



# Advanced concentration measurement of sulfuric acid

# SensoTech

## Our aim: The best technology for your measuring task

- headquarters in Magdeburg-Barleben, Germany
- subsidiaries:
  - Wayne, NJ, USA
  - Shanghai, China
- international team of sales representatives
- worldwide customer relationships
- more than 25 years experience in inline analytical technology
- quality management with certification of DIN EN ISO 9001
- support and trainings



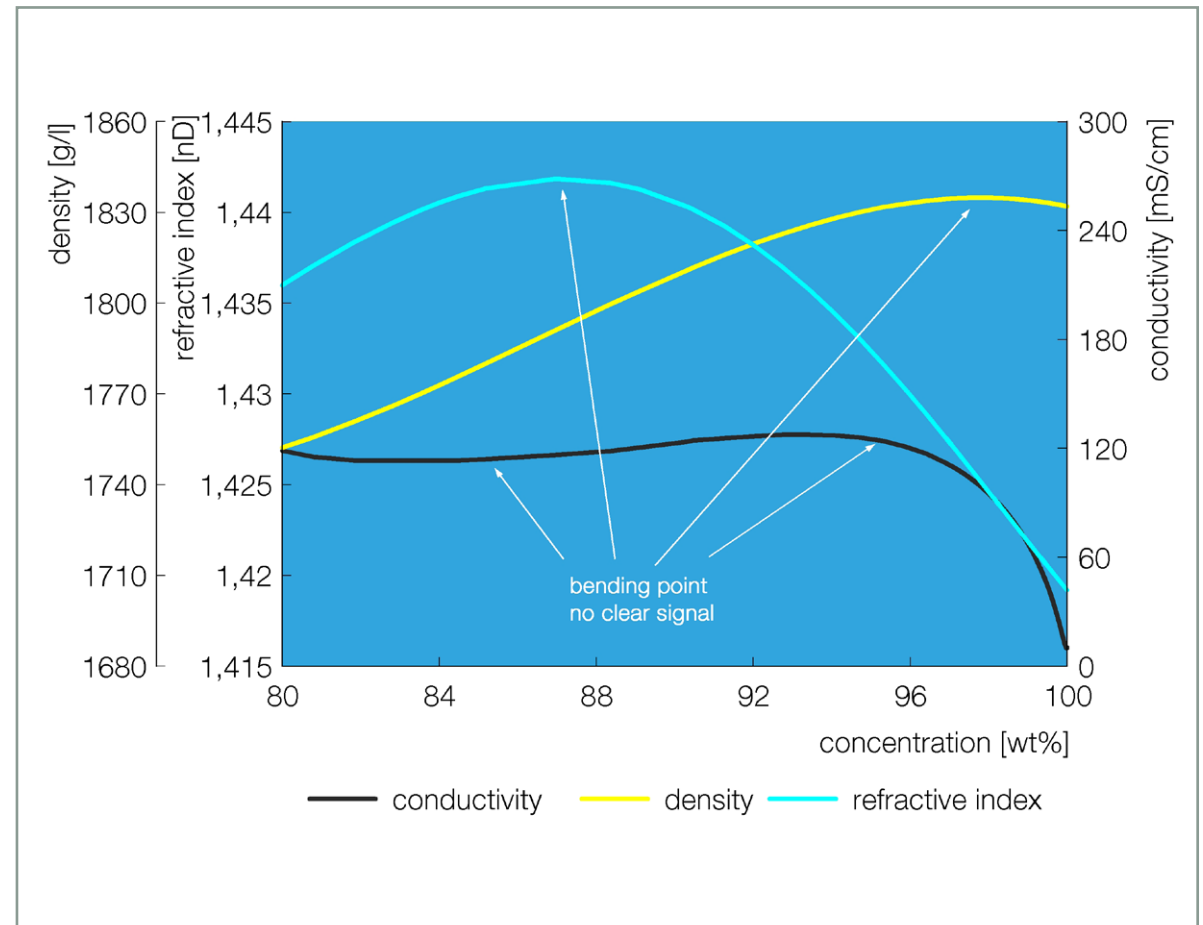
## Detection of sulfuric acid concentration

### Which measurement technique do you use?

- conductivity ?
- density ?
- refractive index ?

→ between 80 wt% and 100 wt%  $H_2SO_4$   
each of this three measurement techniques  
have limitations

→ **What do you know about sonic velocity?**



# Basics of sonic velocity measurement

## Properties

- mechanical vibration beyond the audible range ( $> 20$  kHz)
- measuring technique: frequency  $> 1$  MHz
- sonic velocity as propagation velocity of sonic waves
- sonic velocity as characteristic property of liquids, comparable with specific density, conductivity or refractive index

Medium	Sonic velocity [m/s]	Example
gas	250 to 400	air: 330 m/s
liquid	700 to 2,500	water: 1,500 m/s
solid	4,500 to 6,000	steel: 4,650 m/s



