



# **LiquiSonic® - Digital on-line measurement towards process excellence**

# SensoTech

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

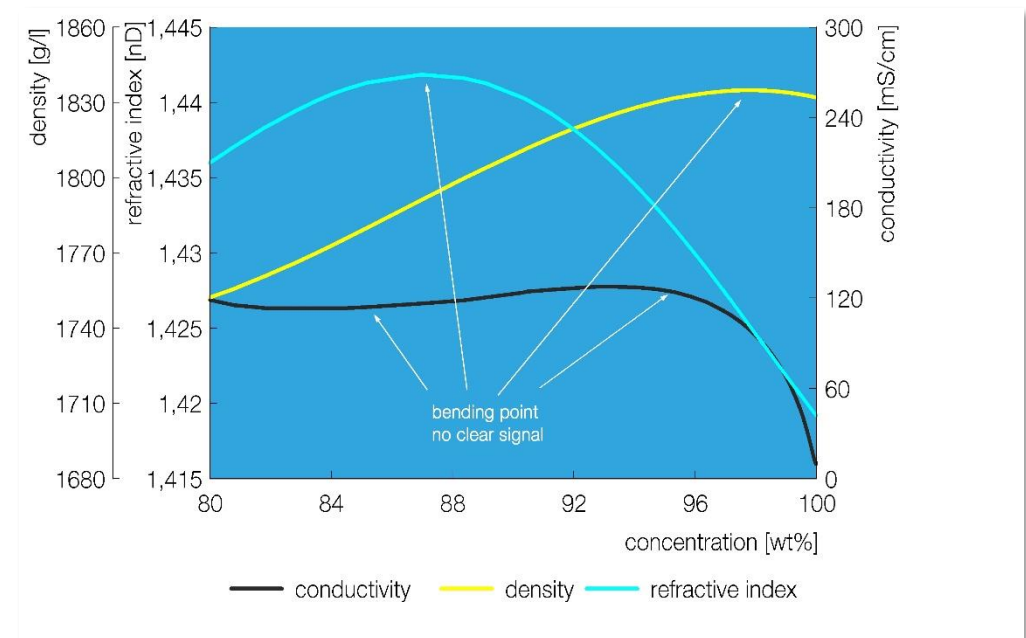
- headquarters in Magdeburg-Barleben, Germany
- subsidiaries in USA and China
- international team of sales representatives
- worldwide customer relationships
- 30 years experience in inline analytical technology
- quality management with certification of DIN EN ISO 9001
- support and trainings



# Monitoring of sulfuric acid concentration

## Which measurement technique do you use?

- conductivity ?
  - density ?
  - refractive index ?
- All these measurement techniques are limited (80 - 100 wt% H<sub>2</sub>SO<sub>4</sub>)
- Still taking samples and waiting for lab results?
- What did 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	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

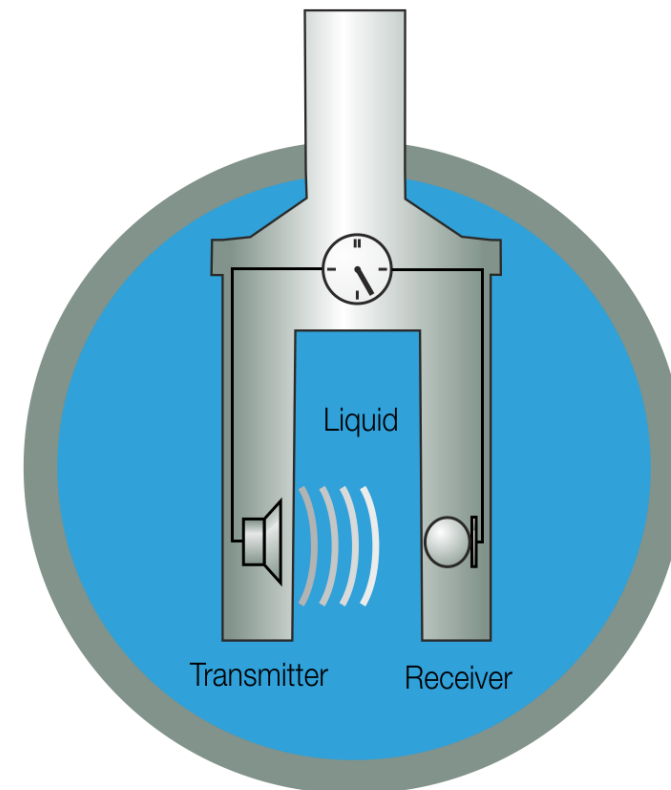
- measurement of the propagation velocity of ultrasonic waves in a liquid:

