

APLICAÇÕES EM FABRICAS DE CLORO

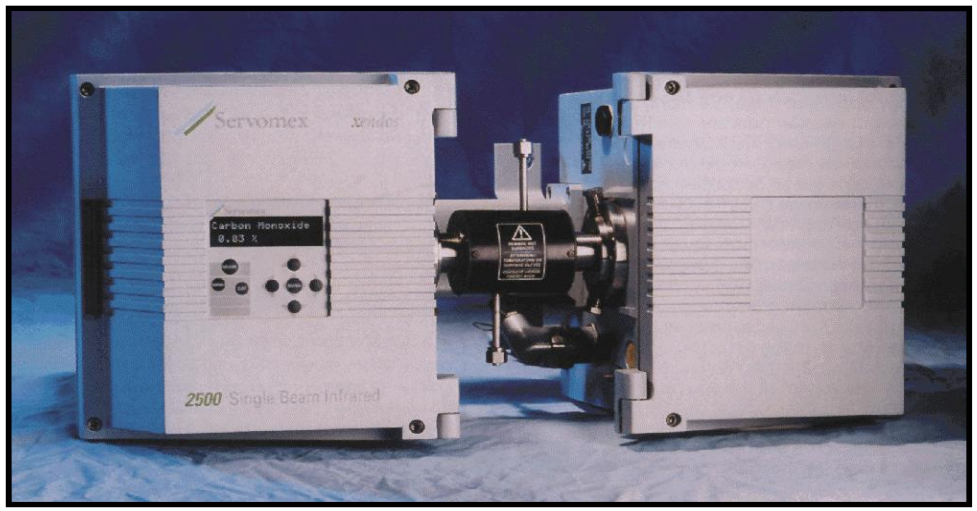


O2 em H2-Segurança do Processo
O2 em Cl2-Qualidade do Produto
Analisador a laser

- **Resposta Rapida- <2 Segundos**
- **Estável- Calibração Anual**
- **Resistente- Sem contato com amostra**
- **In Situ - Sem contato com amostra**
- **Pouca manutenção**

Nova Tecnología

H2 em Cl2-Qualidade do Produto



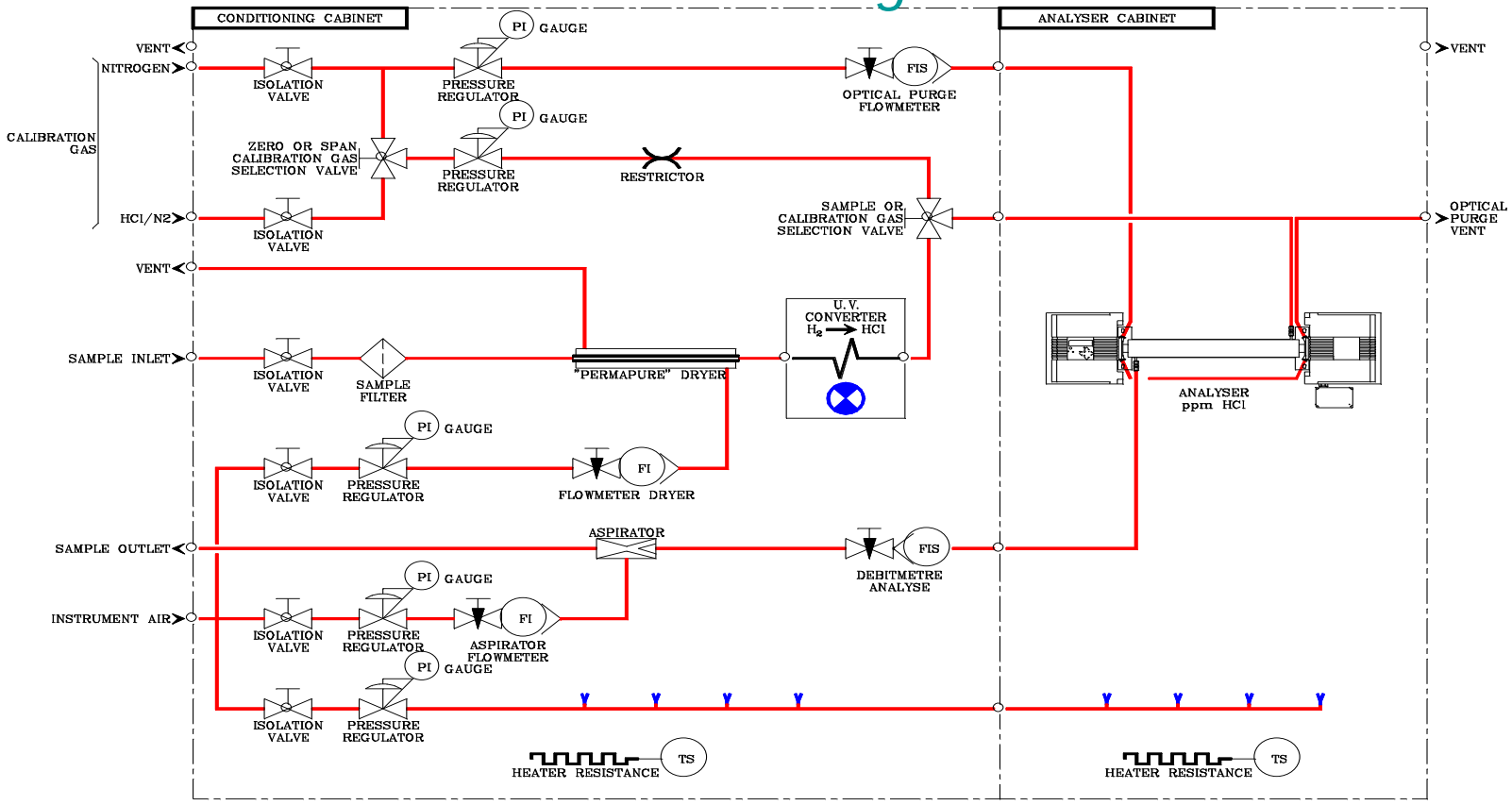
2500 HCl + Conversor UV

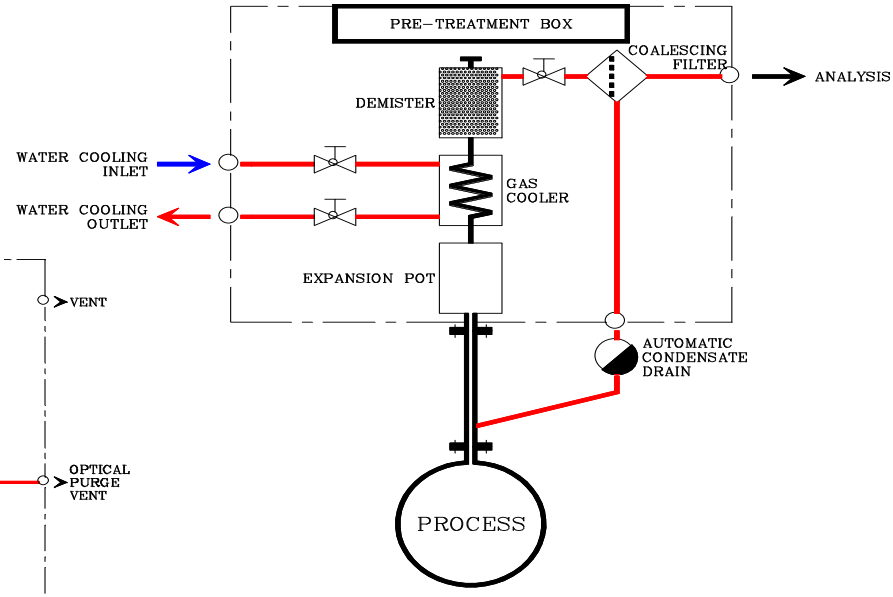
- **H2 +Cl2 = 2HCl, 2HCl/2 = *H2***
- **Estável- interferência cruzada =0**
- **Resistente-Ø contato com amostra-celula de Hastelloy**
- **Resposta Rapida-Melhor do que com TC (termocondutividade)**

Nova Solução

Solução
H2 em Cl2-Qualidade do Produto

Diagrama de Fluxo da Amostragem





Ponto de Amostragem

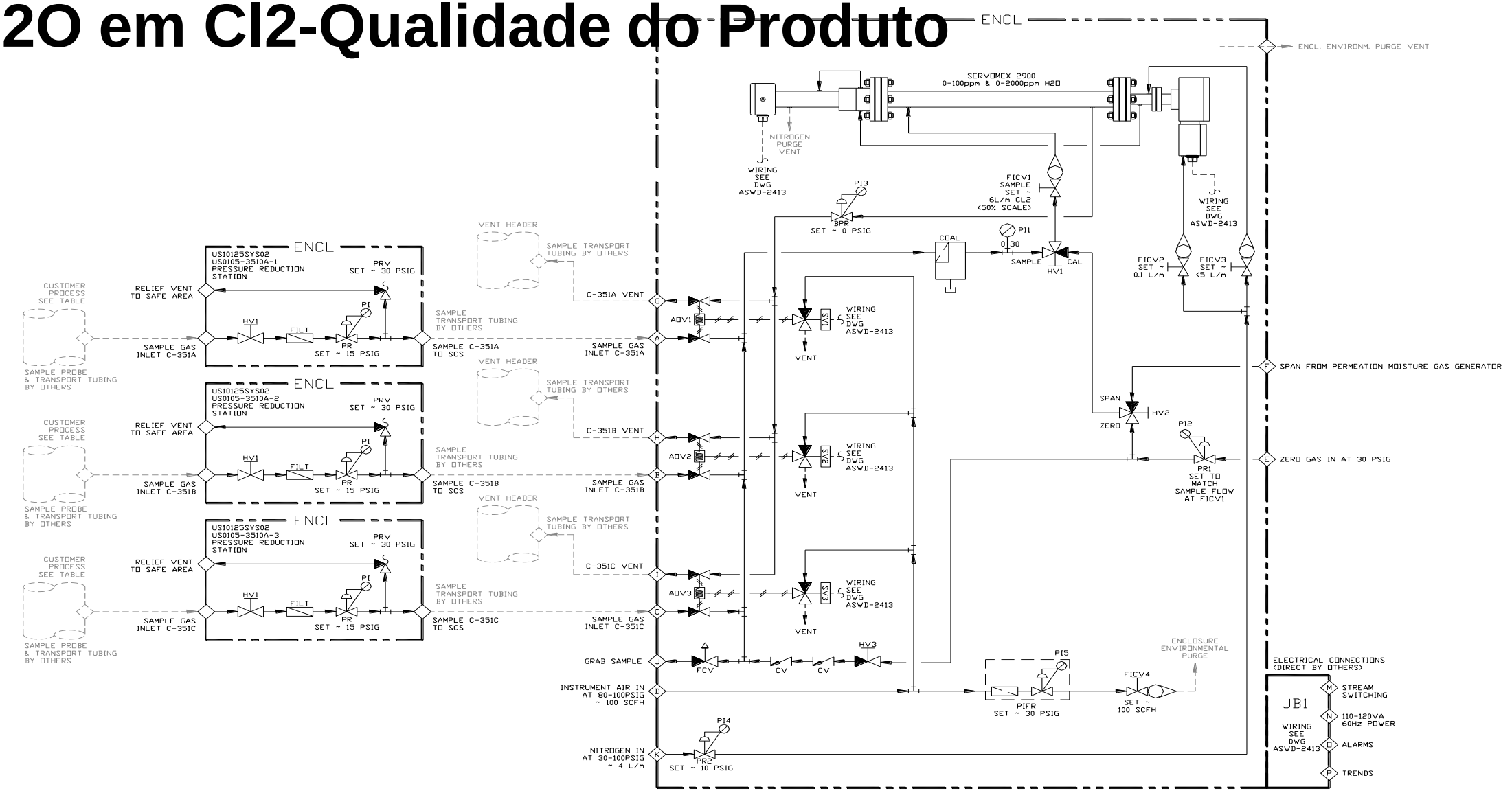
H20 em Cl2-Qualidade do Produto

2900

- **Resposta Rapida-<2 Segundos**
- **Estável-Calibração Anual**
- **Resistente- Sem contato com amostra**
- **Sistema não extrativo-IN SITU**
- **SEM SISTEMA DE AMOSTRAGEM**
- **Baixo limite de deteção-0.03ppm**