## Basics of sonic velocity measurement

### Measuring method

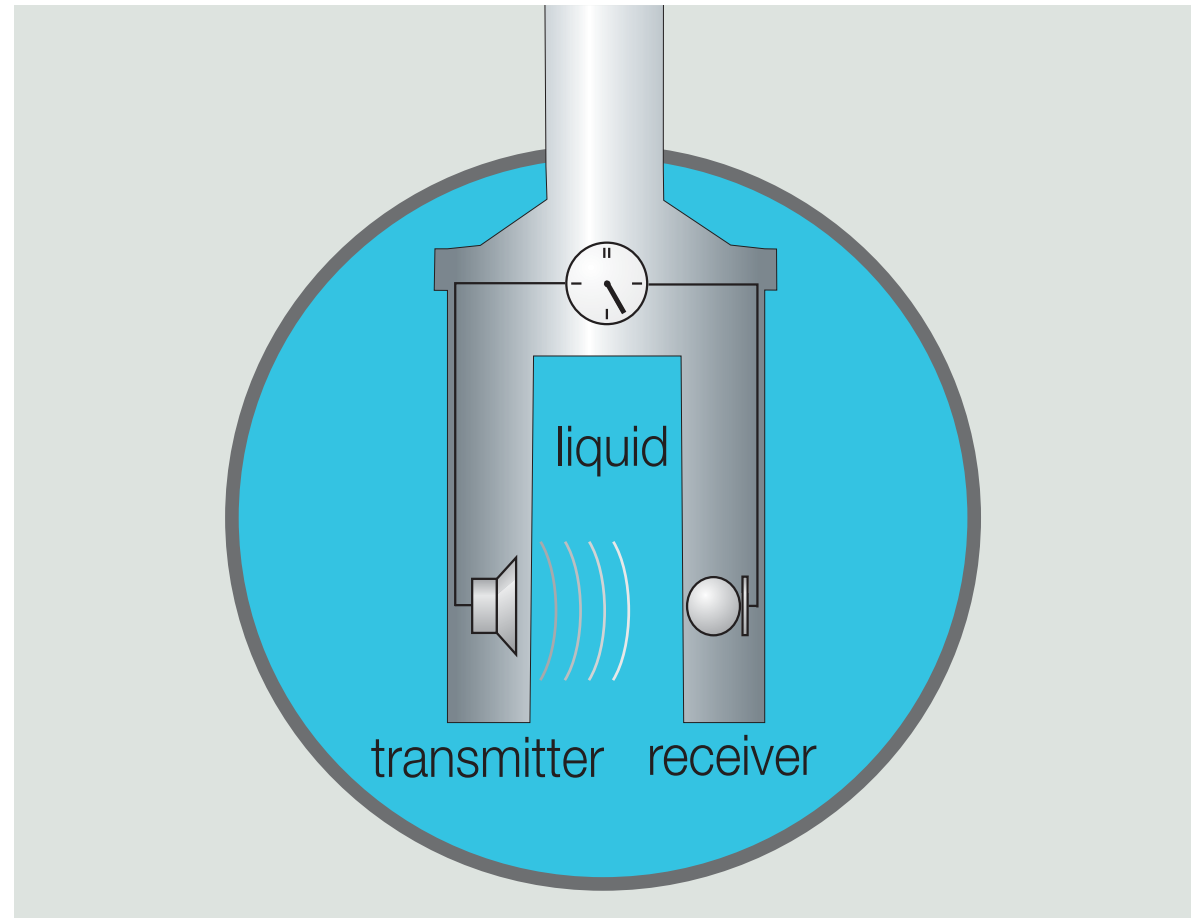
- measurement of the propagation velocity of ultrasonic waves in a liquid:

$$v = \frac{s}{t}$$

v: sonic velocity

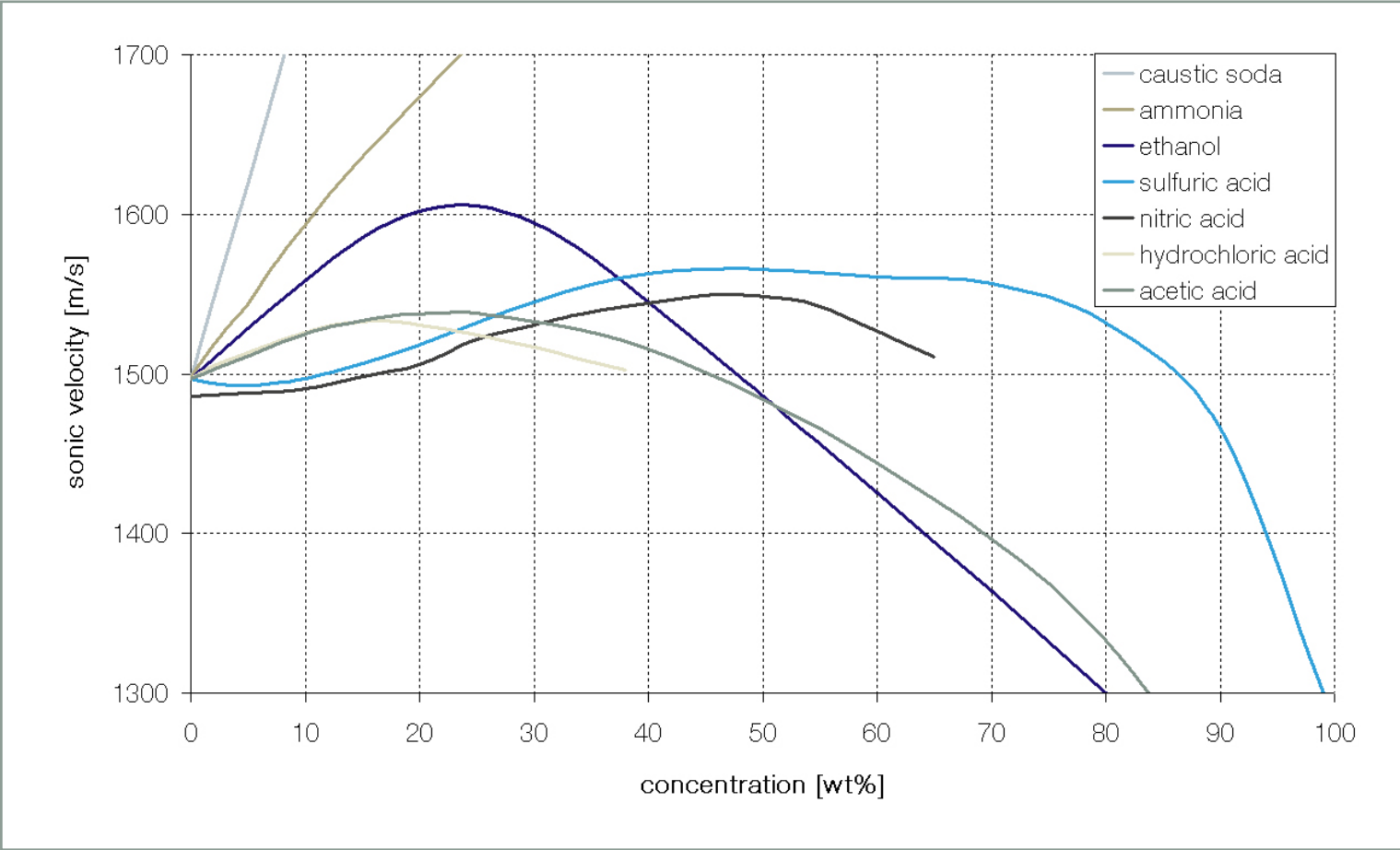
s: distance

t: travel time



# Basics of sonic velocity measurement

## Sonic velocity and concentration



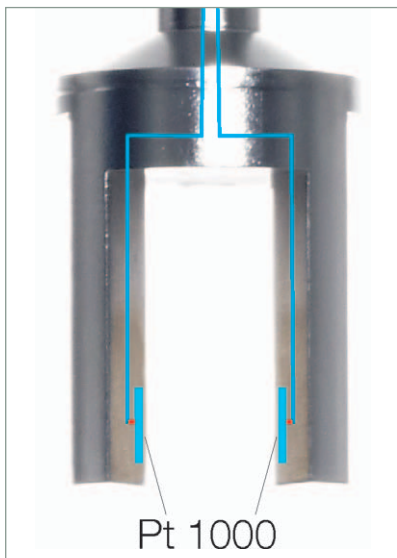
## Basics of sonic velocity measurement

### Coefficient of concentration and temperature

accuracy of the device:

- sonic velocity:  $\pm 0.05$  m/s
- temperature:  $\pm 0.05$  °C

→ In majority of applications the device achieves an accuracy of  $\pm 0.05$  wt%.



Liquid	Working point	Coefficient of concentration	Coefficient of temperature
propanol	60 %, 20 °C	-3.8 ms <sup>-1</sup> /m%	-3.0 ms <sup>-1</sup> /°C
propanol	90 %, 20 °C	-4.3 ms <sup>-1</sup> /m%	-3.1 ms <sup>-1</sup> /°C
propanol	60 %, 80 °C	-5.7 ms <sup>-1</sup> /m%	-3.1 ms <sup>-1</sup> /°C
propanol	90 %, 80 °C	-5.1 ms <sup>-1</sup> /m%	-3.3 ms <sup>-1</sup> /°C
ethanol	80 %, 60 °C	-6.4 ms <sup>-1</sup> m%	-3.5 ms <sup>-1</sup> /°C
acetic acid	80 %, 30 °C	-4.4 ms <sup>-1</sup> /m%	-3.5 ms <sup>-1</sup> /°C
sulfuric acid	80 %, 30 °C	-12 ms <sup>-1</sup> /m%	-3.0 ms <sup>-1</sup> /°C
caustic soda	10 %, 20 °C	20.8 ms <sup>-1</sup> /m%	3.0 ms <sup>-1</sup> /°C
glucose	10 %, 30 °C	4.2 ms <sup>-1</sup> /m%	2.0 ms <sup>-1</sup> /°C
beer	11 %, 2 °C	5.0 ms <sup>-1</sup> /m%	2.5 ms <sup>-1</sup> /°C



