ethylene glycol with water and is used at temperatures up to below -25°C.

For a better surface adhesion on the aircraft, the deicing liquid is additionally mixed with thickeners. Thereby, the deicing liquid works as a protection against refreezing. Depending on the type of aircraft and the weather conditions, different types and concentrations of ADL are used.

Application

The deicing liquid is made from a mixture of water and ethylene glycol or propylene glycol in a ratio of 50 - 80 wt% glycol. The desired concentration of the mixture is controlled on site. The measuring system LiquiSonic® provides a precise inline concentration measurement of the deicing liquid, whereby the target concentration can be exactly adjusted.

During the deicing process, the deicing liquid is mixed with surface water and snow. The diluted ADL is directed in underground channels and stored in collection tanks. The concentration of the collection tank is inline monitored. Depending on the residual concentration, a deicing liquid recycling (>1%) or discharge into the waste water system is initiated.

By use of LiquiSonic® inline concentration analyzers, the residual concentration of the deicing liquid is determined and further processing steps (distillation or waste water treatment) can be controlled.

Customer value

LiquiSonic® analyzer provide precise inline ADL concentration control with real-time monitoring.

LiquiSonic® reduce expensive total organic carbon (TOC) lab measurements:

- time saving: 1 h per day
- cost per hour: 50 € (60 $)
- total cost savings: 10.000 € (12,000 $) per year

The continuous monitoring of the deicing liquid in the waste water ensures compliance with environmental regulations. Costs are reduced as a consequence of the targeted discharge of ADL waste water into the recycling plant of the airport.

Saving potential for Ø 4500 aircrafts with 400 l ADL:

- increase of the reprocessed deicing fluid of 1 % by exact concentration analyze in the wastewater
- cost savings: 18.000 € (24,000 $) per year

Investment: approx. 15.000 € (20,000 $)
Amortization: < 1 year

Installation

The LiquiSonic® sensor is installed in the transport piplines (e.g. DN 50), collecting lines or reservoirs. Particularly in the reservoirs, sensors with a length up to 4 m can be installed.

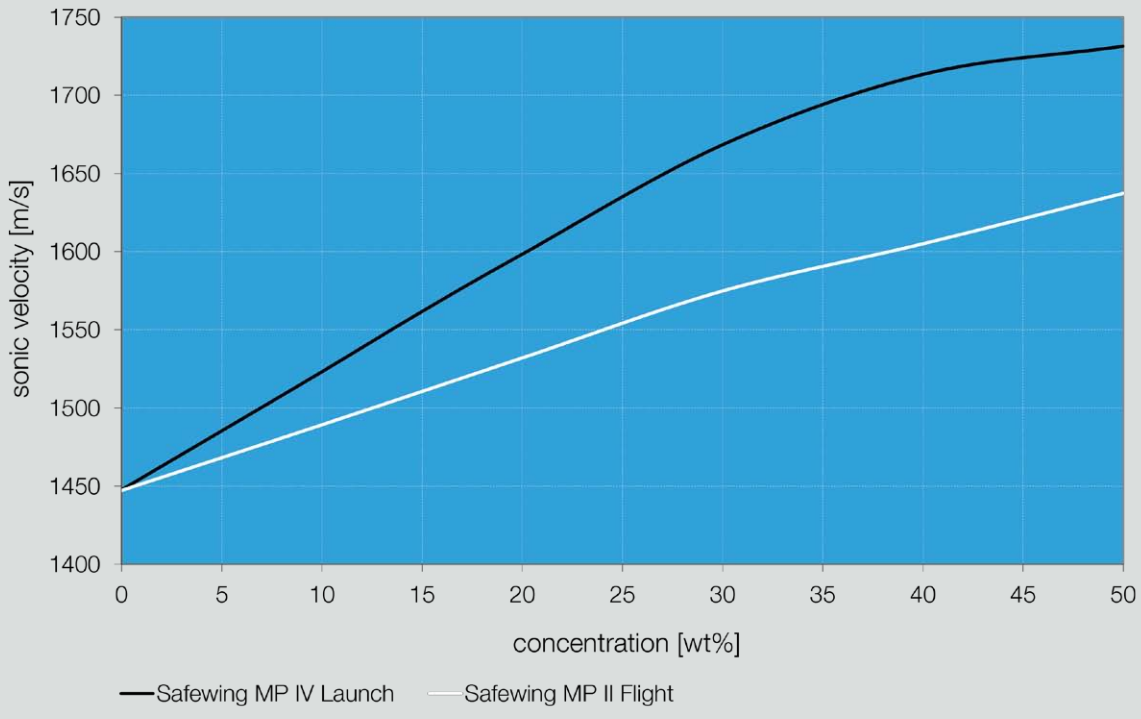
By using the LiquiSonic® controller 30, up to four sensors can be connected, allowing the simultaneous monitoring of several deicing zones. The maximum distance between controller and sensors of 1000 m can be extended, if necessary.

Typical measuring range:
concentration range: 0 to 50 wt%
temperature range: -15 to 30 °C

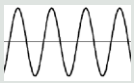
Typical de-icing liquids are:

- propylene glycol
- safewing MP I Eco, MP II Flight, MP III Eco and MP IV launch
- Kilfrost Typ I, II and IV
- Safeway and runway

LiquiSonic® sonic velocity measurement in aircraft deicing liquid



LiquiSonic® 30

	21001311 LiquiSonic® Controller 30 V10
	21010112 Immersion sensor V10 40-14, DIN DN50, L092
	21004350 T-adapter for immersion sensor DN50-50-50 PN16
BUS	21004435 BUS connection: Profibus DP
	21004449 Network integration
	21004110 High power sensor electronic
	21004202 Bus cable indoor (100m)
	21007846 Factory acceptance test (FAT) certificate

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