Nova Tecnología

Solução
H2O em Cl2-Qualidade do Produto



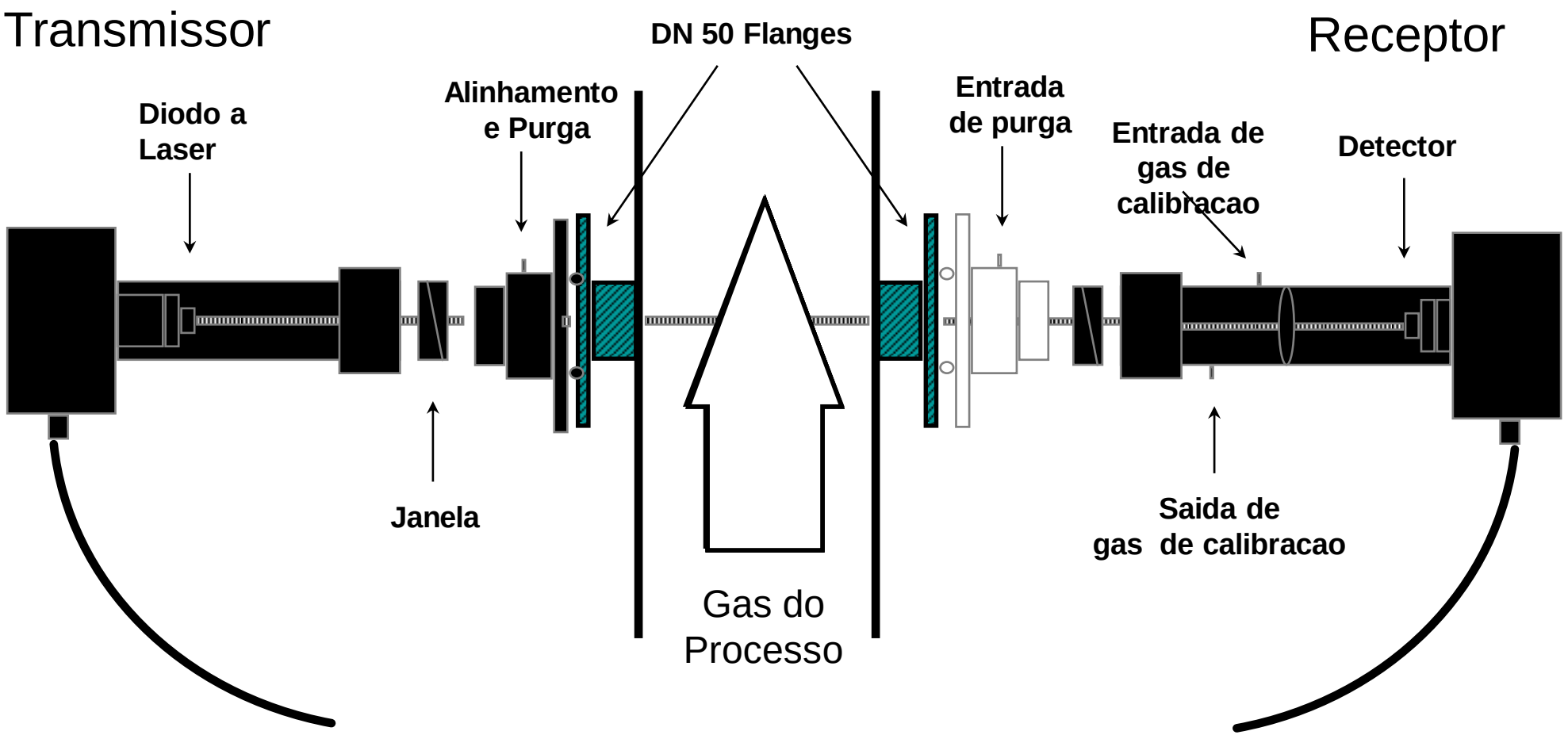
HCl- Emissoes no Incinerador

2900

- **Resposta Rapida-<2 Segundos**
- **Estável-Calibração Anual**
- **In-Situ-Sem Sistema de Amostragem**
- **Baixa Limite de Deteção-0.05ppm**
- **Relatorio em Base Seca (CONAMA)-Medição Opcional H2O**

Nova Tecnología

Instalação
HCl- Emissoes no Incinerador





- LINHA APPLITEK- analisadores diversos de gases e liquidos
- Analisadores de Oxigenio
- Analisadores de diversos gases em Processo e CEMS
- Analisadores de umidade (dew point)
- Analisadores de Combustão
- Detectores fixos e portateis de cloro para proteção da área



TONI® special (Total Ammonia)

Medição on-line de Total Amonia[amonia (NH_3)+monocloramina (NH_2Cl) + dicloramina ($NHCl_2$)] em Ultra-Purified brine

WARNING

- Early Warning
- Evita formação de nitrogen trichloride (NCl_3)
- Evita Explosão do nitrogen trichloride (NCl_3)

Medição on-line FAST do hidrogenio (H_2) em cloro ÚMIDO (Cl_2) using Multi Wavelength **I**nfra**R**ed (IR) Technology

WARNING

- Early Warning
- Avoid hydrogen (H_2) explosion

Safety is not Expensive
It is Priceless !

by: Chris Du Bois

"SAFETY IS NOT EXPENSIVE - IT IS PRICELESS"

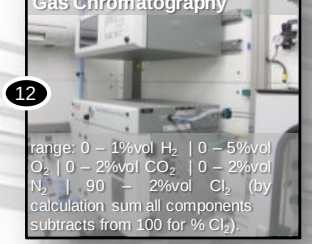
on-line Analyzer Systems for Safety and Control of Chlorine Production Plants

AppliTek

www.applitek.com

WHY ☝ **Quality CONTROL**

Gas Chromatography



12

range: 0 – 1%vol H_2 | 0 – 5%vol O_2 | 0 – 2%vol CO_2 | 0 – 2%vol N_2 | 90 – 2%vol Cl_2 (by calculation sum all components subtracts from 100 for % Cl_2).

17

range: 0.5 – 20 g/kg Na_2SO_4

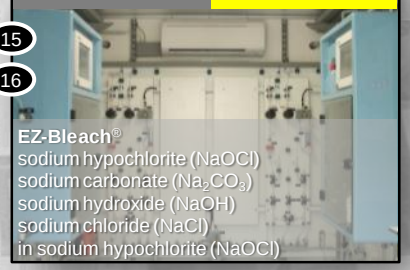
18

range: 1.000 mg/l meta bisulfite ($Na_2S_2O_5$)

WHY ☝ **PROCESS CONTROL** | WHY ☝ **SAFETY**

15

16



EZ-Bleach®

sodium hypochlorite (NaOCl)

sodium carbonate (Na_2CO_3)

sodium hydroxide (NaOH)

sodium chloride (NaCl)

in sodium hypochlorite (NaOCl)

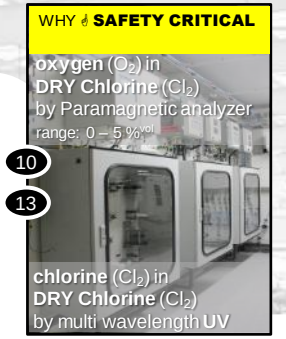
WHY ☝ **SAFETY CRITICAL**

oxygen (O_2) in **DRY Chlorine** (Cl_2) by Paramagnetic analyzer

range: 0 – 5 %vol

10

13



chlorine (Cl_2) in **DRY Chlorine** (Cl_2) by multi wavelength **UV**

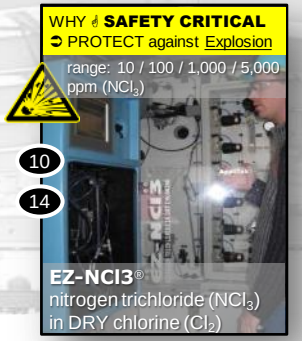
WHY ☝ **SAFETY CRITICAL**

➲ PROTECT against Explosion

range: 10 / 100 / 1,000 / 5,000 ppm (NCl_3)

10

14



EZ-NCl3®

nitrogen trichloride (NCl_3) in DRY chlorine (Cl_2)

WHY ☝ **SAFETY CRITICAL**

➲ PROTECT Plant against hydrogen Explosion

< 30 seconds response time

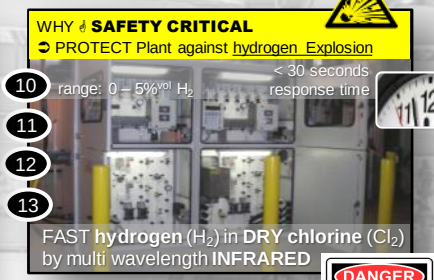
10

range: 0 – 5%vol H_2

11

12

13



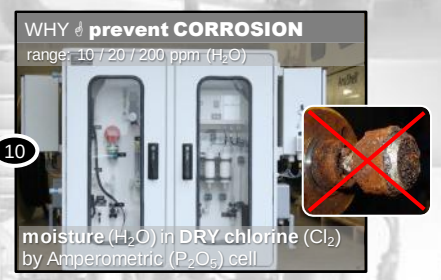
FAST **hydrogen** (H_2) in **DRY chlorine** (Cl_2) by multi wavelength **INFRARED**

DANGER HYDROGEN NO SMOKING NO OPEN FLAME

WHY ☝ **prevent CORROSION**

range: 10 / 20 / 200 ppm (H_2O)

10



moisture (H_2O) in **DRY chlorine** (Cl_2) by Amperometric (P_2O_5) cell

WHY ☝ **SAFETY CRITICAL**

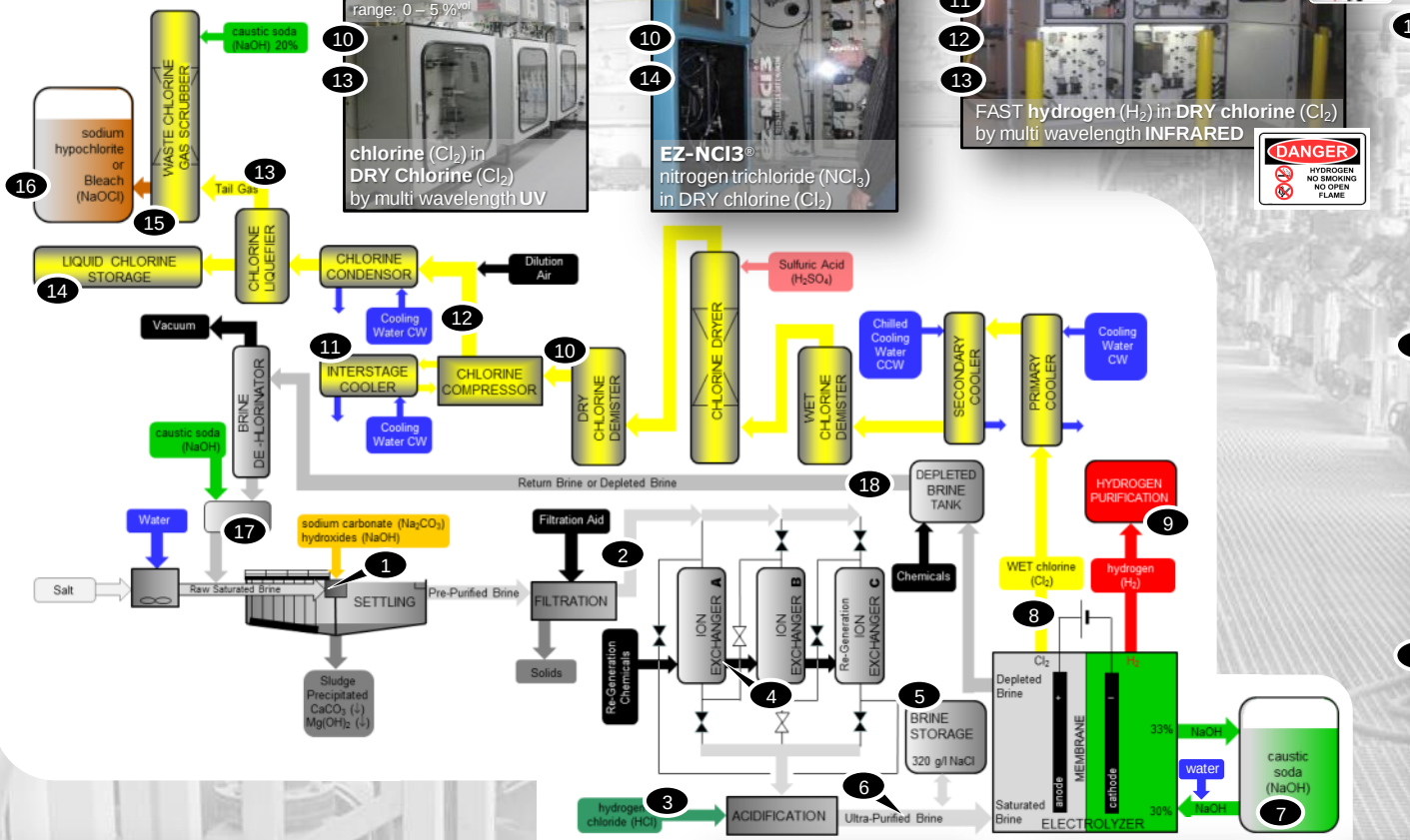
➲ PROTECT against hydrogen Explosion

range: 0 – 200 ppmvol (H_2)