## Concentration measurement in binary liquids

- acids: HCl, H<sub>2</sub>SO<sub>4</sub>, H<sub>3</sub>PO<sub>4</sub>, HNO<sub>3</sub>
- leaches: NaOH, KOH
- inorganics: NaCl, KCl, ammonium sulphate
- organics: ethanol, methanol, hexane
- liquefied gas: propane, butane
- food: beer, juice, milk, whey, dry matters
- cleaning agents, CIP: tenside, NaOH
- emulsion: rolling oil/H<sub>2</sub>O, cooling lubricant/H<sub>2</sub>O
- suspension: NaCl/H<sub>2</sub>O, ammonium sulphate/H<sub>2</sub>O, crystal content
- liquids with nano-particles





## Basics of sonic velocity measurement

### Properties of sonic velocity measurement devices

- sonic velocity as a well-defined and retraceable physical value
- inline measurement
- independent of color, transparency of process liquids
- independent of conductivity
- maintenance free, no moving parts or optical windows
- robust against mechanical vibration and pressure shocks
- easy mounting, directly in main pipe or vessel
- metallic construction, without gaskets, without glued connection
- corrosion resistant due to special material
- temperature range  $-90\text{ }^{\circ}\text{C}$  up to  $200\text{ }^{\circ}\text{C}$

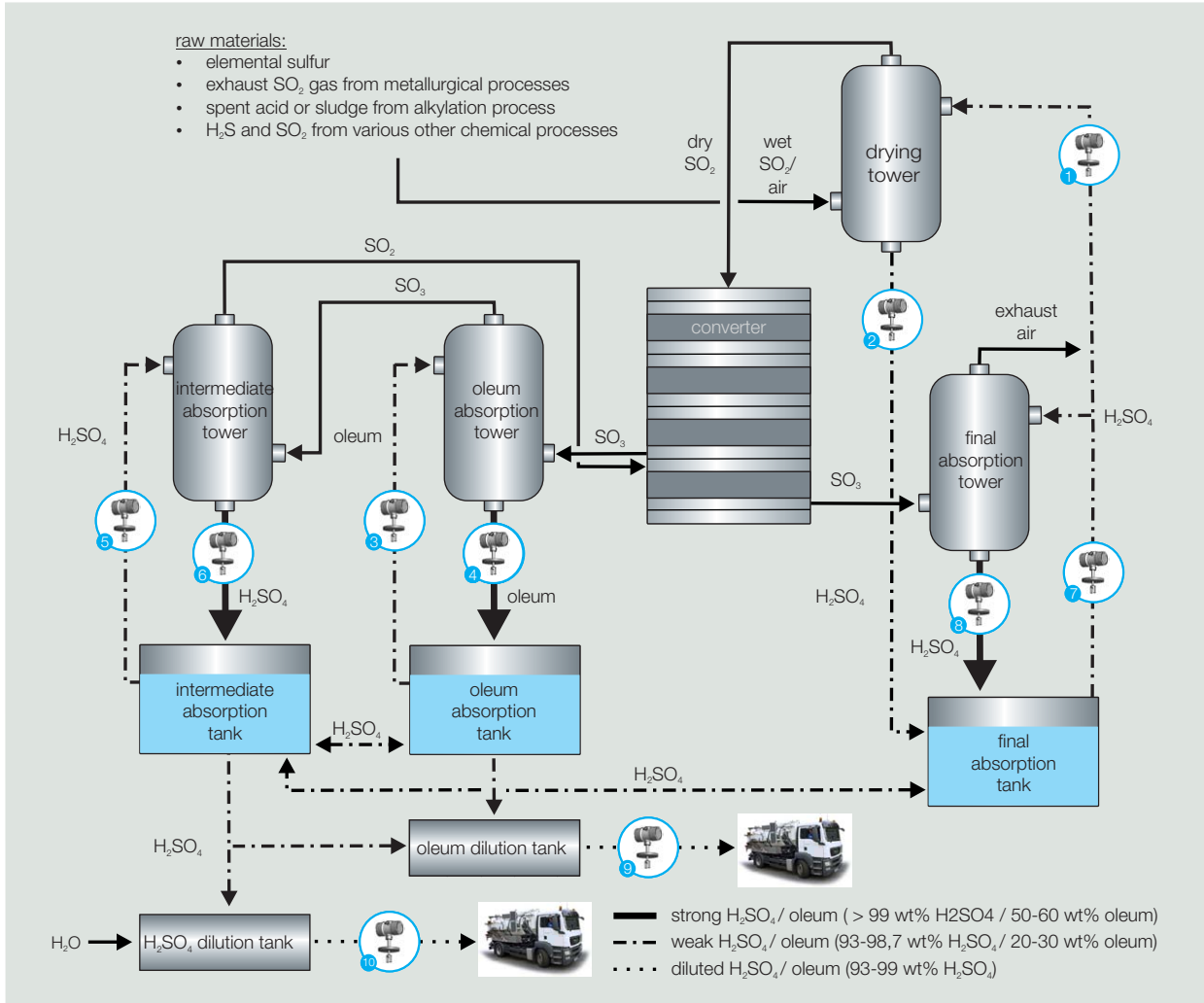
#### Limitation

knowledge of liquid is required (generation of product data sets)



