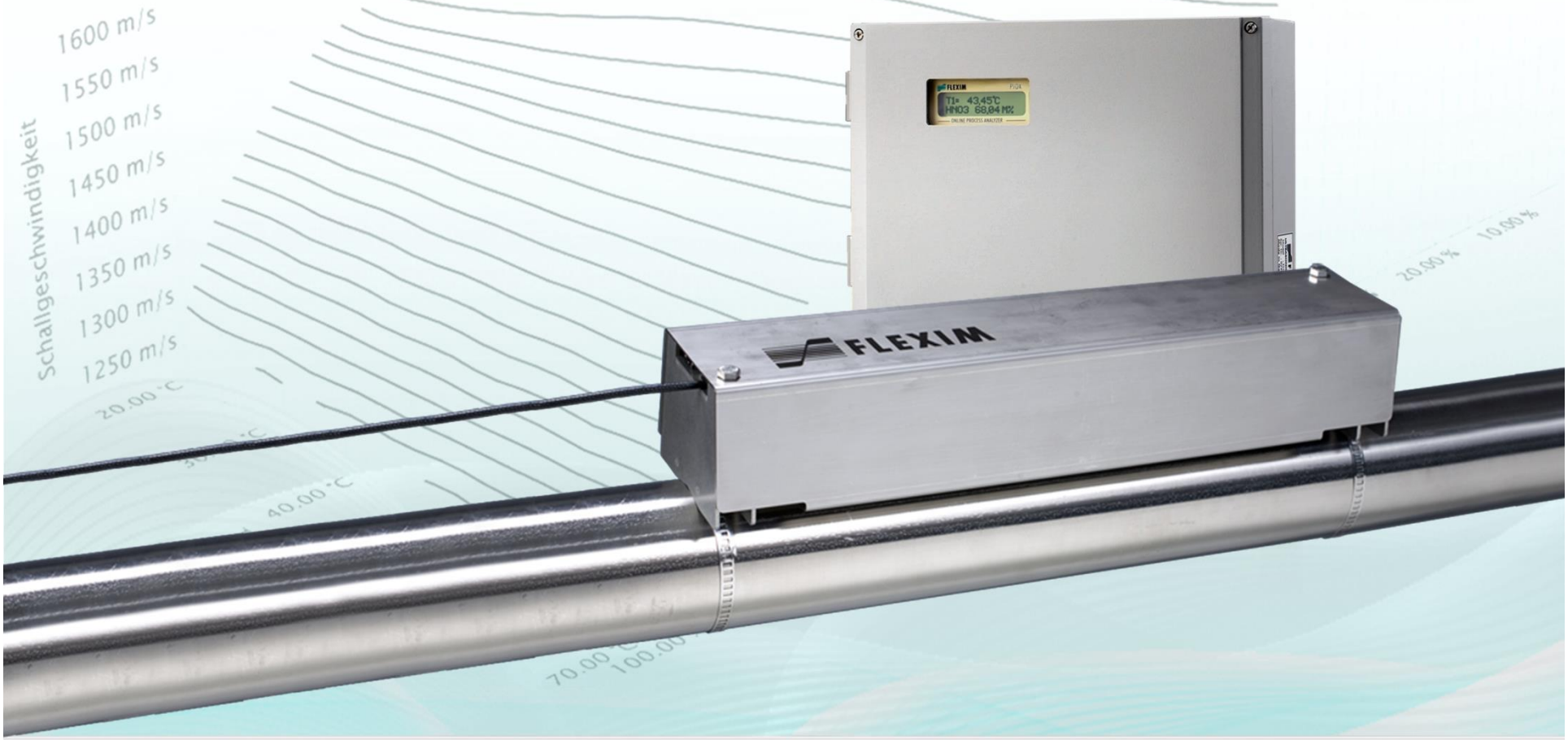
Ultrasonic Analyser PIOX S

Concentration and Flow Measurement with Ultrasound



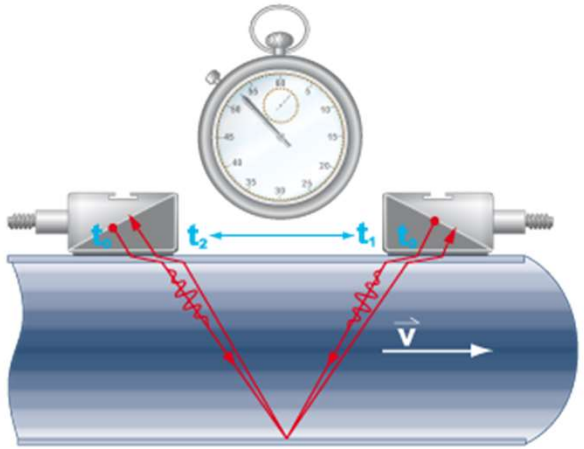
FLEXIM - At a Glance (www.flexim.com)

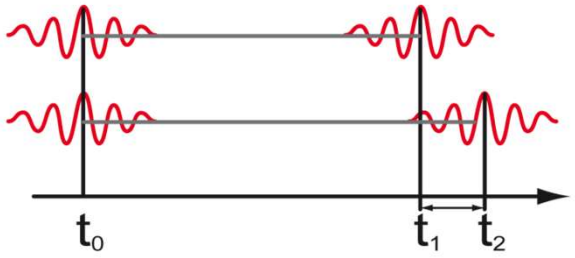
- FLEXIM, a global leader in clamp-on Ultrasonic Flow Measurement
- Highly Innovative metering solutions for Liquids and Gases as well as within Process Analytics
- Headquartered in Berlin, Germany, with more than 400 employees globally
- International presence with subsidiaries in Europe, United States and Asia aside a wide network of partner companies
- Strong competence centers in R&D and in-house production facilities
- Huge installed instrumentation base with over 70,000 meters installed worldwide

Measuring Principle: Ultrasonic Clamp-On

Transit Time Difference Method

- a pair of sensors (transducers) is mounted to the pipe wall
- Both send and receive signals
- one signal in flow direction
- one signal in opposite direction
- result: transit time difference
- time difference is proportional to flow velocity





What can be measured Clamp-on ?