9

oxygen (O_2) in **hydrogen** (H_2) by Electrochemical cell

DANGER HYDROGEN NO SMOKING NO OPEN FLAME

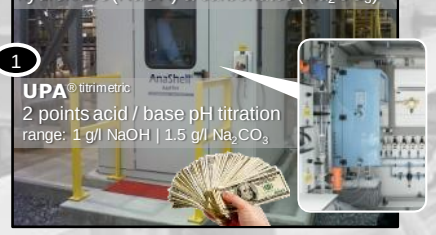


WHY ☝ **brine QUALITY**

➲ Up-stream Control Brine Purification

LIMIT dosage of hydroxides (NaOH) & carbonates (Na_2CO_3)

1



UPA® titrimetric

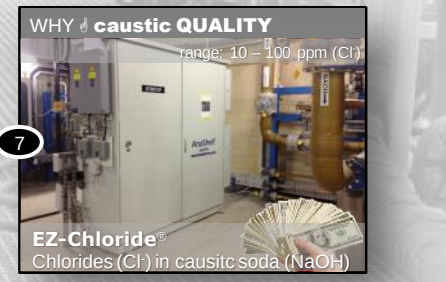
2 points acid / base pH titration

range: 1 g/l NaOH | 1.5 g/l Na_2CO_3

WHY ☝ **caustic QUALITY**

range: 10 – 100 ppm (Cl-)

7



EZ-Chloride®

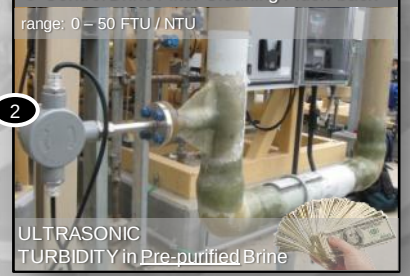
Chlorides (Cl^-) in causitc soda (NaOH)

WHY ☝ **brine QUALITY**

➲ Control Brine Filter Cleaning Flush-back

range: 0 – 50 FTU / NTU

2



ULTRASONIC TURBIDITY in Pre-purified Brine

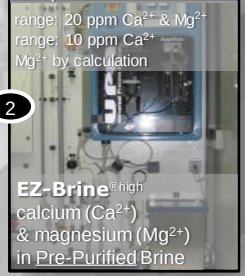
WHY ☝ **brine QUALITY**

➲ Up-stream Control

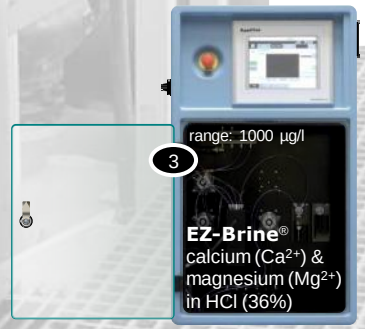
range: 20 ppm Ca^{2+} & Mg^{2+}

range: 10 ppm Ca^{2+} Mg^{2+} by calculation

2



EZ-Brine®high calcium (Ca^{2+}) & magnesium (Mg^{2+}) in Pre-Purified Brine



range: 1000 µg/l

3

EZ-Brine® calcium (Ca^{2+}) & magnesium (Mg^{2+}) in HCl (36%)

WHY ☝ **brine QUALITY**

➲ AVOID membrane damage

range: 0 – 50 – 100 ppb

4

5

6

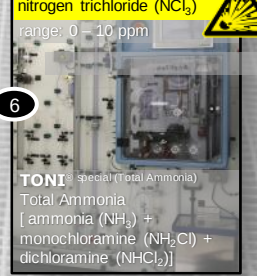
EZ-Brine® calcium (Ca^{2+}) & magnesium (Mg^{2+}) in Ultra-Purified Brine

WHY ☝ **SAFETY CRITICAL**

➲ AVOID formation of nitrogen trichloride (NCl_3)

range: 0 – 10 ppm

6



TONI® special (Total Ammonia)

Total Ammonia [ammonia (NH_3) + monochloramine (NH_2Cl) + dichloramine ($NHCl_2$)]

WHY ☝ **SAFETY CRITICAL**

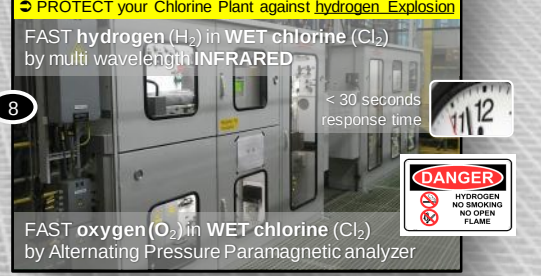
➲ EARLY WARNING hydrogen detection

➲ PROTECT your Chlorine Plant against hydrogen Explosion

Explosion risk

FAST **hydrogen** (H_2) in **WET chlorine** (Cl_2) by multi wavelength **INFRARED**

8



< 30 seconds response time

DANGER HYDROGEN NO SMOKING NO OPEN FLAME

FAST **oxygen** (O_2) in **WET chlorine** (Cl_2) by Alternating Pressure Paramagnetic analyzer



WORLD chlorine council

Safety Workshop: Process Safety Management (PSM)

AppliTek

Nov. 14th 2014 Hilton – São Paulo Brazil

www.applitek.com

Leading supplier of on-line brine analyzer systems

"Works good, Looks Good"

Associated Member

The Chlorine Institute, Inc.

Technical Correspondent

eurochlor 17



WORLD chlorine council

Safety Workshop: Process Safety Management (PSM)

AppliTek

Nov. 14th 2014 Hilton – São Paulo Brazil

www.applitek.com

Leading supplier of Safety Critical (Life Saving) on-line hydrogen analyzer systems

"Works good, Looks Good"

Associated Member

The Chlorine Institute, Inc.

Technical Correspondent

eurochlor 17.

TONI® special (Total Ammonia)

on-line Total Ammonia [ammonia (NH_3) + monochloramine (NH_2Cl) + dichloramine ($NHCl_2$)] in Ultra-Purified brine

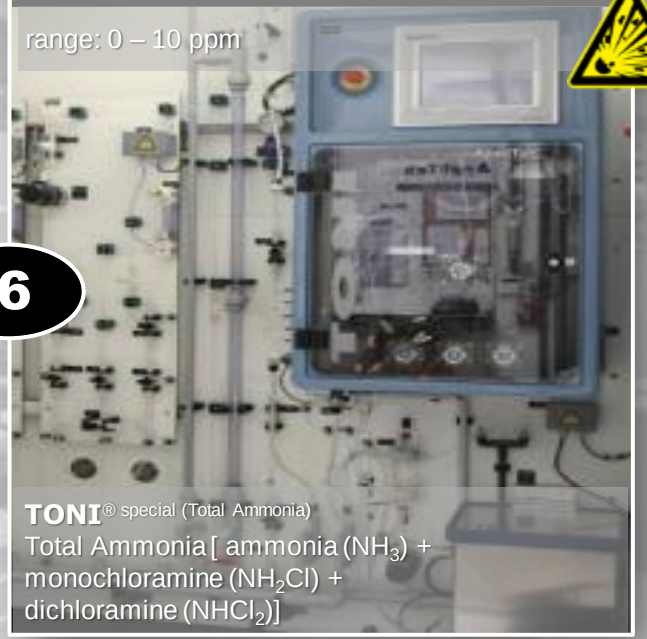
WARNING

- Early Warning
- Prevent formation of nitrogen trichloride (NCl_3)
- Avoid nitrogen trichloride (NCl_3) explosion

6

WHY ☝ **SAFETY CRITICAL**
➲ AVOID formation of nitrogen trichloride NCl_3)

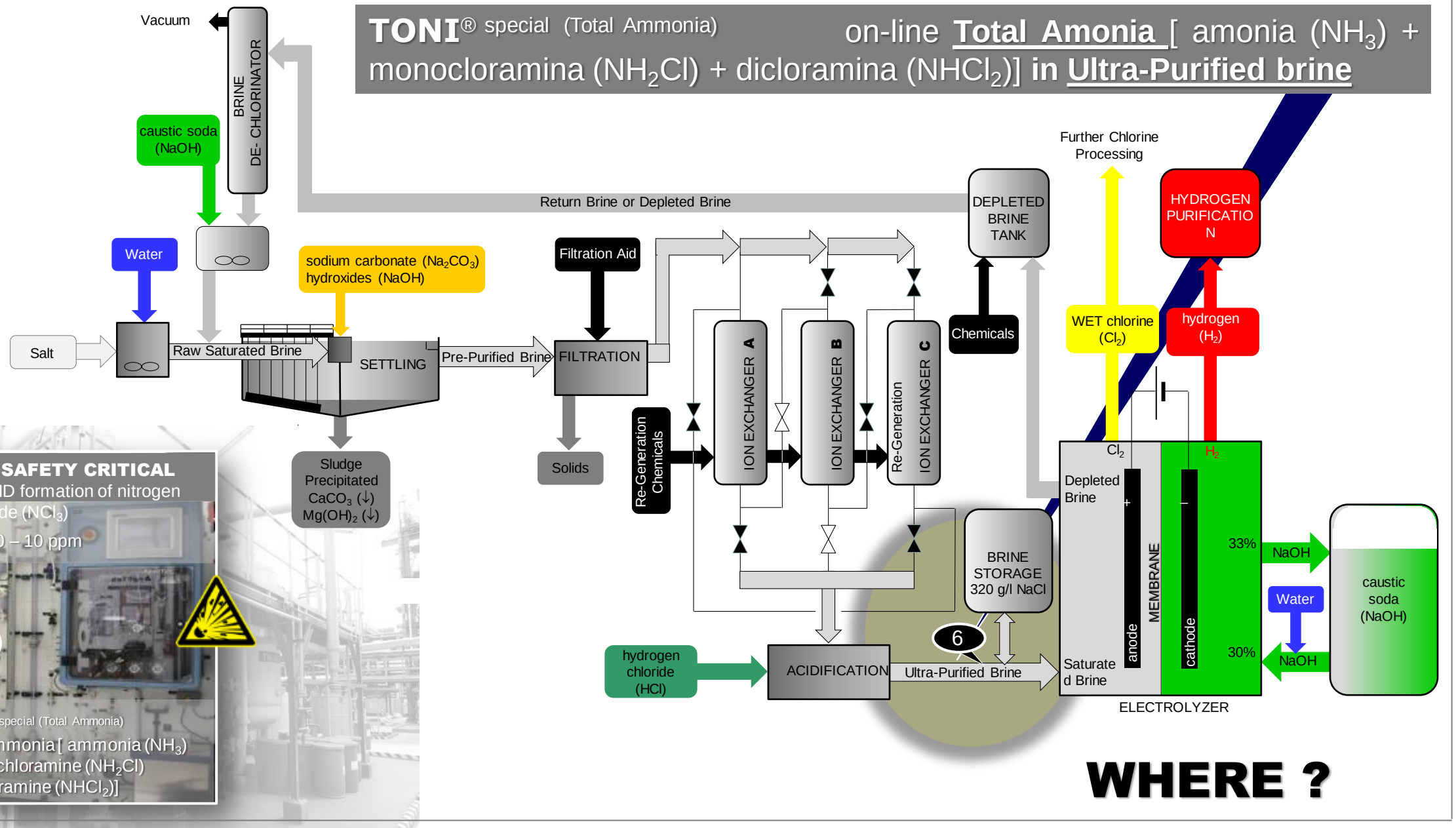
range: 0 – 10 ppm



TONI® special (Total Ammonia)
Total Ammonia [ammonia (NH_3) + monochloramine (NH_2Cl) + dichloramine ($NHCl_2$)]




TONI® special (Total Ammonia) on-line Total Amonia [amonia (NH_3) + monocloramina (NH_2Cl) + dicloramina ($NHCl_2$)] in Ultra-Purified brine



WHY ☝ **SAFETY CRITICAL**
➲ AVOID formation of nitrogen trichloride (NCl_3)
range: 0 – 10 ppm

6

TONI® special (Total Ammonia)
Total Ammonia [ammonia (NH_3)
+ monochloramine (NH_2Cl)
+ dichloramine ($NHCl_2$)]

WHERE ?