# Chemical industry

## Sulfuric acid and Oleum production



## 3-component-analysis

### Combination measurement

#### Basic

- combination of sonic velocity with different physical values like density, conductivity or refractive index

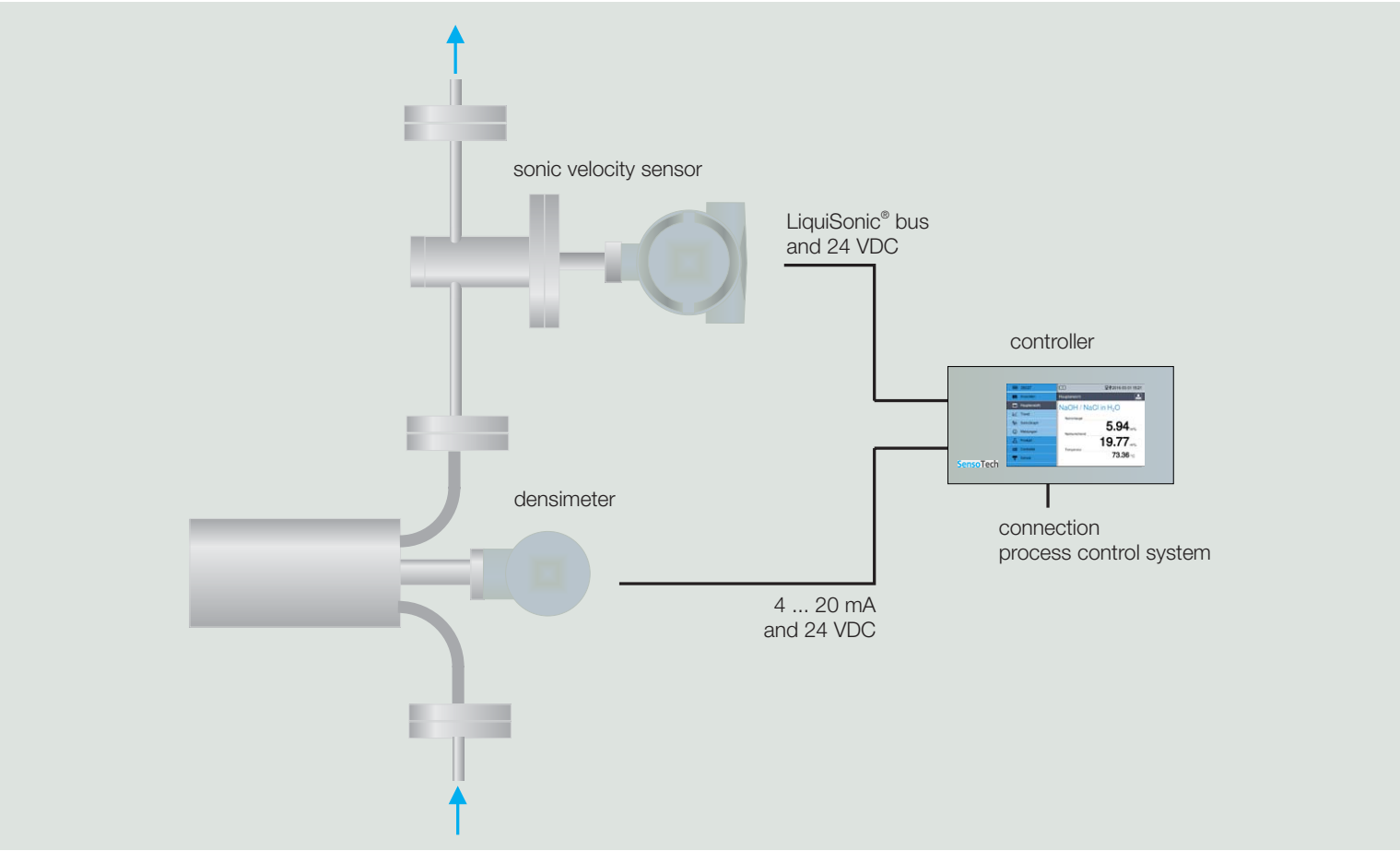
#### Examples of solutions

- sonic velocity and density
  - methanol and formaldehyde in water
  - ethanol and acetic acid in water
  - sulphuric acid and oleum
- sonic velocity and conductivity
  - caustic soda and sodium chloride in water
  - hydrochloric acid and Iron in water
  - caustic soda and propanol in water
- sonic velocity and refractive index
  - dextrose equivalent of carbohydrate