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

v: sonic velocity

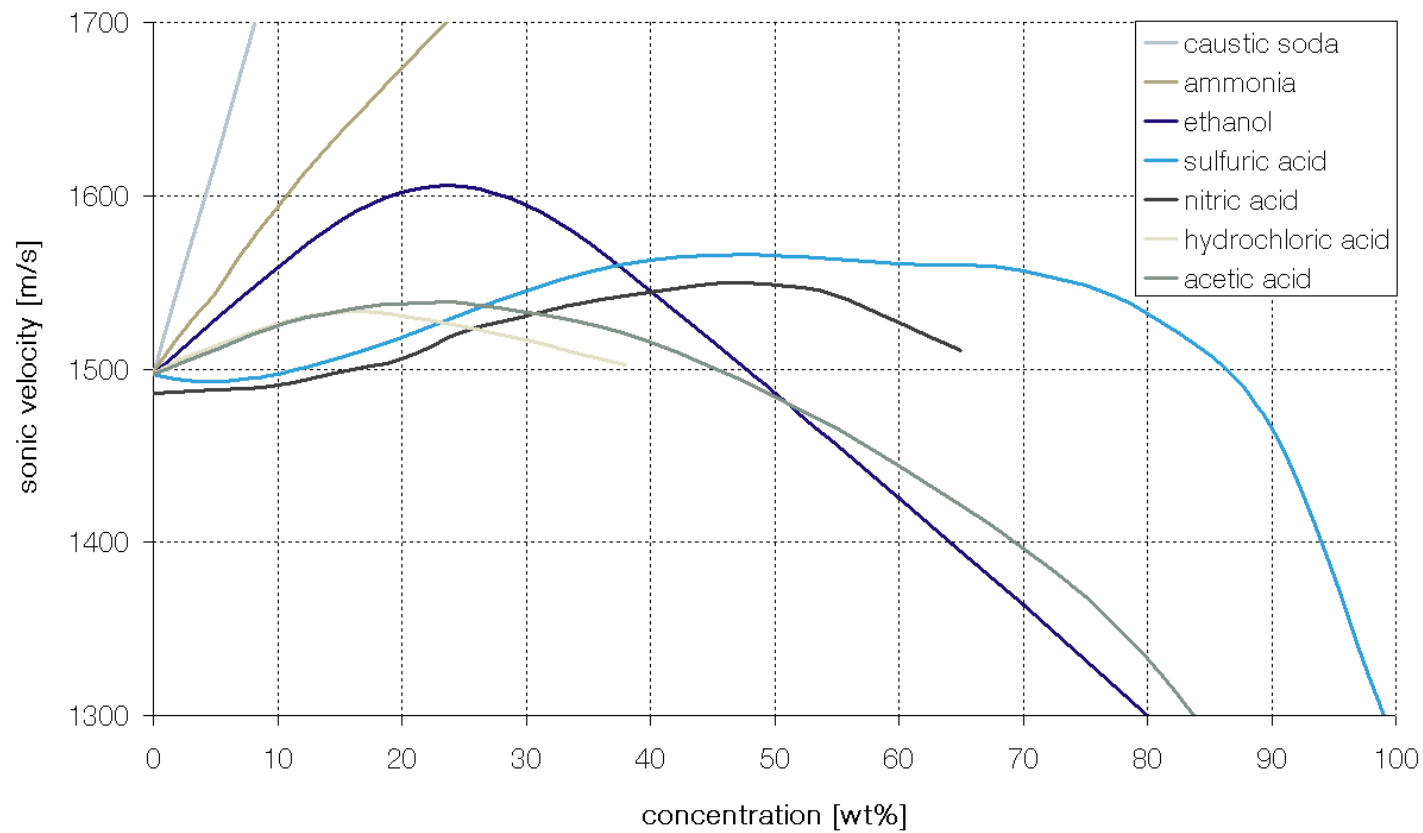
s: distance

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%.