TONI® special (Total Ammonia) on-line **Total Ammonia** [ammonia (NH_3) + monochloramine (NH_2Cl) + dichloramine ($NHCl_2$)] **in Ultra-Purified brine**

WHY ? ☝ EARLY WARNING:

Prevent formation of Nitrogen trichloride (NCl_3) | avoid explosion

➲ Most Chlorine (Cl_2) is produced by electrolysis of brine generated by dissolving Sodium Chloride (NaCl) or Potassium Chloride (KCl) in water (H_2O). Side reactions with the Nitrogen impurities in the salt can lead to the formation of Nitrogen trichloride (NCl_3) during the Chlorine process.

➲ Nitrogen compounds present in the BRINE are the main source for the formation of Nitrogen trichloride (NCl_3).

➲ In certain parts of the Chlorine production, the Chlorine is either liquefied or evaporated. Due to its lower volatility, the NCl_3 accumulates in liquid Chlorine.

➲ Traces of Ammonia (NH_3) and other Nitrogen compounds in BRINE can produce NCl_3 in Chlorine.



TONI® special (Total Ammonia) on-line **Total Ammonia** [ammonia (NH_3) + monochloramine (NH_2Cl) + dichloramine ($NHCl_2$)] **in Ultra-Purified brine**

WHY ? ☝ EARLY WARNING:

Prevent formation of Nitrogen trichloride (NCl_3) | avoid explosion

Prevention of Nitrogen trichloride (NCl_3) formation:

- Approximately 25% of Nitrogen trichloride (NCl_3) formed in cells enters the chlorine process (1)
- Ammonia in cell feed brine is the major source (1)

Learning from incidents:

Nitrogen trichlorinde incident @ Orica, Yarraville – 30 July 1998 (1)

One of the conclusions after investigation was: "Inaccurate method and inadequate frequency of analysis for ammonia in brine"

(1) "Managing Risks Nitrogen Trichloride" by Shane Fast - Vice President The Chlorine Institute @ the WORLD chlorine council meeting.

N-compounds + Cl_2 → NCl_3

TONI® special (Total Ammonia) on-line **Total Ammonia** [ammonia (NH_3) + monochloramine (NH_2Cl) + dichloramine ($NHCl_2$)] **in Ultra-Purified brine**

HOW ?

Measuring Principle TONI® special (Total Ammonia)

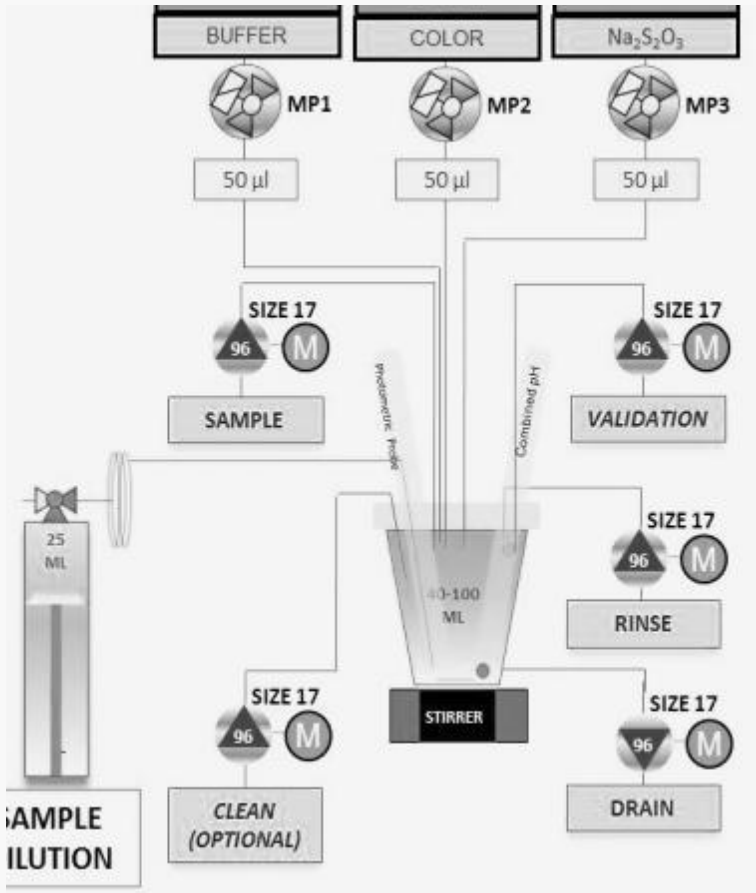
by Colorimetric analysis (Adapted Berthelot method conform ASTM 4500-NH_3 F)

To determine the total amount of NH_3, NH_2Cl and $NHCl_2$, NH_2Cl and $NHCl_2$ they have to be converted to NH_3. This is done by adding thiosulphate.

Reactions:

$4\ NH_2Cl + Na_2S_2O_3 + 5\ H_2O \rightarrow 2\ NaHSO_4 + 4\ NH_3 + 4\ HCl$

$2\ NHCl_2 + Na_2S_2O_3 + 5\ H_2O \rightarrow 2\ NaHSO_4 + 2\ NH_3 + 4\ HCl$



TONI® special (Total Ammonia) on-line **Total Ammonia** [ammonia (NH_3) + monochloramine (NH_2Cl) + dichloramine ($NHCl_2$)] **in Ultra-Purified brine**

HOW ?

Measuring Principle TONI® special (Total Ammonia)

- injection of BRINE sample in analyzer
- addition of buffer → Alkaline
- Initial absorbance value is measured at (λ) 630 nm (ABS 1)
- addition of color solution
- Final Absorbance value is measured at (λ) 630 nm (ABS 2)
- calculation of result: Lambert Beer's Law **ABS = Є . b. C**

Є = molar absorptivity (l . cm-1. mol-1)
b = path length (cm)
C = concentration (mol/liter)

TONI® special (Total Ammonia) on-line **Total Ammonia** [ammonia (NH_3) + monochloramine (NH_2Cl) + dichloramine ($NHCl_2$)] **in Ultra-Purified brine**

HOW ?

methodology: colorimetric measurement using adapted Berthelot method

conforms to: ASTM 4500-NH_3 F

λ_{LED}: 630 nm

range: 0 - 2 mg/l NH_3

(0 - 10 mg/l NH_3 by Sample dilution) ~ 0 – 50 mg/l N-NH_3

higher range by Sample dilution*

detection limit: ≤ 100 µg/l (for 0-1 mg/l NH_3)

precision: < 2% full scale range for standard test solutions

cycle time: 1 cycle/25 minutes

stream selection: 1 stream (up to 3 streams optional)



TONI® special (Total Ammonia) on-line **Total Ammonia** [ammonia (NH_3) + monochloramine (NH_2Cl) + dichloramine ($NHCl_2$)] **in Ultra-Purified brine**

Field Example

AnaShell® protective shelter
Including single stream
TONI® Special (Total Ammonia)
in Ultra-purified brine
USA



TONI® special (Total Ammonia) on-line **Total Ammonia** [ammonia (NH_3) + monochloramine (NH_2Cl) + dichloramine ($NHCl_2$)] **in Ultra-Purified brine**

Field Example

AnaShell® protective shelter
Including single stream
TONI® Special (Total Ammonia)
in Ultra-purified brine
USA



Early Warning !

Plant SAFETY Critical Equipment

➲ Eliminating the risk of hydrogen explosions in chlor-alkali plants

on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength INFRARED




Safetymatters

Explosion risk



WORLD chlorine council

Safety Workshop: Process Safety Management (PSM)

AppliTek

Nov. 14th 2014 Hilton – São Paulo Brazil

www.applitek.com

on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed

8

Vacuum

BRINE DE- CHLORINATOR

caustic soda (NaOH)

Water

sodium carbonate (Na_2CO_3)
hydroxides (NaOH)

Salt

Raw Saturated Brine

SETTLING

Sludge Precipitated
$CaCO_3$ (↓)
$Mg(OH)_2$ (↓)

Pre-Purified Brine

Filtration Aid

FILTRATION

Solids

Return Brine or Depleted Brine

DEPLETED BRINE TANK

Chemicals

Re-Generation Chemicals

ION EXCHANGER A

ION EXCHANGER B

Re-Generation

ION EXCHANGER C

Further Chlorine Processing

HYDROGEN PURIFICATION

WET chlorine (Cl_2)

hydrogen (H_2)

8

Cl_2

H_2

Depleted Brine

+

anode

MEMBRANE

cathode

−

33%

30%

Saturated Brine

ELECTROLYZER

NaOH

Water

NaOH

caustic soda (NaOH)

BRINE STORAGE 320 g/l NaCl

hydrogen chloride (HCl)

ACIDIFICATION

Ultra-Purified Brine

➲ EARLY WARNING hydrogen detection
➲ PROTECT your Chlorine Plant against hydrogen Explosion

FAST **hydrogen** (H_2) in **WET chlorine** (Cl_2)
by multi wavelength **INFRARED**

< 30 seconds response time

DANGER
HYDROGEN
NO SMOKING
NO OPEN FLAME

FAST **oxygen** (O_2) in **WET chlorine** (Cl_2)
by Alternating Pressure Paramagnetic analyzer

8

SAFETY FIRST

Safety is not Expensive
It is Priceless !

WHERE ?



High H_2 present

High Energy present

Defined as: **General Purpose Zone (NON explosion Proof)**

WHY ?

Low voltage

High Current = High Energy

High Electrical Current → NO electrical Ex Proof Technology possible

Chlorine Electrolysis Process

on-line Hydrogen Analyzer system

FAST on-line analysis of Hydrogen (H_2) in WET Chlorine gas to keep the gas matrix within the flammability limits.

Safety is not Expensive
It is Priceless !

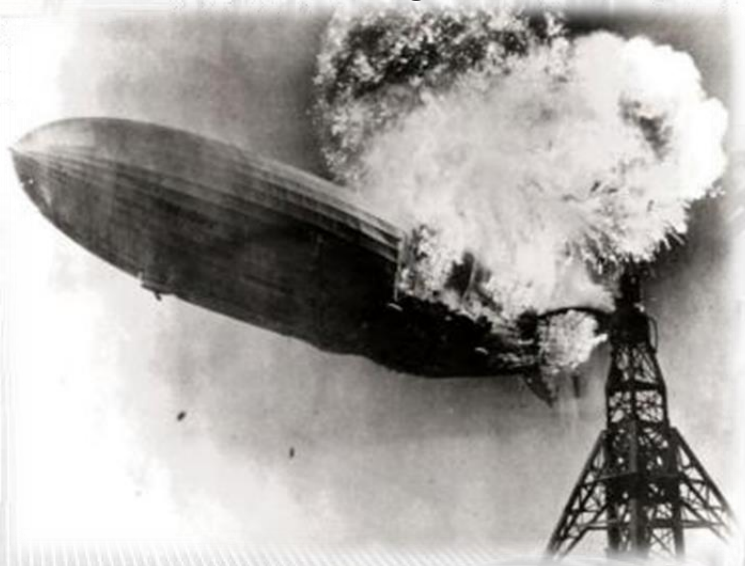
- **Field Proven Technology**
- **FAST Response** (T90 = 15 seconds)
- GOOD results during **start-up** CELL ROOM
- HAZOP approved

Misconceptions !