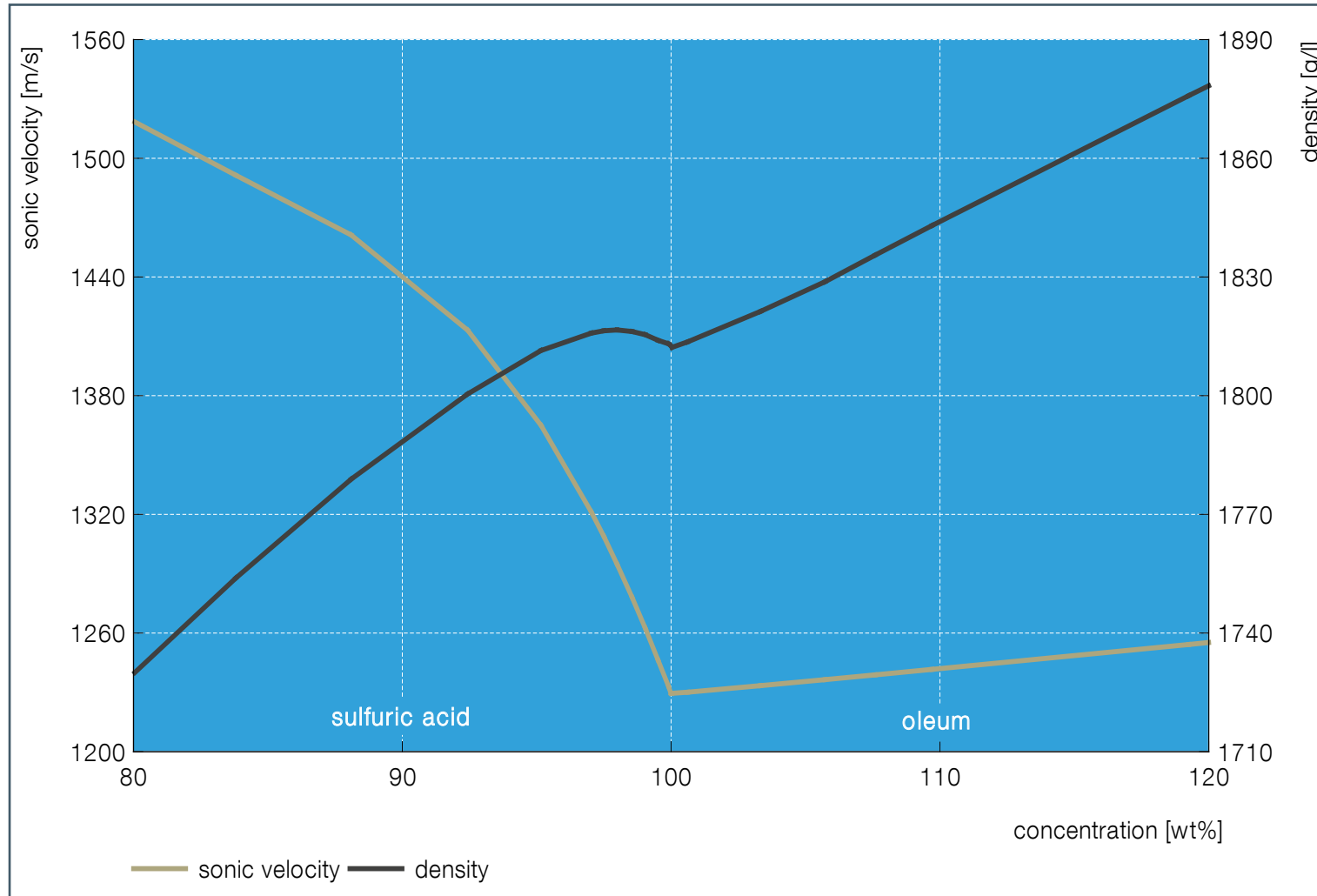
# 3-component-analysis

## Combination of sonic velocity and density



## 3-component-analysis

### Detection of sulfuric acid