Flow Measurement

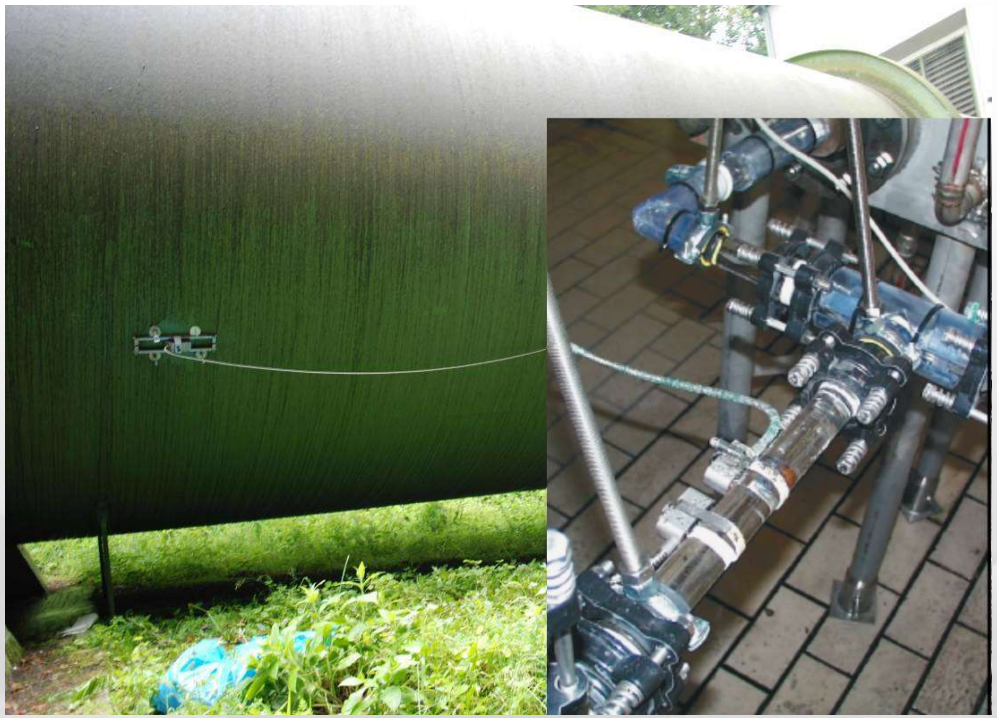
- Liquids in pipes from 6mm to 6.500 mm diameter
- Gases - 4 bar and up – no upper pressure limit
- up to 200°C, or up to 400°C with special coupling system (WI)

Concentration Measurement

- Liquids – binary compositions
- Concentration or density

Product Identification

- Liquid identification
- Interface detection
- Batch tracking
- Media control



Common ground - differences

CLAMP-ON

Measurement:

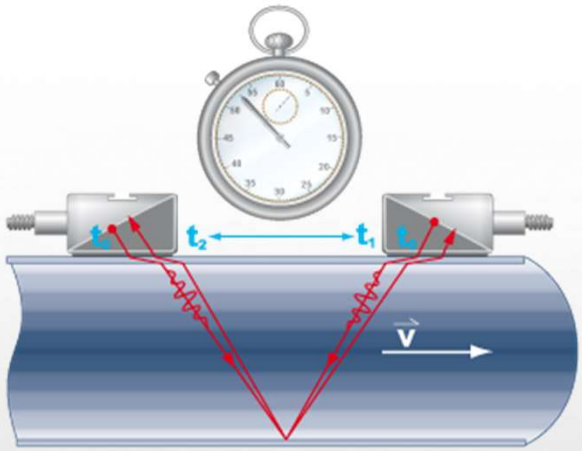
- Volume flow
- Mass flow (T)

Medium:

- Liquid / Gas
- Fixed composition

Hardware:

- Transducer
- Transmitter



equal components

PIOX-S

Measurement:

- Concentration
- Volume flow
- Mass flow (T,%)

Medium:

- Liquid only
- Variable composition

Hardware:

- Transducer
- Transmitter
- Temperature probe

Software:

- additional functions

Collection and analysis of process data

Measurement of process status

- Temperatur
- Pressure
- Flow

No qualities of the product

Measurement of a single feature

- Conductivity
- Density
- **Refractive Index**
- **Ultrasonic Sound**
- Redox Potential
- PH Value