Explosion risk

Plant SAFETY Critical Equipment

Hindenburg disaster



May 6, 1937 Lakehurst, New Jersey

- **hydrogen is a light gas** → ~~**NO RISK**~~
- **hydrogen is not an hydrocarbon** → ~~**NO RISK**~~

one of your ONLY protections is to have an

Safety is not Expensive
It is Priceless !



on-line analyzer system for the FAST determination of hydrogen (H_2) in WET chlorine (Cl_2)

FAST

hydrogen is not waiting to ignite until you are ready with analysis !!!

Every second counts !!!

Response time of < 35 seconds T90

Do not install an analyzer systems that needs minutes to show results

WORLD chlorine council®

presented by Jean-Pol Debelle (Technical Director Eurochlor)
@ WCC Global Safety Team meeting in Dubai, UAE
October 24th 2013

The 10 WCC Cardinal Rules

1. Remain in safe concentration range for hydrogen in chlorine
2. Use titanium only with wet enough chlorine
3. Insure low moisture content for dry chlorine handling and uses
4. Control chlorine maximum temperature to avoid iron fire
5. Avoid contact between chlorine and organics
6. Avoid formation/concentration of nitrogen trichloride
7. Write operating procedures/Manage the changes
8. Insure sufficient training/information of all personnel
9. Prepare and test emergency response plans
10. Do not forget incidents investigation and experience sharing

Safety is not Expensive
It is Priceless !

WORLD chlorine council®

presented by Jean-Pol Debelle (Technical Director Eurochlor)
@ WCC Global Safety Team meeting in Dubai, UAE
October 24th 2013

Remain in safe concentration range for hydrogen in chlorine

- **Explosion risk if hydrogen concentration in chlorine between about 4 and 93 %** (precise values vary in function of pressure, temperature, presence of other constituents …)
- **Additionally to preventative actions, monitoring (on-line analysers) is mandatory**:
  - Some hydrogen is produced in the cells, but quantity can increase (bad brine quality) and there can be some mixing with chlorine (damaged membrane or diaphragm …)
  - concentration of hydrogen increases also when chlorine is liquefied …
- Hydrogen can also be produced downstream, by steel corrosion …

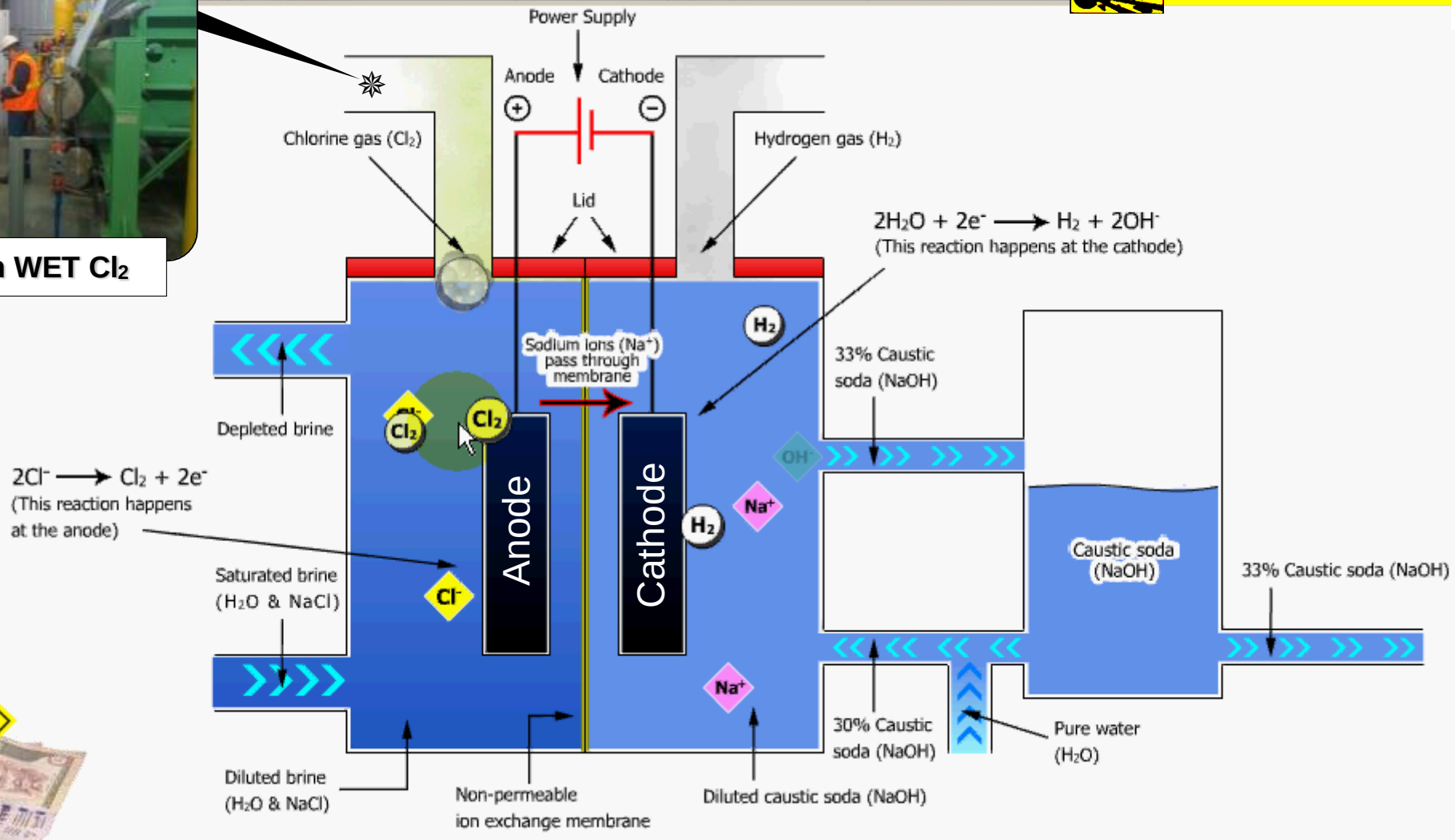
Safety is not Expensive
It is Priceless !

on-line H_2 in WET Cl_2

Membrane type Chlorine Production

Plant SAFETY Critical Equipment

DANGER
HYDROGEN
NO SMOKING
NO OPEN FLAME



Safety is not Expensive
It is Priceless !

"Courtesy of the Euro Chlor federation, www.eurochlor.org "

Protect Your plant against HYDROGEN Explosions

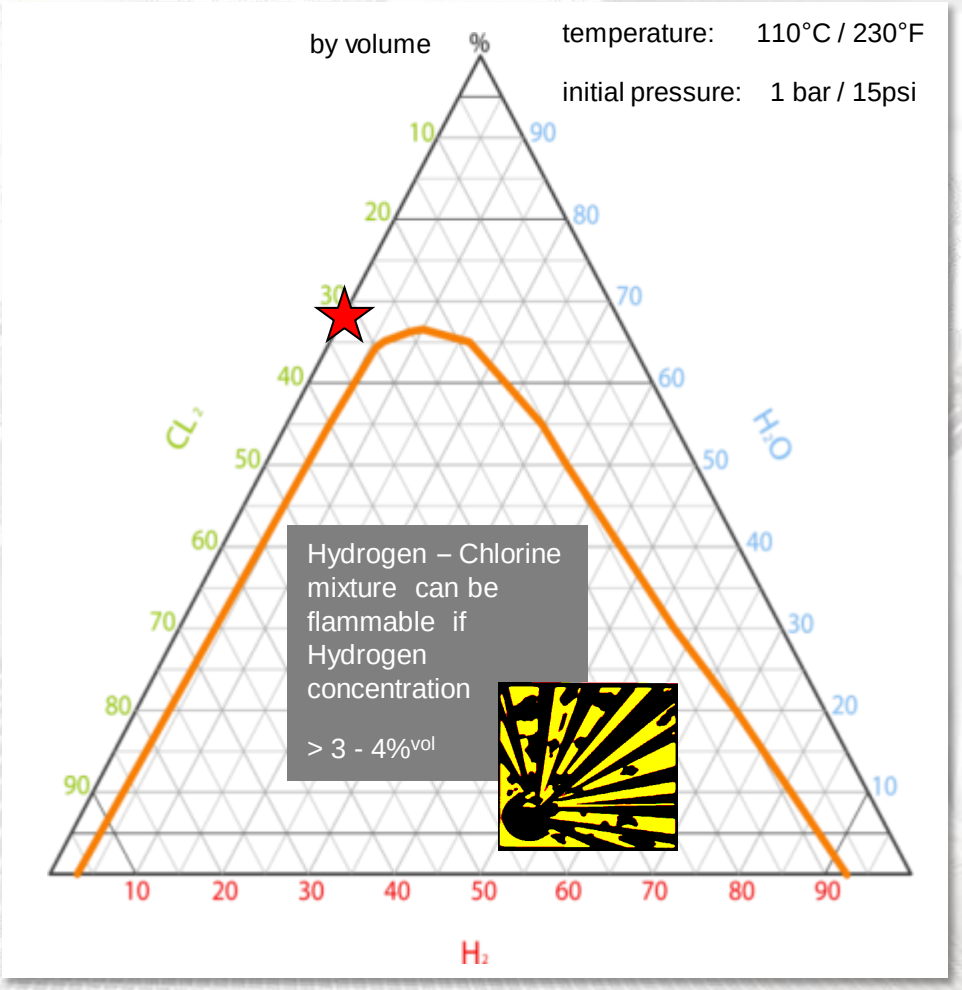
Hydrogen – Chlorine mixture can be flammable if Hydrogen > 4% (v/v)

WHY ?

Gas	Chlorine Cell gas
Chlorine	31%^{vol}
Hydrogen	**0.2%^{vol}**
Water vapor	68.2%^{vol}
Inerts	0.6%^{vol}

typical gas - matrix @ wet chlorine header electrolysis cells:

Safety is not Expensive
It is Priceless !






Protect Your plant against HYDROGEN Explosions

Hydrogen – Chlorine mixture can be flammable if Hydrogen > 4% (v/v)

typical chlorine gas travel time = 2,5min.

WHY ?

Gas	chlorine cell gas	outlet compressor	50% liquefaction	90% liquefaction
Chlorine	31%vol	97,5%vol	48.7%vol	9.7%vol
Hydrogen	**0.2%vol** →	**0.6%vol** →	**1.2%vol** →	**5%vol** DANGER
water vapor	68.2%vol	-	-	-
Inerts	0.6%vol	1.9%vol	50.1%vol	85.3%vol

ⓘ REMARK: Liquefaction is a Dynamic process. Dry Air, Nitrogen or even in some cases CO_2 are injected to keep the mixture H_2 – Cl_2 outside the flammable limits

T90 = 15s

DRYER
removal of water vapor

T90 = 15s

1st LIQUEFACTION
Cl_2 gas condensed to Liquid Chlorine

T90 = 15s

2nd LIQUEFACTION
Cl_2 gas condensed to Liquid Chlorine

T90 = 15s

Double system for Safety

on-line H_2 in WET Cl_2

on-line H_2 in DRY Cl_2

Double system for Safety

on-line H_2 in DRY Cl_2

Safety is not Expensive
It is Priceless !