Pt 1000

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

# Application fields of LiquiSonic®

## Your industry, your applications

### Concentration measurement (binary or tertiary mixture)

- concentration of inorganic / organic liquids, emulsion und suspension

### Phase separation

- phase interface detection in pipes and vessels
- phase position in vessels
- inspection of incoming goods

### Polymerization

- concentration of monomers
- monitoring of a polymerization process
- content of remaining monomer and concentration of polymer

### Crystallization

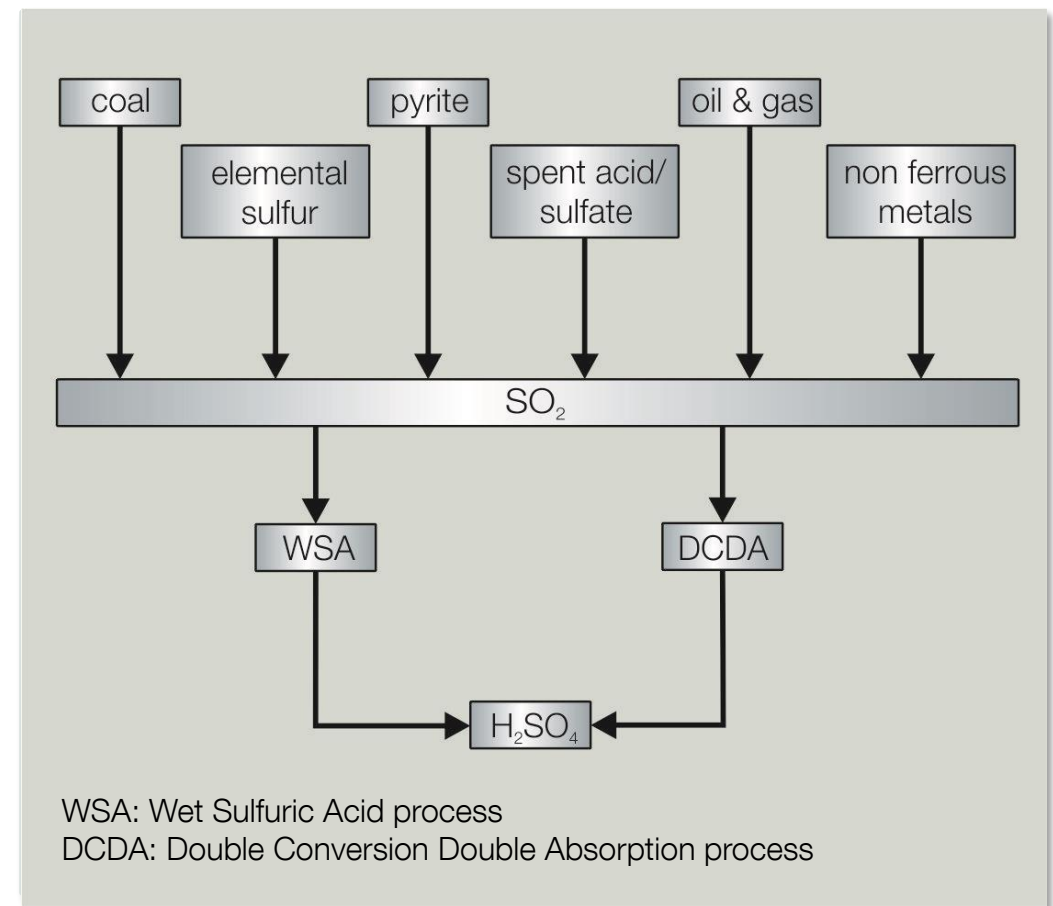
- determination of saturation and crystallization temperature
- determination of supersaturation
- determination of growth kinetics