and oleum



## LiquiSonic® controller

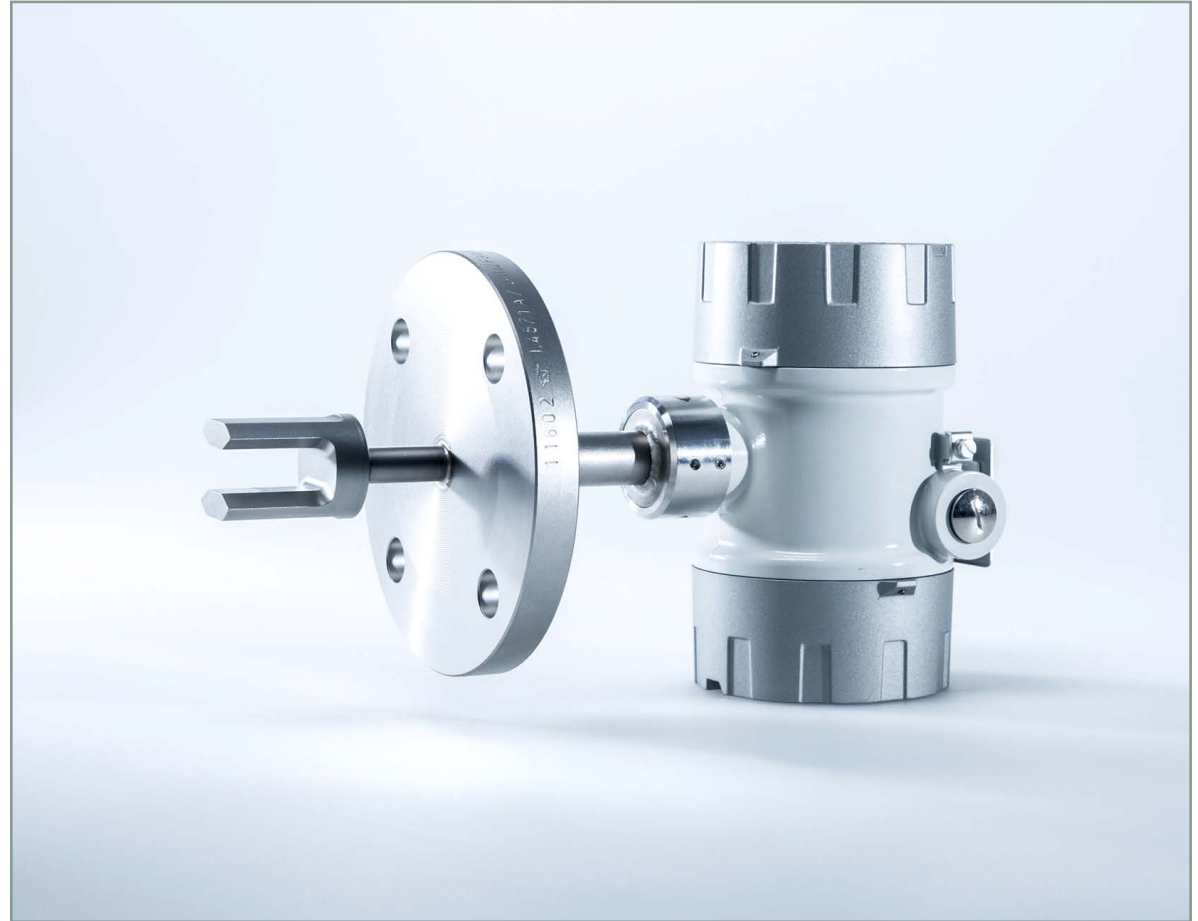
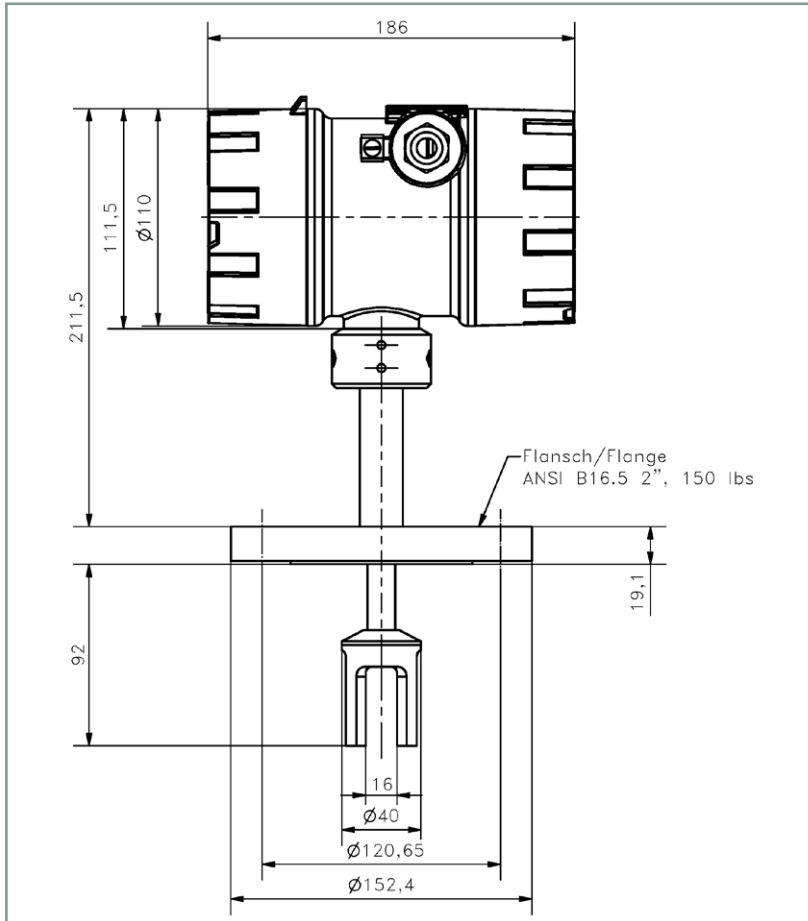
### Measuring data to analyze and monitor