PIOX-S

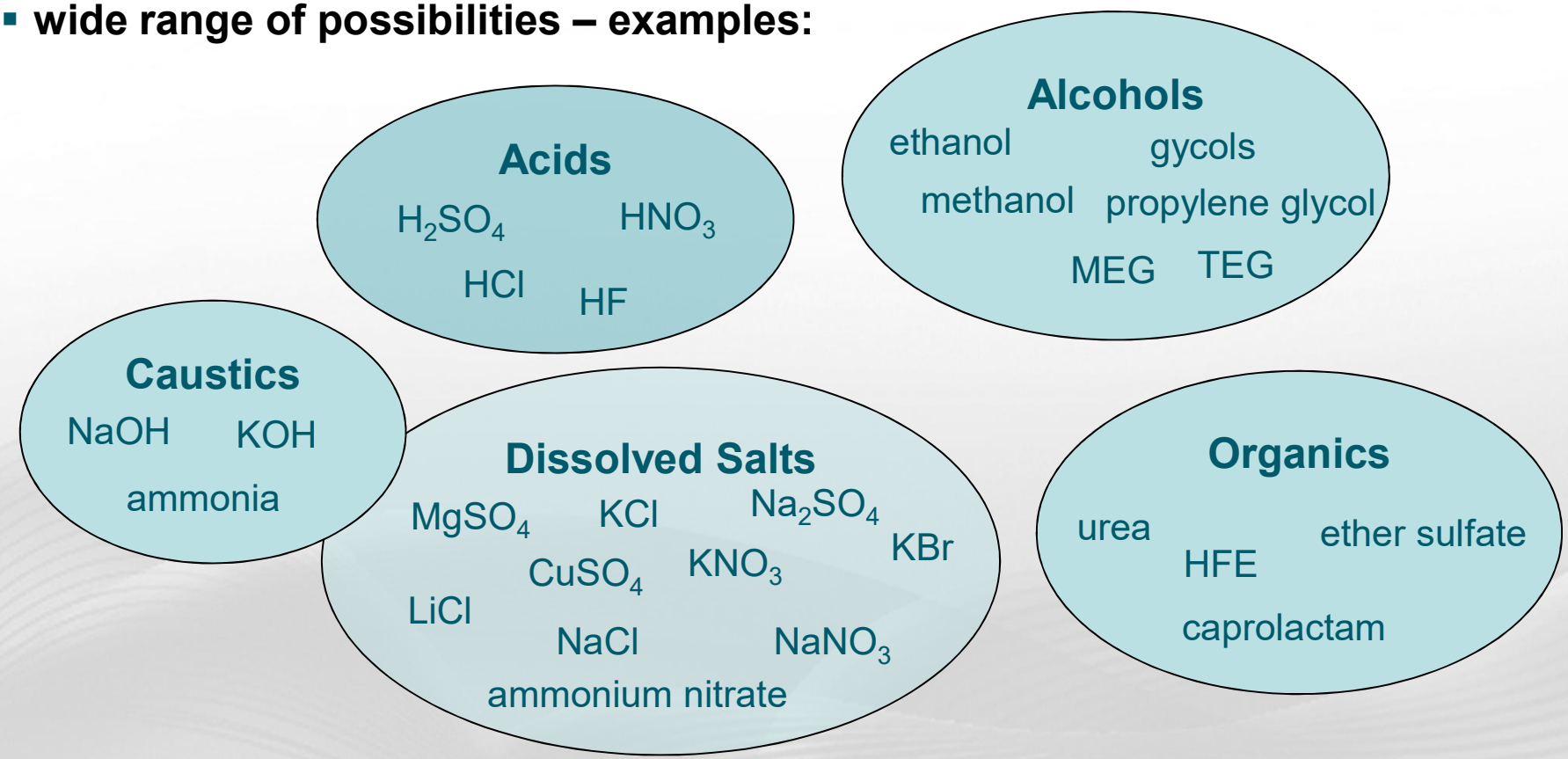
Measurement of more than one ...al variable ...variate)

- NIR Spectroscopy
- Raman Spectroscopy

Media Overview

What can be measured ?

- **2 component systems : or additional components are negligible (<< 1%)**
  or additional components are constant
- **wide range of possibilities – examples:**



Speed of Sound

Sound speed characterizes a fluid

Several fluids – same condition

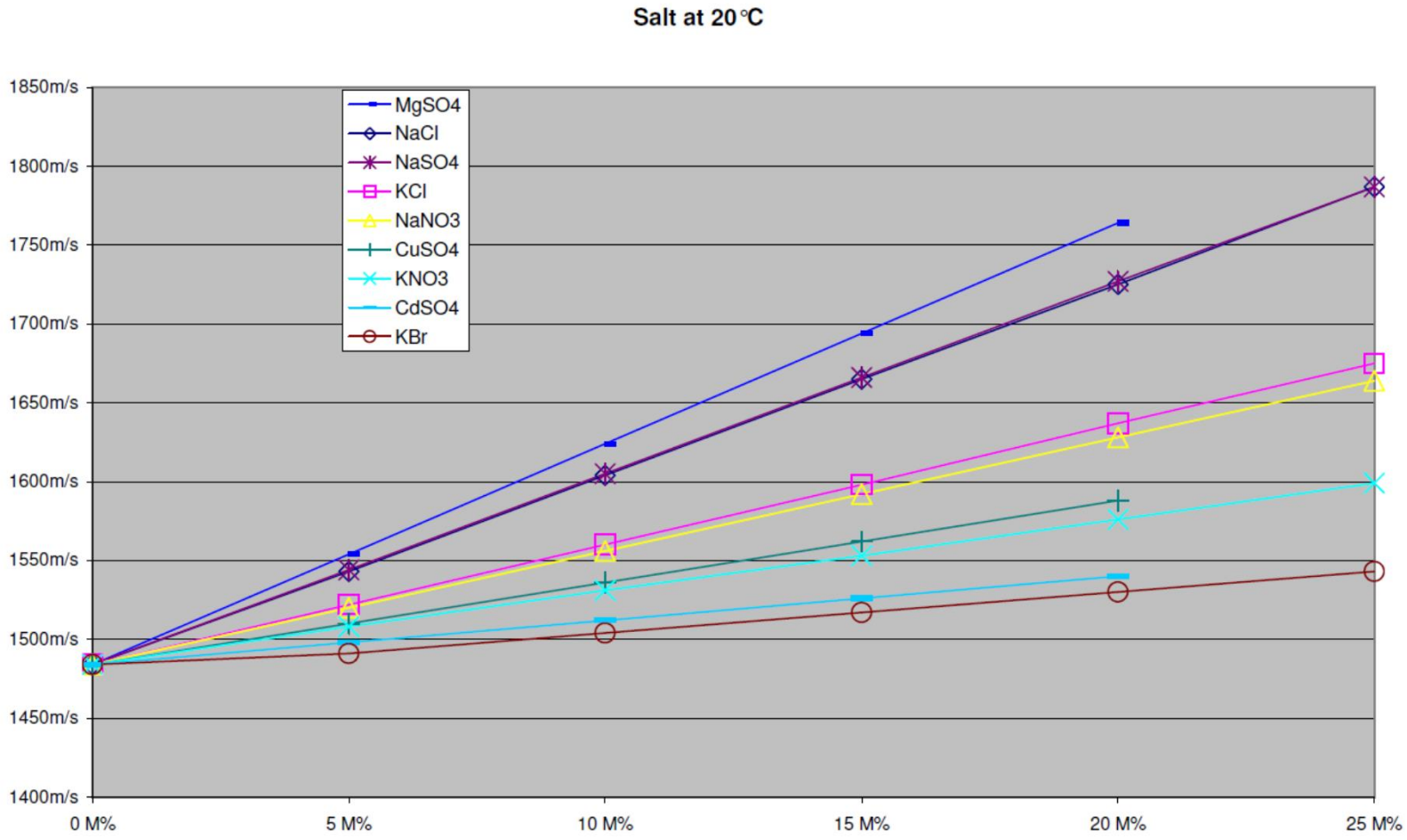
water	1480 m/s
crude oil	1300 m/s
hexane	1080 m/s
butane	943 m/s
caustic soda 50%	2400 m/s