# Sulfuric acid and oleum production

## Different raw materials – different industries

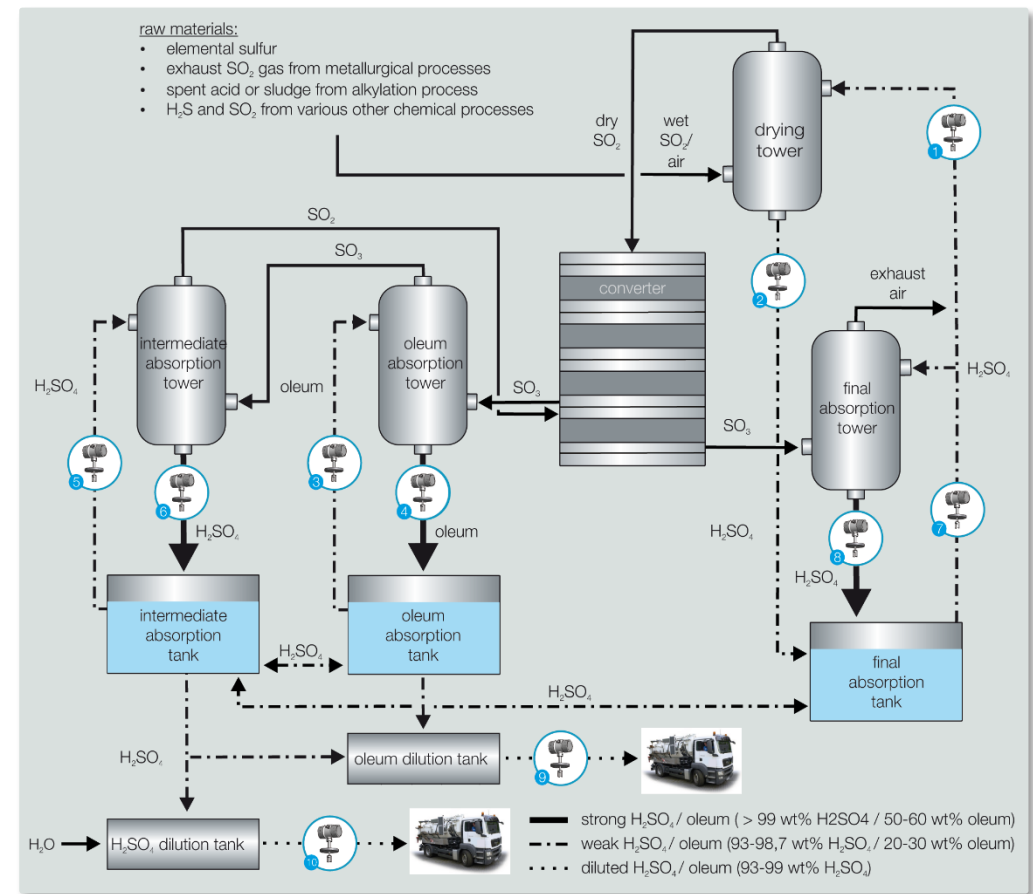
- diverse raw materials
- materials are typical for certain industrial manufacturing processes
- sulfuric acid production is typically coupled to:
  - crude oil refinery
  - metal industry
  - petrochemical industry
  - fertilizer production
  - coal mining
  - viscose production



# Sulfuric acid and oleum production

## Double contact double absorption process (DCDA)

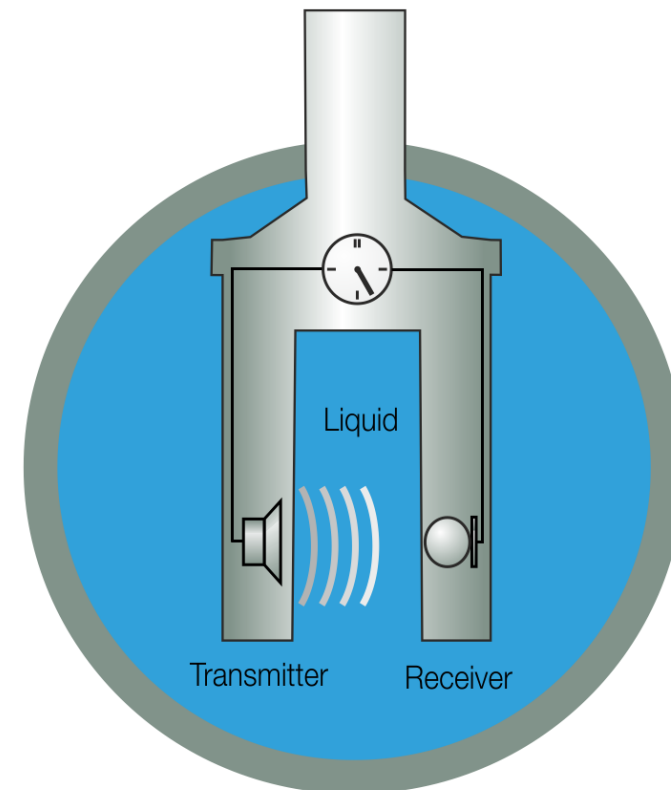
- sulfuric acid production ( $H_2SO_4$ ) based on sulfur burning (S)
- production process requires an exact determination of  $H_2SO_4$  strength between 90 wt% and 100 wt%
- detection of the oleum strength ( $> 100$  wt%), avoiding safe-critical process situations such as acid runaways and emissions
- sensor installation:
  - drying tower
  - oleum absorption tower
  - intermediate absorption tower
  - final absorption tower
  - dilution of sulfuric acid / oleum to the preferred target concentration