WORLD chlorine council

Safety Workshop: Process Safety Management (PSM)

AppliTek

Nov. 14th 2014 Hilton – São Paulo Brazil

www.applitek.com

on-line analyzer system for the FAST determination of hydrogen (H_2) in WET chlorine (Cl_2)

by Gas-Chromatograph (GC) 1

- Discontinuous measurement
- Long analysis time (several min.!)
- Can only be used for Quality Control
- Cannot be used for Process Control
- Cannot be used for SAFETY
- Complex Technology
- High Maintenance
- Low Up-time

by Thermal Conductivity (TC) 2

UV light

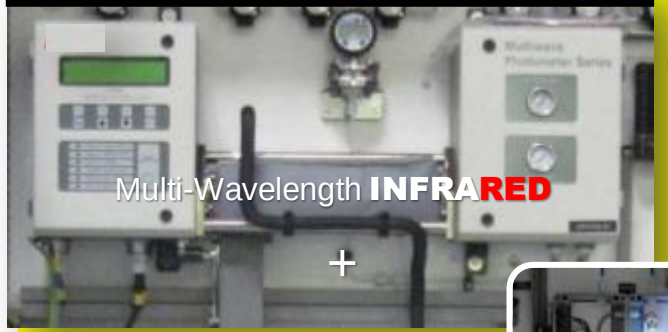
$H_2 + Cl_2 \Rightarrow 2\ HCl$

differential measurement

Δ Delta TC before - and after oxidation by UV

- Not Selective measurement for H_2
- Calibration Matrix - dependable
- Does not react first 6 – 12 min. after Plant Start-up
- Cannot be used for SAFETY during Plant Start-up

by Multi-Wavelength INFRARED (MW-IR) 3



UV light

$H_2 + Cl_2 \Rightarrow 2\ HCl$

H_2 and Cl_2 is oxidized by UV to HCl

HCl is measured by MW-IR

% HCl stoechiometrically equal to H_2

- **Selective** measurement for H_2
- Calibration **Matrix - independable**
- **Fast Response** (T90 < 20 seconds)
- **Shows Good results @ Plant Start-up**
- **Best Available Technology**
- **Field Proven** – High Up-time



WORLD chlorine council

Safety Workshop: Process Safety Management (PSM)

AppliTek

Nov. 14th 2014 Hilton – São Paulo Brazil

www.applitek.com

on-line FAST determination of hydrogen (H_2) in DRY chlorine (Cl_2) by Multi-Wavelength InfraRed

caustic soda (NaOH) 20%

WASTE CHLORINE GAS SCRUBBER

sodium hypochlorite or bleach (NaOCl)

Tail Gas 13

CHLORINE LIQUEFIER

LIQUID CHLORINE STORAGE

CHLORINE CONDENSOR

Cooling Water CW

Dilution Air

12

High chlorine Pressure | Low chlorine Pressure

INTERSTAGE COOLER 11

Cooling Water CW

CHLORINE COMPRESSOR

10

DRY CHLORINE DEMISTER

CHLORINE DRYER

sulfuric acid (H_2SO_4)

WET CHLORINE DEMISTER

Chilled Cooling Water CCW

SECONDARY COOLER

PRIMARY COOLER

Cooling Water CW

WET chlorine (Cl_2)

chlorine travel time = ± 5 to 6 minutes

hydrogen – chlorine mixture can be flammable if Hydrogen > 4% (v/v)

WHY ☝ **SAFETY CRITICAL**

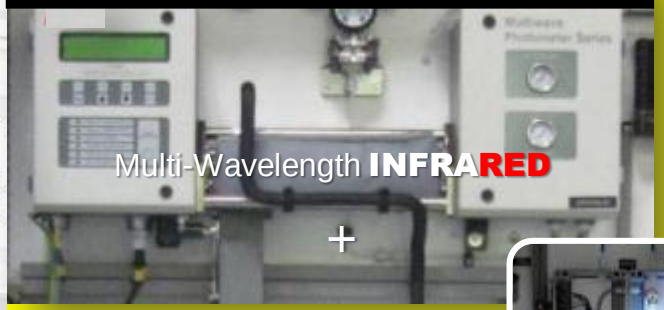
➲ PROTECT Plant against hydrogen Explosion



8 on-line analyzer system for the FAST determination of hydrogen (H_2) in WET chlorine (Cl_2)

by Multi-Wavelength INFRARED (MW-IR)

3



UV light

$H_2 + Cl_2 \Rightarrow 2\ HCl$

H_2 and Cl_2 is oxidized by UV to HCl

HCl is measured by MW-IR

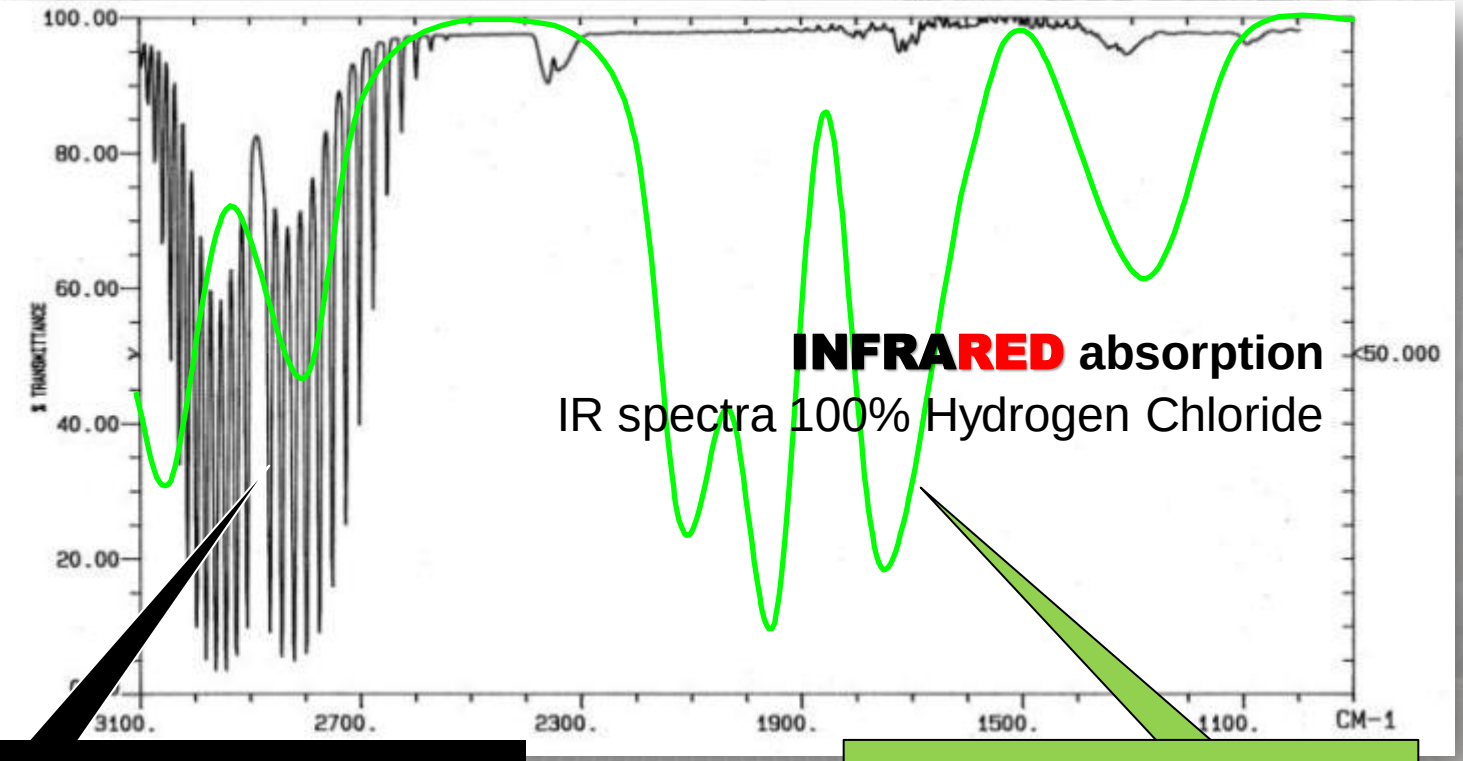
% HCl stoechiometrically equal to H_2

- **Selective** measurement for H_2
- Calibration **Matrix - independable**
- **Fast Response** (T90 < 20 seconds)
- **Shows Good results @ Plant Start-up**
- **Best Available Technology**
- **Field Proven** – High Up-time

HOW ?

Best Available Technology

Multi-Wavelength **INFRARED** measurements eliminates the influence of the environment and distinguish between H_2O and HCl. This allows measurement of HCl in WET chlorine.





World chlorine council

Safety Workshop: Process Safety Management (PSM)

AppliTek

Nov. 14th 2014 Hilton – São Paulo Brazil

www.applitek.com

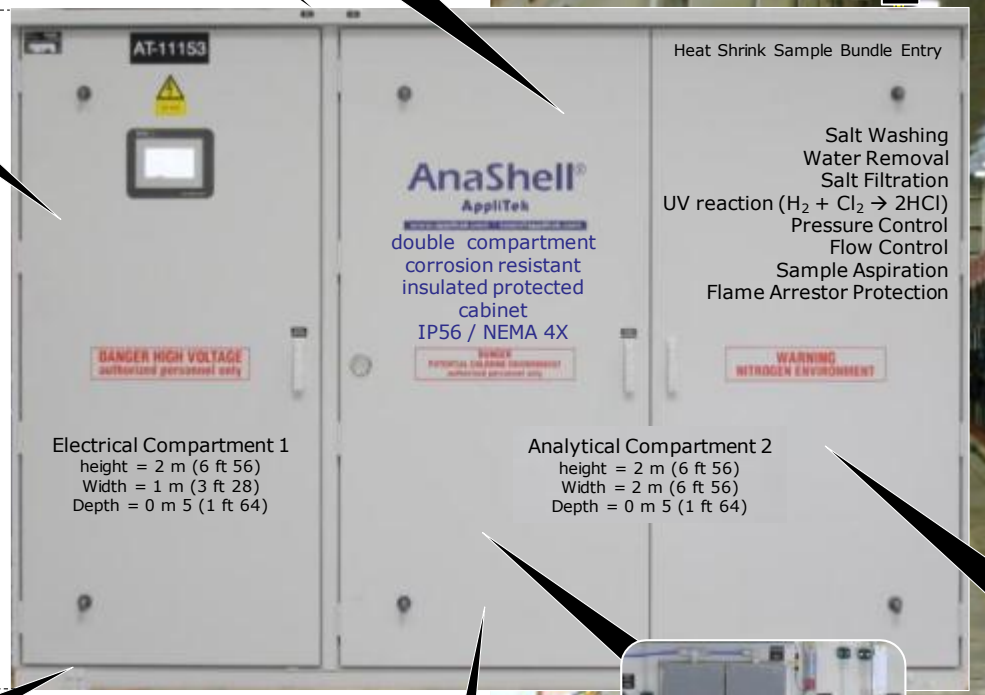
single stream on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed

1


Vortex Cooler


Multi-wavelength InfraRed analyzer


Logic Control



Height = 2 m (6 ft 56)

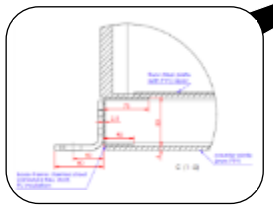
Width = 3 m (9 ft 84)

Heat Shrink Sample Bundle Entry

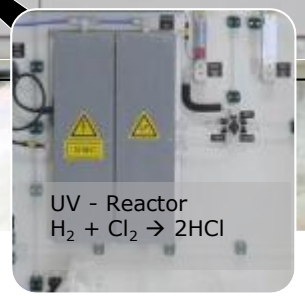
Salt Washing
Water Removal
Salt Filtration
UV reaction ($H_2 + Cl_2 \rightarrow 2HCl$)
Pressure Control
Flow Control
Sample Aspiration
Flame Arrestor Protection

Electrical Compartment 1
height = 2 m (6 ft 56)
Width = 1 m (3 ft 28)
Depth = 0 m 5 (1 ft 64)

Analytical Compartment 2
height = 2 m (6 ft 56)
Width = 2 m (6 ft 56)
Depth = 0 m 5 (1 ft 64)