Same fluid – serveral conditions

80% H_2SO_4 (30°C)	1530 m/s
80% H_2SO_4 (80°C)	1456 m/s
96% H_2SO_4 (30°C)	1337 m/s
96% H_2SO_4 (80°C)	1269 m/s

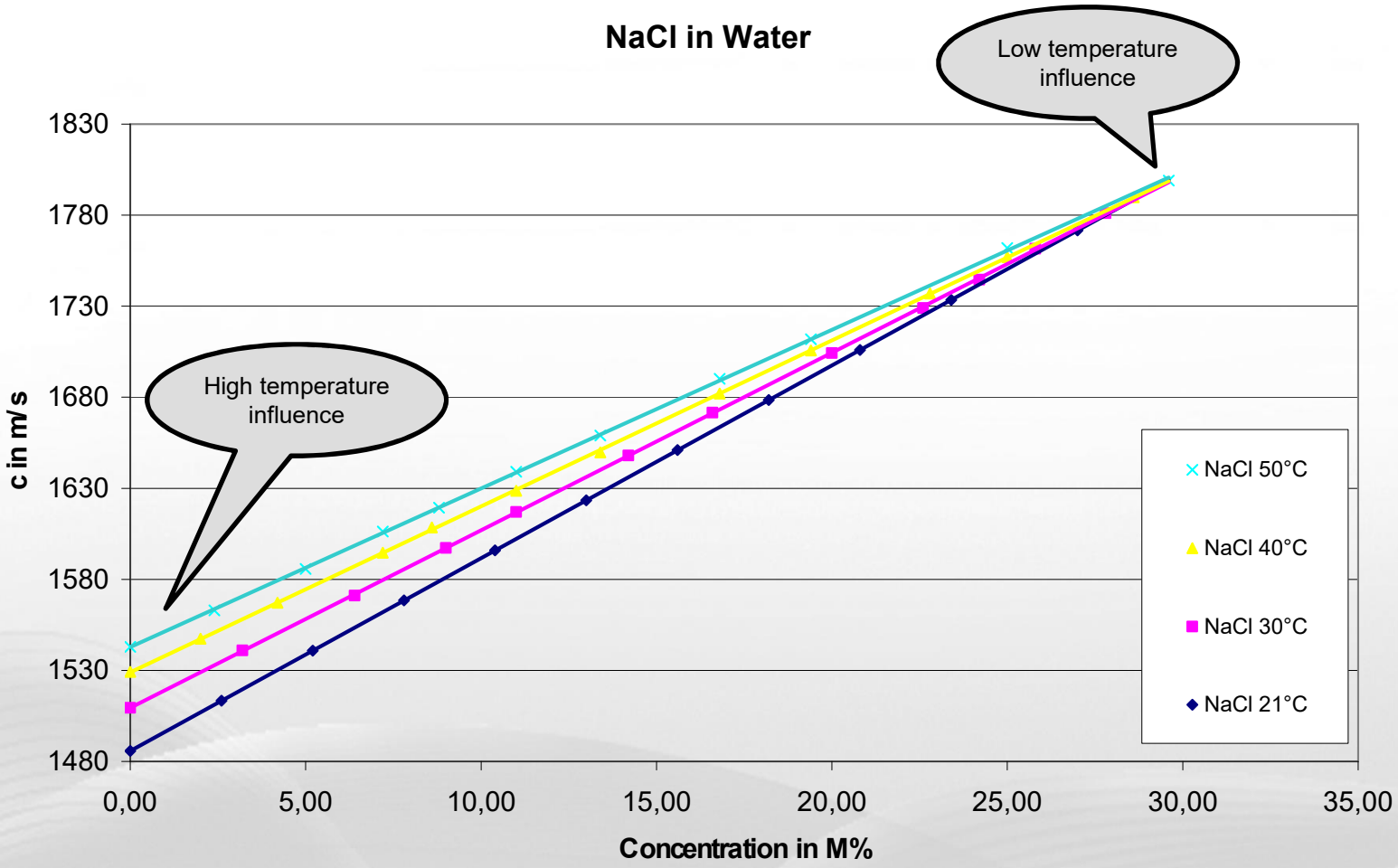
- Sound speed can identify a fluid
- Sound speed can determine the concentration
- Sound speed can detect a fluid change

Example: Sound Speed of Salts



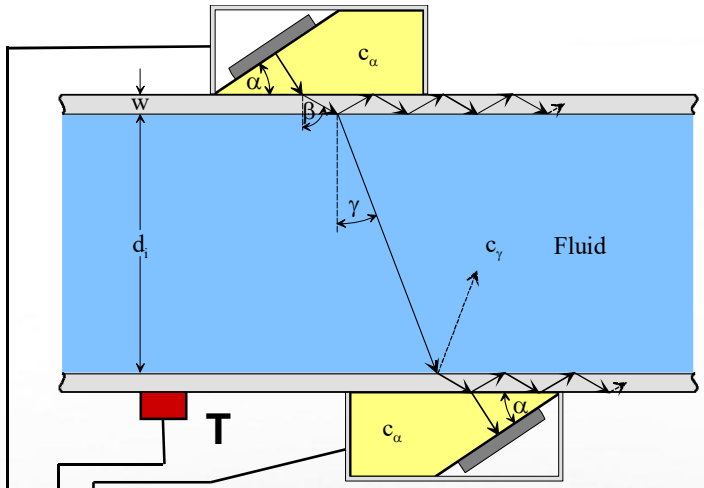
Different slopes – different measuring effects