# Sulfuric acid and oleum production

## Customer benefits: sonic velocity - inline

- easy installation: plug 'n play
- maintenance-free and excellent long term-stability
- improved process control
  - precise  $\text{H}_2\text{SO}_4$  strength  $\pm 0.05 \text{ wt}\%$
  - corrosion protection
- no unclear laboratory values anymore
  - unexpected laboratory values  $\rightarrow$  repetition (titration)  $\rightarrow$  additional personnel and material costs
  - Until clear result: operator has to adjust process parameters  $\rightarrow$  e.g. increase concentration  $\rightarrow$  costs
  - in case of titration error: too low concentration (increased corrosion rate)
- inline measurement 24/7 real-time data
- corrosion-resistant sensor material
  - Hastelloy C2000, Hastelloy BC1 Hybrid
  - Tantalum
  - PFA coating



# Sulfuric acid and oleum production

## Customer benefits: sonic velocity - inline

- improved process control
- LiquiSonic® replaces laboratory costs:
  - No titration anymore (common laboratory method)
  - sampling time: 15 minutes
  - sampling frequency: 6 times per day
  - labor costs per day: 75€/d (96,6\$/d)
  - costs per year (230 working days):
    - $230d \times 75€/d = 17.250€/y$  ( $23,800\$/y$ )
    - **amortization < 1 year**
- one sensor for all applications (reduced costs for spare parts)
- comprehensive diagnostic capabilities
- powerful data storage

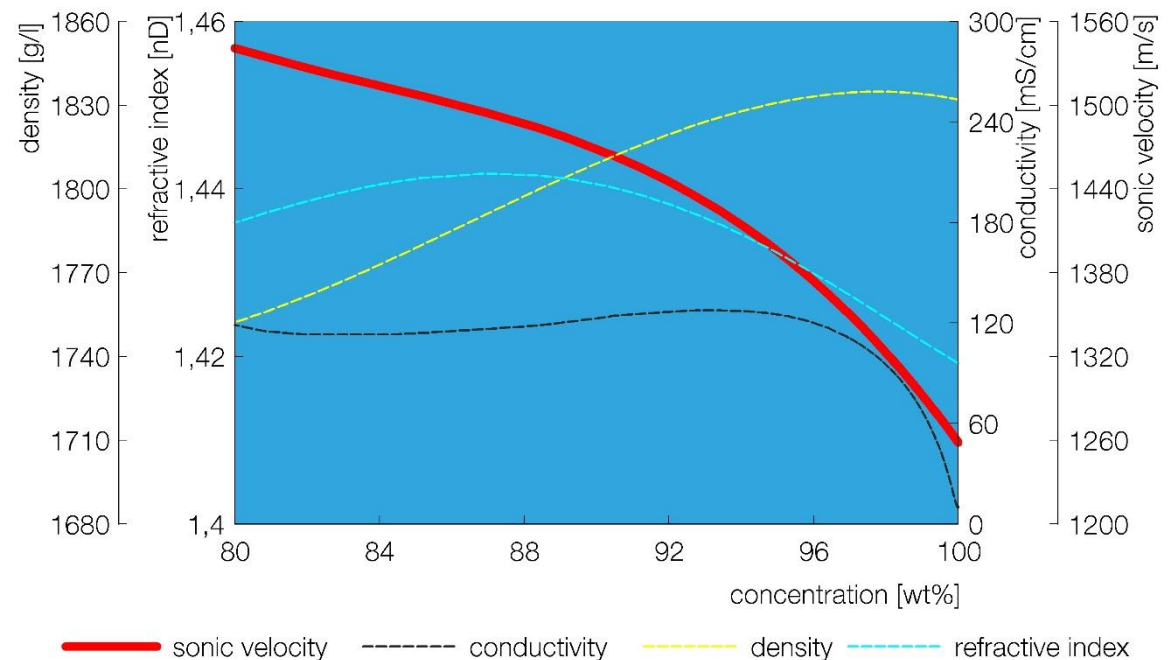


# Sulfuric acid and oleum production

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

### Sonic velocity!












- outstanding accuracy of  $\pm 0.05$  wt%
- no bending point
- increased plant safety
  - acid runaway can be detected (concentration drop)
  - no too low concentration = no corrosion
- unmatched lifespan  $\rightarrow$  15 years
- corrosion-resistant (Hastelloy C2000, BC1-Hybrid)
- maintenance-free
- no drift