Lifting / Mounting Support

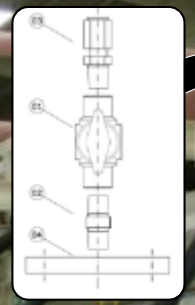

Condensate Drain Pump


UV - Reactor
$H_2 + Cl_2 \rightarrow 2HCl$


Water Condensation

typical ± 10 m (32 ft)

Thermostatically controlled electrically traced thick wall PFA insulated sample bundle



Process Valve by Customer

DIP-tube

STOP Main Chlorine Header

- **Selective** measurement for H_2
- Calibration **Matrix - independable**
- **Fast Response** (T90 < 30 seconds)
- **Shows Good results @ Plant Start-up**
- **Best Available Technology**
- **Field Proven** – High Up-time

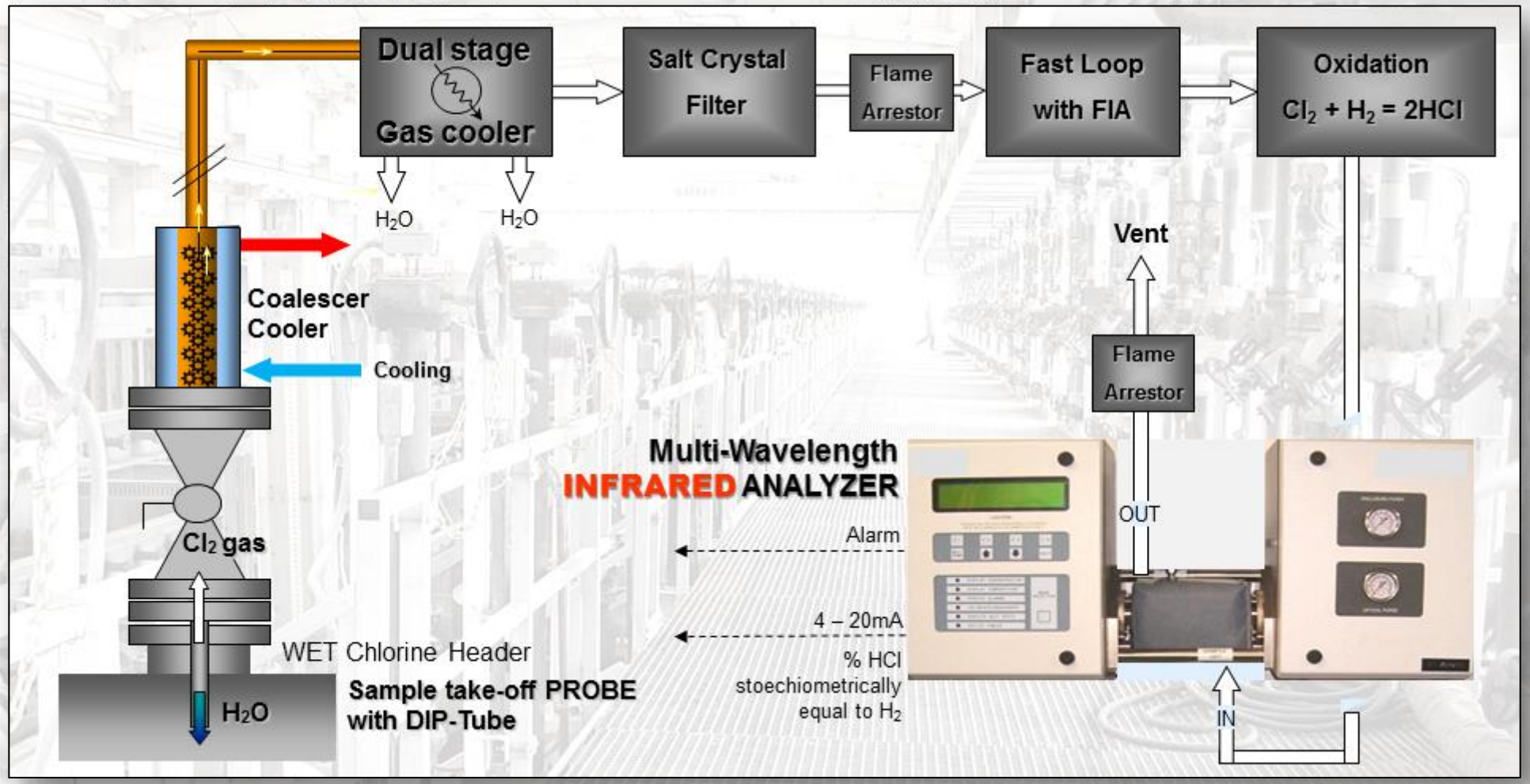


8 on-line analyzer system for the FAST determination of hydrogen (H_2) in WET chlorine (Cl_2)

by Multi-Wavelength INFRARED (MW-IR)

3

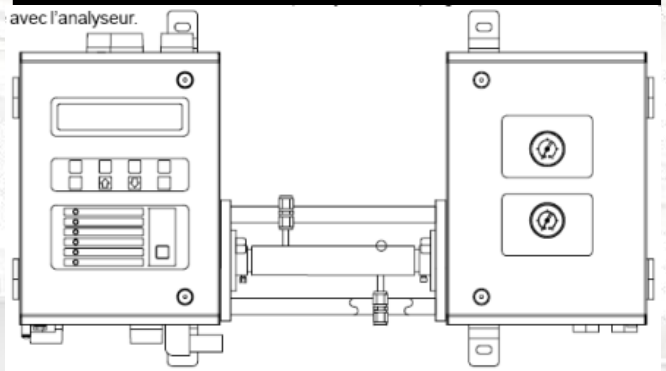
HOW ?
Best Available Technology



8 on-line analyzer system for the FAST determination of hydrogen (H_2) in WET chlorine (Cl_2)

by Multi-Wavelength INFRARED (MW-IR)

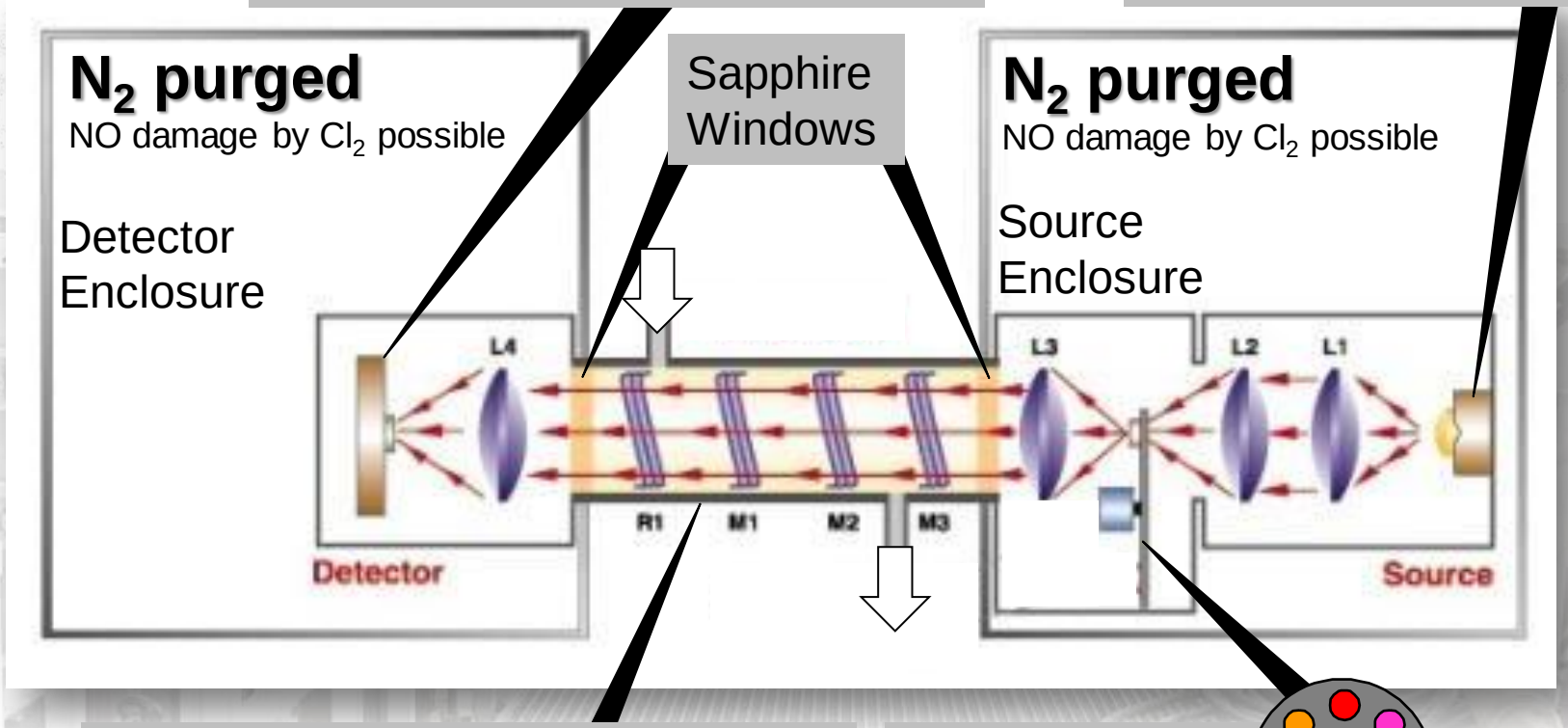
3



HOW ?

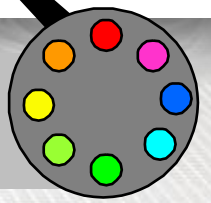
Pyro Electric Lithium Tantalite solid-state **INFRARED** Detector (FET transistor) *with Medium Sensitivity but High stability.*

Broadband (Pt) **INFRARED** source



Heated Hastelloy-C Sample Cell up to 34 bar (510psi)

Rotating Optical Filter



Best Available Technology



WORLD chlorine council

Safety Workshop: Process Safety Management (PSM)

AppliTek

Nov. 14th 2014 Hilton – São Paulo Brazil

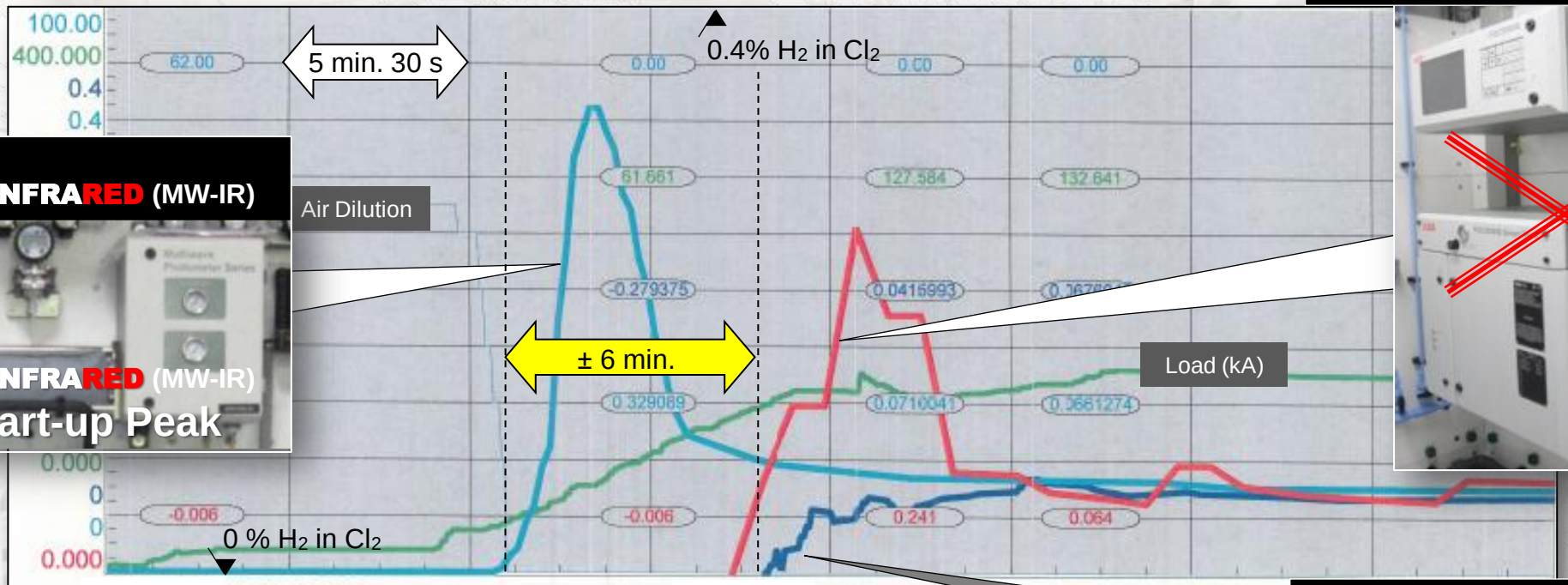
www.applitek.com

8 on-line analyzer system for the FAST determination of hydrogen (H_2) in WET chlorine (Cl_2)