Example: Brine – Sodium Chloride



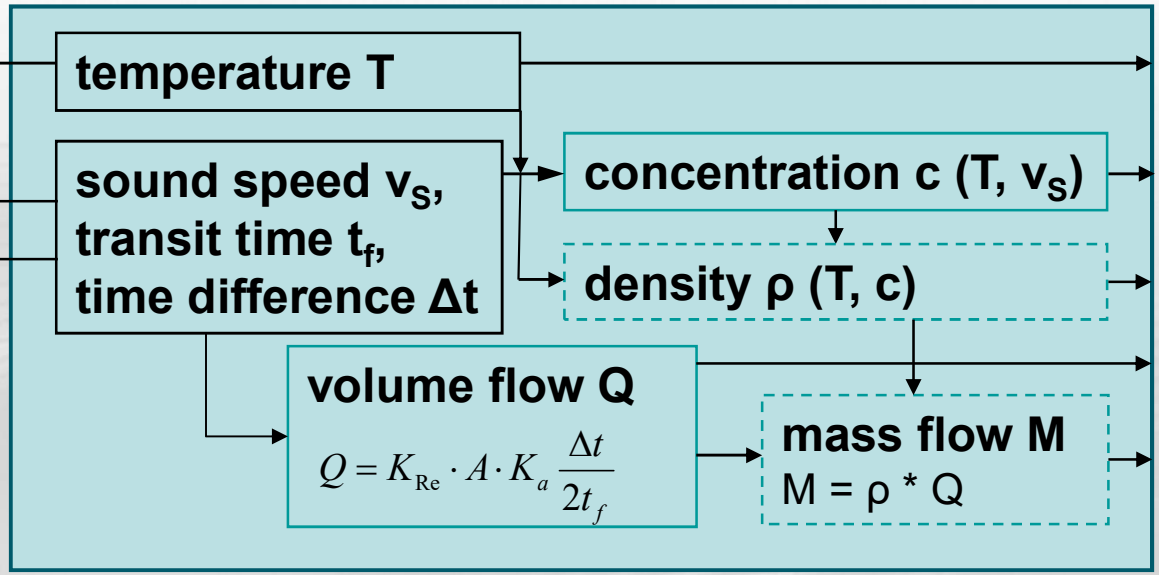
- measuring effect: 10…12 m/s change per M%
- achievable accuracy: up to 0.05 M%

Measuring Principle PIOX S



Concentration or density is calculated as function of sound speed and temperature

Transducer distance must be calculated for the whole concentration range



Outputs :

- temperature
- concentration
- density*
- volume flow
- mass flow*

* Option -> PIOX SM

FLUXUS Mass flow - PIOX S - PIOX SM

Input | Output

FLUXUS

transit time difference Δt
pipe parameter / flow velocity v_F
ROM-media: transducer distance (pipe, medium)

temperature T
ROM-Media: ρ (T)

volume flow
Q (A, Δt, v_F)

density
ρ (T)

mass flow
M = ρ (T) * Q

PIOX S

sound speed v_S
temperature T
data set: c (T, v_S)

volume flow
Q (A, Δt, v_F)

concentration
c (T, v_S)

PIOX SM

sound speed v_S
temperature T
data set: c (T, v_S)

temperature T
concentration c
data set: ρ (T, c)

volume flow
Q (A, Δt, v_F)

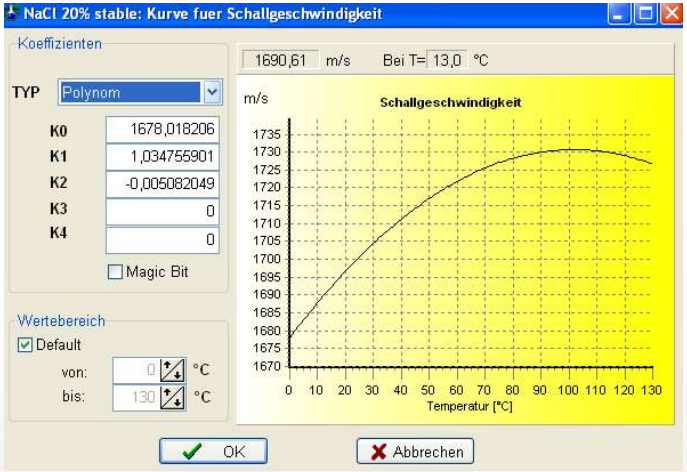
concentration
c (T, v_S)

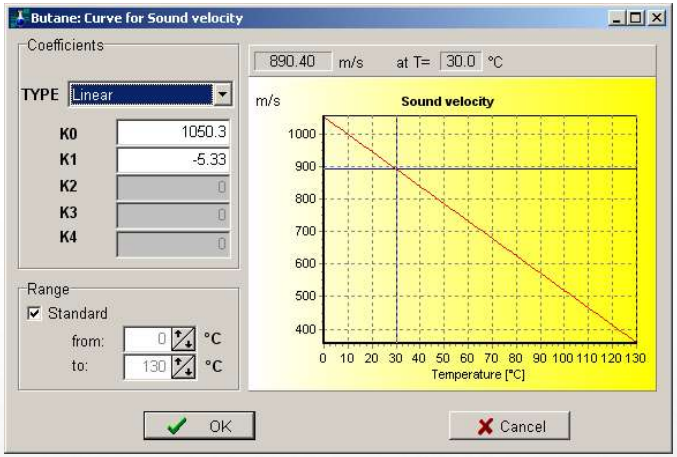
density
ρ (T, c)

mass flow
M = ρ (T, c) * Q

Temperature Measurement

Temperature measurement is mandatory (often crucial)





Clamp-on probe or intrusive probe ???