# Sulfuric acid and oleum production

## Comparison of analyzers for H<sub>2</sub>SO<sub>4</sub> and Oleum

- sonic velocity inline: the only measurement system with high accuracy level for all ranges
- conductivity: inflection point between 80 – 95 wt%
- density: inflection point between 95 - 99.99 wt%

concentration range	80 - 95 % H <sub>2</sub> SO <sub>4</sub>	95 - 99.99 % H <sub>2</sub> SO <sub>4</sub>	20 - 30 % Oleum	65 % Oleum
technology				
SensoTech sonic velocity inline				
conductivity				
density				

# Sulfuric acid and oleum production

## LiquiSonic® – your powerful H<sub>2</sub>SO<sub>4</sub> analyzer

- LiquiSonic® Controller 30 V10
  - Profibus DP
  - MODBUS RTU
  - MODBUS TCP
  - analog outputs: 4 x 4-20 mA
  - digital outputs: 6x electrical relays
  - operation via touch display or browser
  - manages up to 4 sensors
- LiquiSonic® immersion sensor 40-14
  - length: customized
  - max. temperature: 120 °C (optional 200 °C)
  - process connection: DIN, ANSI
- LiquiSonic® sensor materials
  - hastelloy C2000
  - hastelloy Hybrid-BC-1
  - tantalum
  - PFA coating



# Sulfuric acid and oleum production

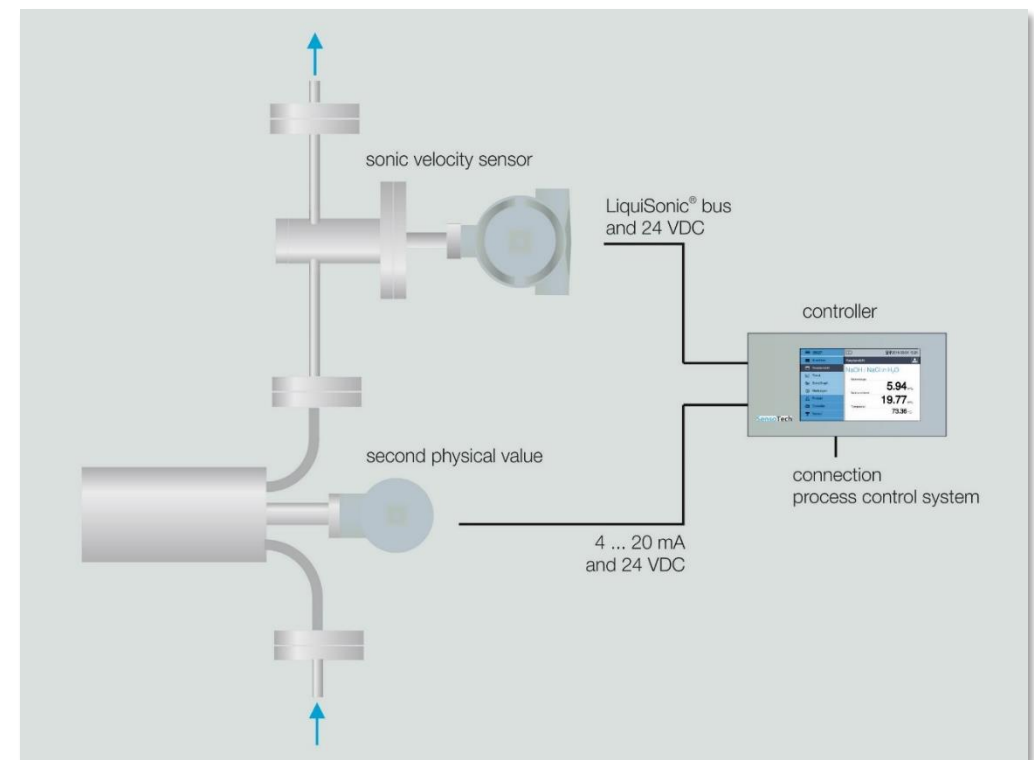
## Combination measurement for 3-component-analysis