- panel mounting casing
- material: powder-coated steel
- front panel: anodized aluminum
- display protection: glass
- protection degree: IP30 (NEMA 2), front: IP65 (NEMA 4)
- display: capacitive touch screen, 7", 800 x 480 (16 Mio. colors)
- front panel: 260 x 133 mm (10.2" x 5.2")
- panel cut-out: 242 x 122 mm (9.5" x 4.8")
- installation depth: 250 mm (9.8")



# LiquiSonic® sensor

## Immersion sensor 40-14, DN 50, L92



# LiquiSonic<sup>®</sup> system

## Variants

### LiquiSonic<sup>®</sup> 30

standard device with all functions

### LiquiSonic<sup>®</sup> 20

low budget version with only basic functions

### LiquiSonic<sup>®</sup> 40

powerful version to calculate 2 different concentrations in a 3-component mixture

### LiquiSonic<sup>®</sup> 50

optimal application in crystallization and polymerization processes

### LiquiSonic<sup>®</sup> Lab

version for laboratories and thus flexible using possible



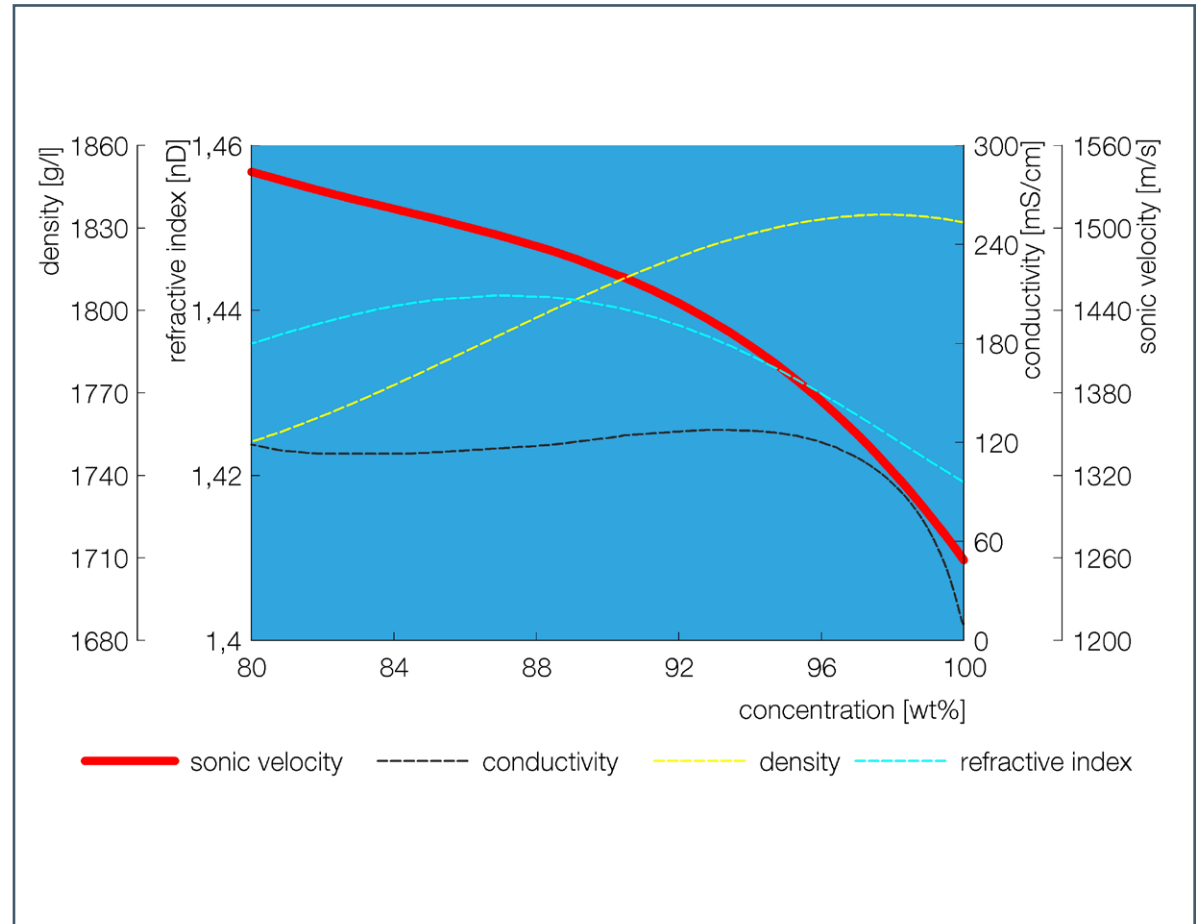


# Detection of sulfuric acid concentration

## Which measurement technique are you going to use in the future?

### Sonic velocity!

- outstanding accuracy of  $\pm 0.05$  wt%
- no bending point
- unmatched lifespan  $\rightarrow$  15 years
- corrosion-resistant due to HC2000
- maintenance-free
- no drift
- no moving parts or optical windows



# We are committed to quality in every way.





In liquids, we set the measure.

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