Clamp-on probe sufficient for

- slow temperature changes in process
- small temperature influence on sound speed

☛ good isolation necessary

Inline temperature probe for

- fast temperature changes
- high temperature influence on sound speed

PIOX S Ultrasonic System

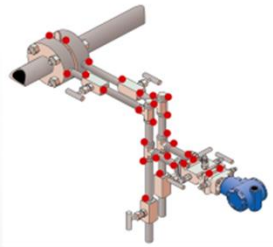
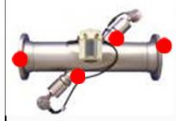
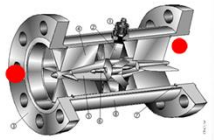
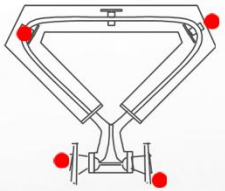
Tranducers

- for almost all types of pipes: 6..6500mm
- for almost all pipe materials
- ATEX approval optional
- up to 200°C

Transmitters (F704 / F705, F709, F6xx for test)

- concentration or density
- & flow measurement (optional 2 channel)
- optional for ATEX zone 2

Potential leakage risk for other flow technique

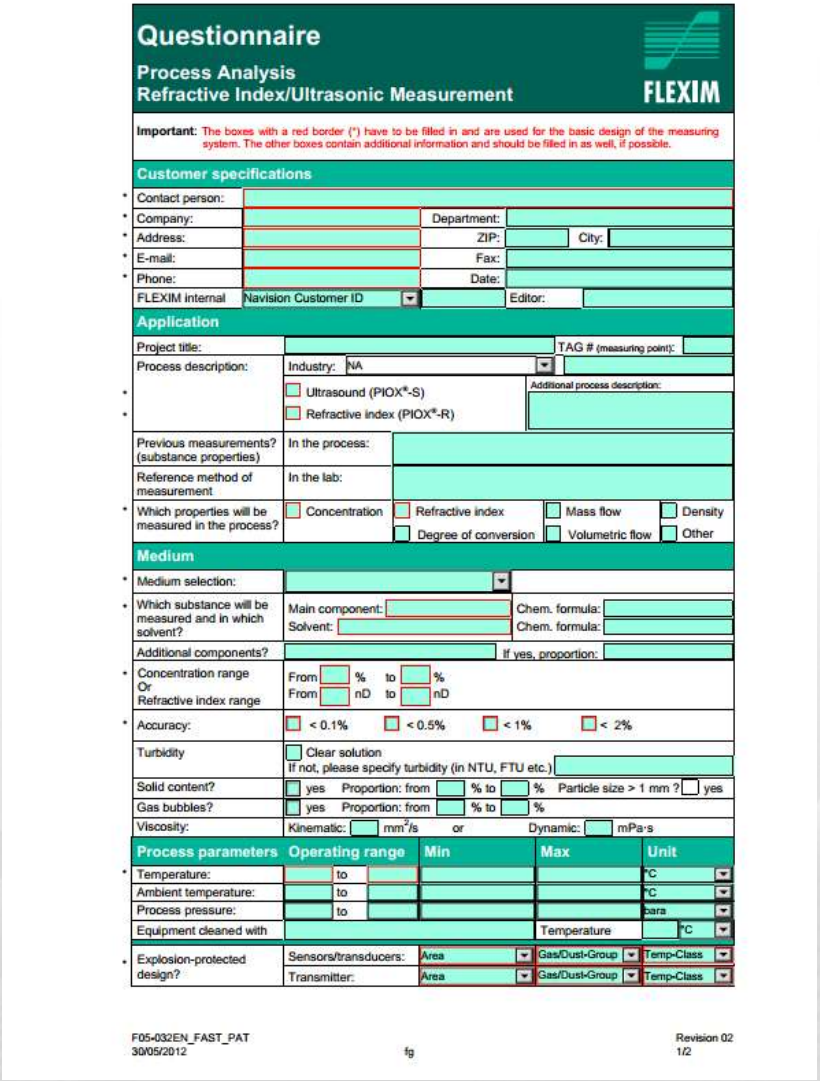
	dp flow	Orific / Venturi	Vortex / pitot	Wetted USM	Turbine meter	Coriolis
Type of flow measurement						
Potential Leak points	28	8	5	2 or 4	2	2 or 4

3 Important Questions

What is necessary to ask :

- **What shall be measured ?**
  - which component shall be monitored ?
  - what is the solvent ? (not always water !)
  - is there anything else in ? (3rd component, gas, particles)
- **What is the measuring range ?**
  - concentration range, that is necessary for process
- **What is the temperature range ?**

Fill in the fast form ➔



Questionnaire

Process Analysis
Refractive Index/Ultrasonic Measurement

FLEXIM

Important: The boxes with a red border (*) have to be filled in and are used for the basic design of the measuring system. The other boxes contain additional information and should be filled in as well, if possible.

Customer specifications

* Contact person:			
* Company:		Department:	
* Address:		ZIP: City:	
* E-mail:		Fax:	
* Phone:		Date:	
FLEXIM internal	Navision Customer ID		Editor:

Application

Project title:		TAG # (measuring point):
* Process description:	Industry: NA	
*	☐ Ultrasound (PIOX®-S)	Additional process description:
*	☐ Refractive index (PIOX®-R)	
Previous measurements? (substance properties)	In the process:	
Reference method of measurement	In the lab:	
* Which properties will be measured in the process?	☐ Concentration ☐ Refractive index ☐ Mass flow ☐ Density ☐ Degree of conversion ☐ Volumetric flow ☐ Other	

Medium

* Medium selection:		
* Which substance will be measured and in which solvent?	Main component:	Chem. formula:
	Solvent:	Chem. formula:
Additional components?		If yes, proportion:
* Concentration range Or Refractive index range	From % to %	
	From nD to nD	
* Accuracy:	☐ < 0.1% ☐ < 0.5% ☐ < 1% ☐ < 2%	
Turbidity	☐ Clear solution If not, please specify turbidity (in NTU, FTU etc.)	
Solid content?	☐ yes Proportion: from % to %	Particle size > 1 mm ? ☐ yes
Gas bubbles?	☐ yes Proportion: from % to %	
Viscosity:	Kinematic: mm^2/s or	Dynamic: mPa·s