### Basic

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

### Examples of applications

- sonic velocity and density
  - methanol and formaldehyde in water
  - ethanol and acetic acid in water
  - [sulfuric 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

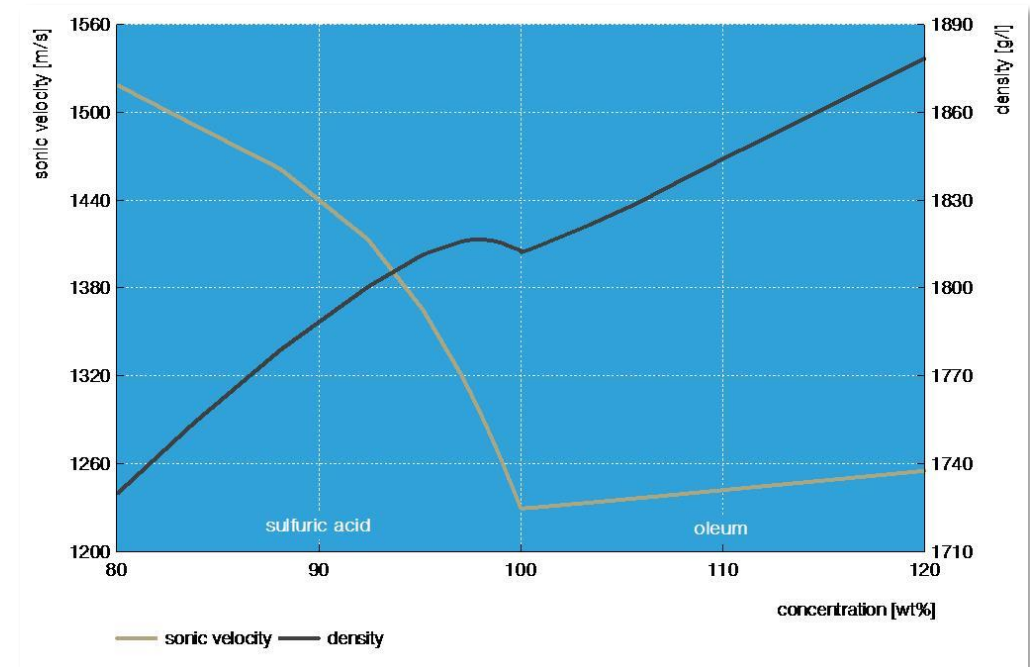




# Sulfuric acid and oleum production

## LiquiSonic® – one system for two applications

- Two applications at one installation point
  - 90 – 100 wt%  $\text{H}_2\text{SO}_4$
  - 0 – 20 wt% free  $\text{SO}_3$  (oleum strength)
- LiquiSonic® 40 solve this applications
  - sonic velocity and density in combination
  - long-time stability and maintenance-free system
- Sulfuric acid in 3-component applications
  - $\text{H}_2\text{SO}_4$  /  $\text{H}_3\text{PO}_4$  in  $\text{H}_2\text{O}$  (mixed acid)
  - $\text{H}_2\text{SO}_4$  /  $\text{HCl}$  in  $\text{H}_2\text{O}$  (mixed acid)
  - $\text{H}_2\text{SO}_4$  /  $\text{HF}$  in  $\text{H}_2\text{O}$  (semiconductor etching)
  - $\text{H}_2\text{SO}_4$  /  $\text{H}_2\text{CrO}_4$  in  $\text{H}_2\text{O}$  (chrome bath)
  - $\text{H}_2\text{SO}_4$  /  $\text{Fe}_2\text{SO}_4$  in  $\text{H}_2\text{O}$  (iron pickling bath)
  - $\text{H}_2\text{SO}_4$  /  $\text{Al}_2(\text{SO}_4)_3$  in  $\text{H}_2\text{O}$  (aluminium pickling bath)
  - And many more



Contact [SensoTech](http://www.sensotech.com) to solve your  $\text{H}_2\text{SO}_4$  application!

# Sulfuric acid and oleum production

## References

 we know how	 The Chemical Company	 Tomorrow's Answers Today			
	 BRIGHT SCIENCE. BRIGHTER LIVING.		 degussa.		
	 The world is our inspiration	 Energizing Chemistry		 Resources for a changing world	 Metals for Progress
 Formosa Plastics®					 PEÑALES®

# We are committed to quality in every way.





In liquids, we set the measure.

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