Process parameters	Operating range	Min	Max	Unit
* Temperature:	to			°C
Ambient temperature:	to			°C
Process pressure:	to			bara
Equipment cleaned with			Temperature	°C
* Explosion-protected design?	Sensors/transducers:	Area	Gas/Dust-Group	Temp-Class
	Transmitter:	Area	Gas/Dust-Group	Temp-Class

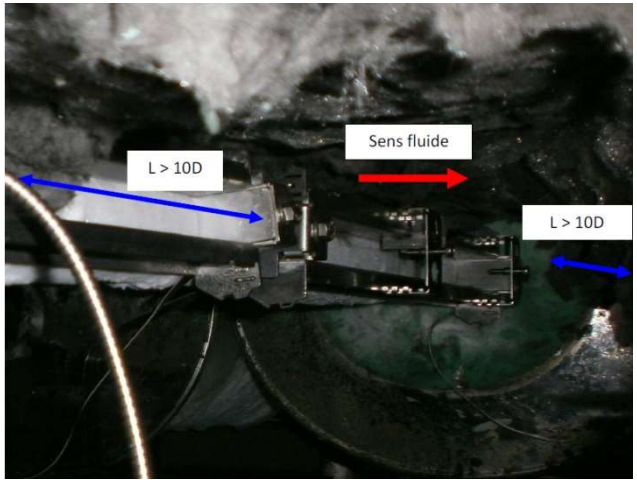
F05-032EN_FAST_PAT 30/05/2012 fg Revision 02 1/2

Fertilizer Industry Applications

Nitric Acid Measuring Location

- 1 PIOX S; HNO3 58% after Bleacher
- 1 PIOX S; water content in concentrated, liquid ammonia
- 2 PIOX SM (S705) in ammonium nitrate (30-160°C; 30-95wt%) and (0-45wt% at 70°C)

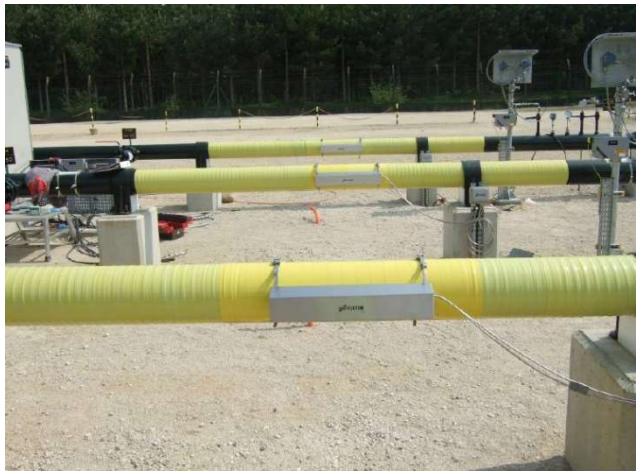
PIOX S – Water Content in Ammonia



PIOX S – Water Content in Ammonia

Fertilizer Industry Applications

PIOX S – aquaeous ammonia 24wt%



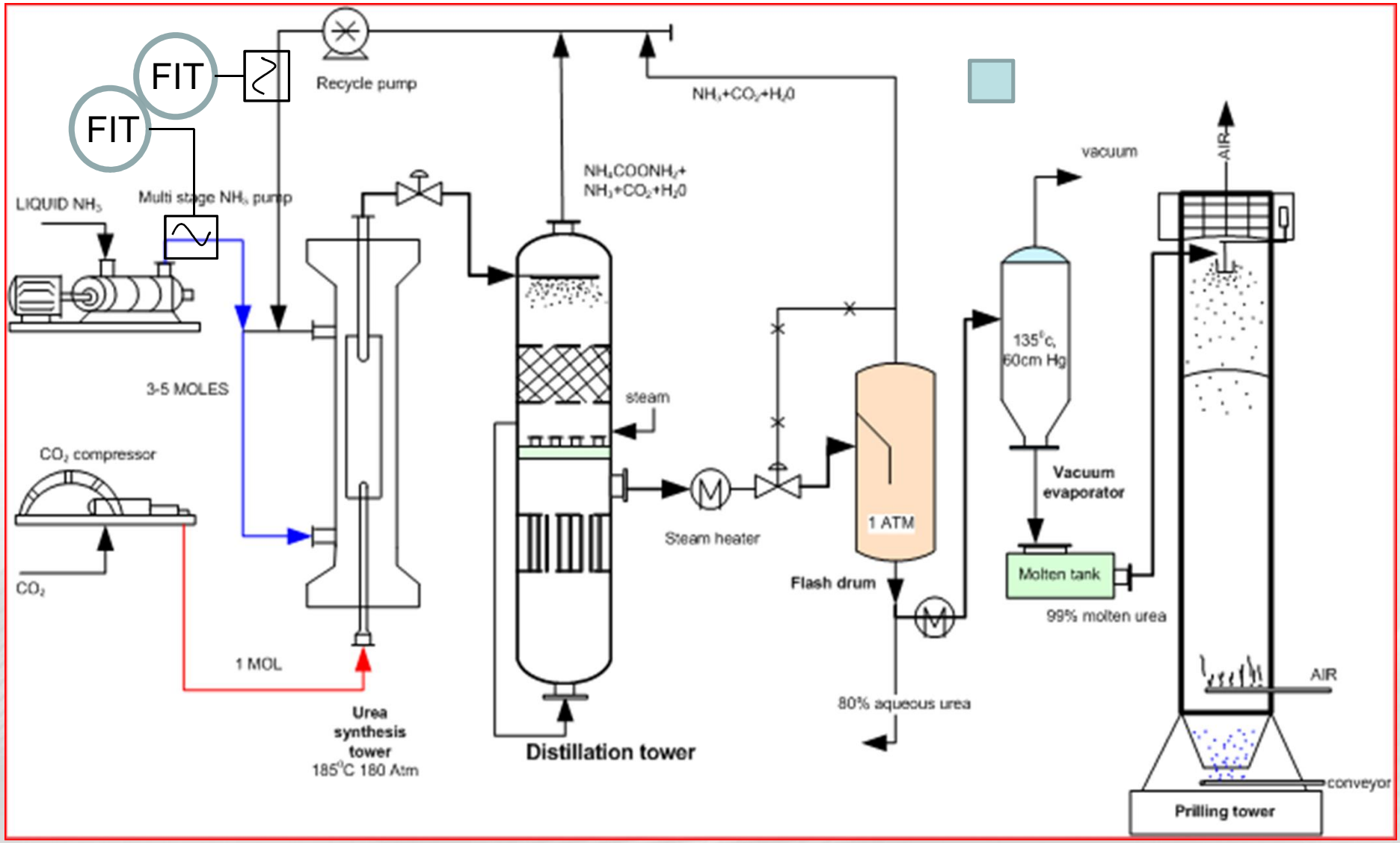
Water Flow monitoring

- 2 PIOX S; HNO3 >98,5wt% and HNO3 53%
- 1 PIOX S; aquaeous ammonia 24wt%
- 3 F501 for water applications
- 1 F601

PIOX S - HNO3 >98,5wt%

PETRONAS Fertilizer Kedah Sdn Bhd (PFK) is a Malaysian urea production company.

The Urea Manufacturing Process



Source: Engineers Guide - http://enggyd.blogspot.de

Application - Technical Details

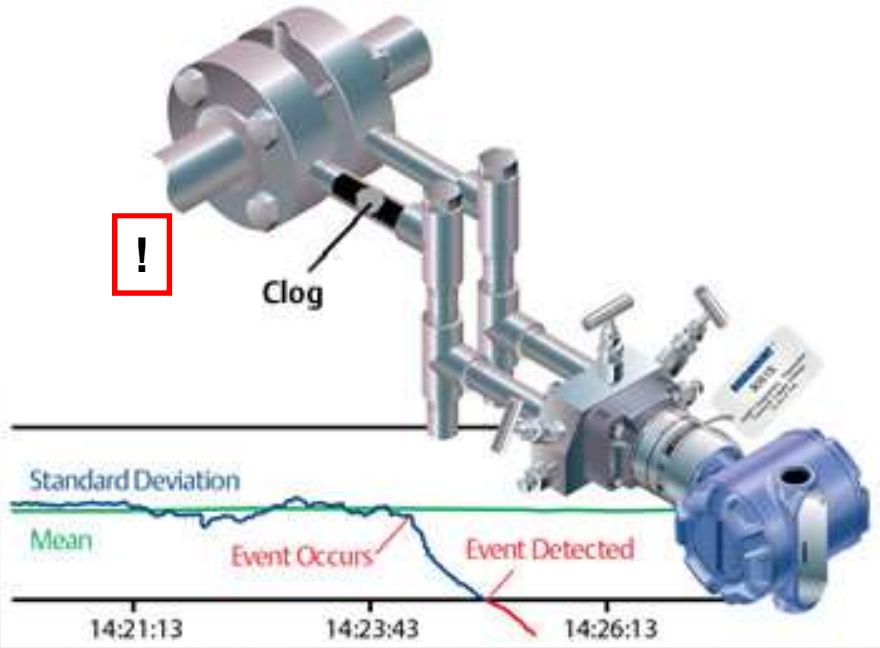
PFK asked for a demonstration on two high pressure flow applications around their UREA reactor:

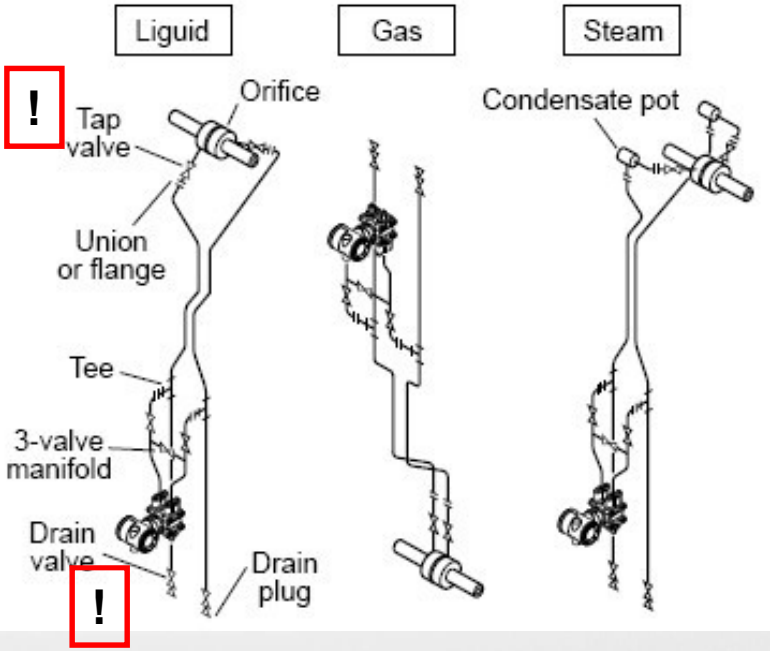
1) **Ammonia liquid feed from multi stage pump into the reactor**
   Piping: 6” ANSI2500# - 168.3 x 20.8mm
   Operational pressure 18MP

2) **Ammonia Carbamate recirculation from distillation into urea reactor**
   Piping: 4” ANSI2500# - 114.6 x 17.3mm
   Operational pressure 18MP

Both lines where initially equipped with Venturi primary elements and differential pressure transmitters connected via impulse tubing and high pressure tap valve and 3-valve manifold

Application - Customer Motivation





PFK found that the impulse tubing clogged over time by particle sediments.

Clogged impulse lines can be flushed by opening the tap valve and the drain valve → that's standard procedure.

In this case it is considered dangerous to bleed the tubing due to the very high operational pressure and the toxic process medium – NH3. Maintenance on the systems can only be carried out with personnel wearing breathing apparatus / PPE, and has a risk of blocking the Tap / Drain valves and causing a process leakage.

Picture Source: Emerson Product Brochure

Thank you for your attention !

Questions ???