Start-up Membrane type Chlorine Plant

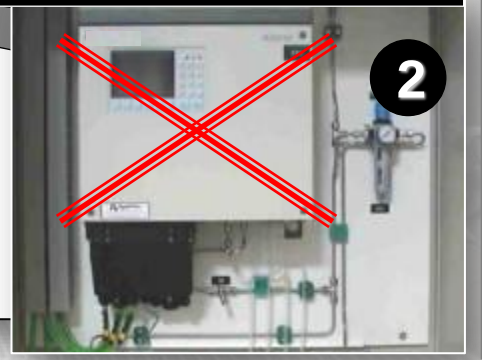
by Gas-Chromatograph (GC)

by Multi-Wavelength INFRARED (MW-IR)



Name	Description	Value	Level	Status	Aut	Plot Min	Plot Max	Units
	Air Feed to Cl2 Header		Good	Good		0.00	100.00	%
	Total KA		Good	Good		0.000	400.000	KA
	H2 in Wet Cl2		Good	Good		0	0.4	%
	H2 in Wet Cl2 (Backup)		Good	Good		0	0.4	%
	Wet Hydrogen GC					0	0.4	%
	Cellroom H2		Good	Good		0.000	0.400	Pct.

by Thermal Conductivity (TC)





WORLD chlorine council

Safety Workshop: Process Safety Management (PSM)

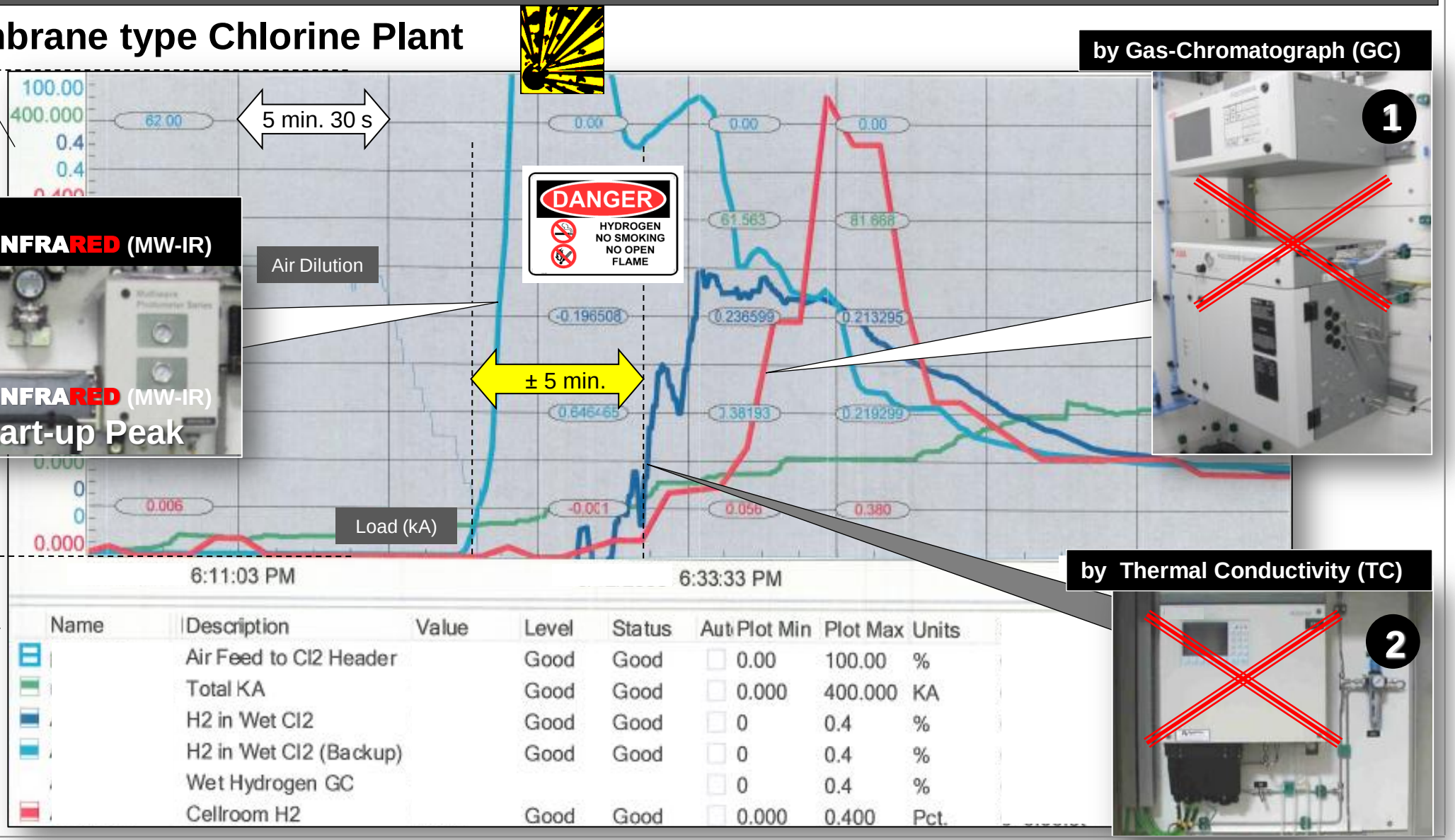
AppliTek

Nov. 14th 2014 Hilton – São Paulo Brazil

www.applitek.com

8 on-line analyzer system for the FAST determination of hydrogen (H_2) in WET chlorine (Cl_2)

Start-up Membrane type Chlorine Plant



DANGER
HYDROGEN
NO SMOKING
NO OPEN
FLAME

by Multi-Wavelength INFRARED (MW-IR)

by Gas-Chromatograph (GC)

by Thermal Conductivity (TC)

Name	Description	Value	Level	Status	Aut	Plot Min	Plot Max	Units
	Air Feed to Cl2 Header		Good	Good		0.00	100.00	%
	Total KA		Good	Good		0.000	400.000	KA
	H2 in Wet Cl2		Good	Good		0	0.4	%
	H2 in Wet Cl2 (Backup)		Good	Good		0	0.4	%
	Wet Hydrogen GC					0	0.4	%
	Cellroom H2		Good	Good		0.000	0.400	Pct.



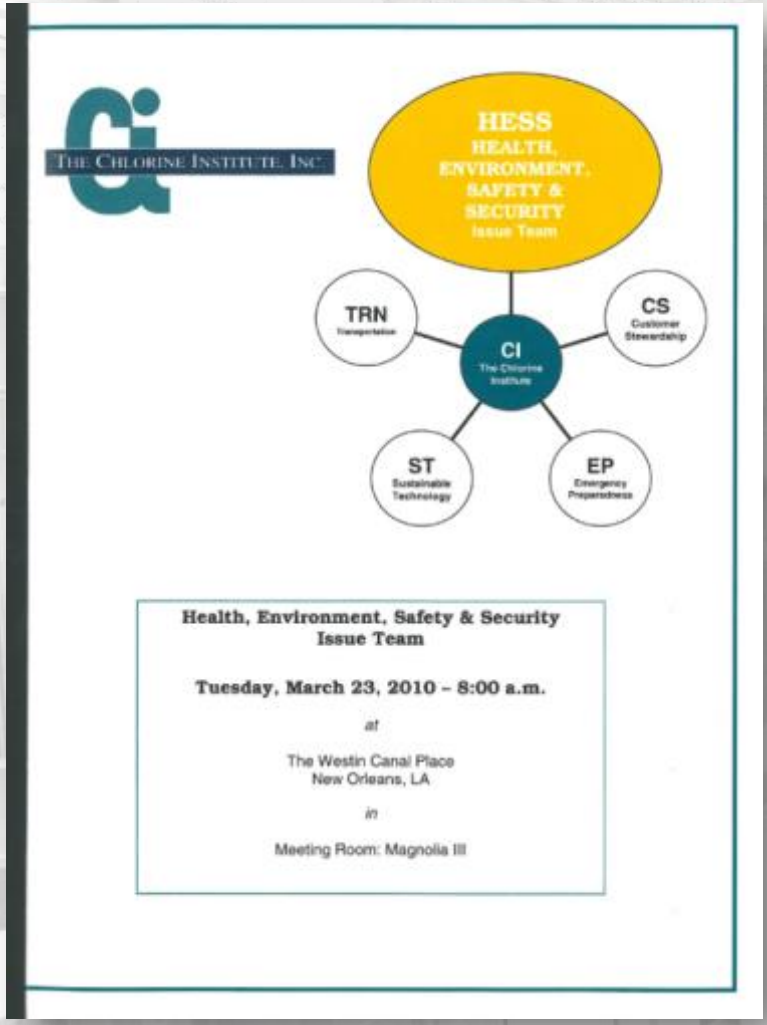
Hydrogen (H_2) peak during Start-up Membrane type Chlorine Plant

Migration of hydrogen from the cathode compartment to the anode compartment is caused by small holes in the membrane. This hydrogen flow is mainly depending on the pressure difference of the two compartments, the pressure in the cathode compartment is higher than in the anode compartment. This pressure difference is kept constant. Consequently, the flow of hydrogen to the anode compartment is more or less independent of the cell load.

During start up of the cell, there is hardly any chlorine flow, and consequently, you achieve a rather high hydrogen concentration. With increasing chlorine production, this hydrogen is diluted, and the hydrogen concentration decreases.

8 on-line analyzer system for the FAST determination of hydrogen (H_2) in WET chlorine (Cl_2)

Hydrogen (H_2) peak during Start-up Membrane type Chlorine Plant



Hydrogen in Wet Chlorine

The issue of excessive hydrogen concentrations on the chlorine side of a membrane cell during start-up has been raised. The peak concentrations can be dangerously high depending on the speed at which the facility goes trough the start up procedure. The Issue team discussed the issue and agreed that the phenomenon was generally understood by all producers

Start-up Membrane type Chlorine Plant

2%^{vol} H_2 in Cl_2

± 20 min.

Δ P H_2 / Cl_2 (mbar)

0,85%^{vol} H_2 in Cl_2

Load (kA)

START

0%^{vol} H_2 in Cl_2

17/10/2013 1:46:55 PM

by
Multi-Wavelength **INFRARED** (MW-IR)

on-line hydrogen (H_2) in WET chlorine (Cl_2) — PRECONDITIONING

FIELD proven preconditioning @ Sample Take Off Point (STOP)

- Sample Probe with DIP-tube
- Sample Cooler / Coalescer




on-line hydrogen (H_2) in WET chlorine (Cl_2)

PRECONDITIONING

measures the sample after oxidation

($H_2 + Cl_2 \rightarrow 2HCl$)

H_2 and Cl_2 is Oxidized by UV to HCl and is measured by the **INFRARED** analyzer



on-line hydrogen (H_2) in WET chlorine (Cl_2)

PRECONDITIONING

FIELD proven preconditioning

- Salt Filtration
- Water removal
- UV reactor ($H_2 + Cl_2 \rightarrow 2HCl$)
- Flow & Pressure Control

Protect Your plant against HYDROGEN Explosions

Due to high electrical currents a Chlorine Production Plant is defined as General Purpose zone → Need for Flame Arrestors

ANALYZER system

Chlorine resistant Flame Arrestor

Protection

Chlorine resistant Flame Arrestor

CHLORINE Plant

Your Analyzer system can be a source of explosion for your plant !



on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength INFRARED

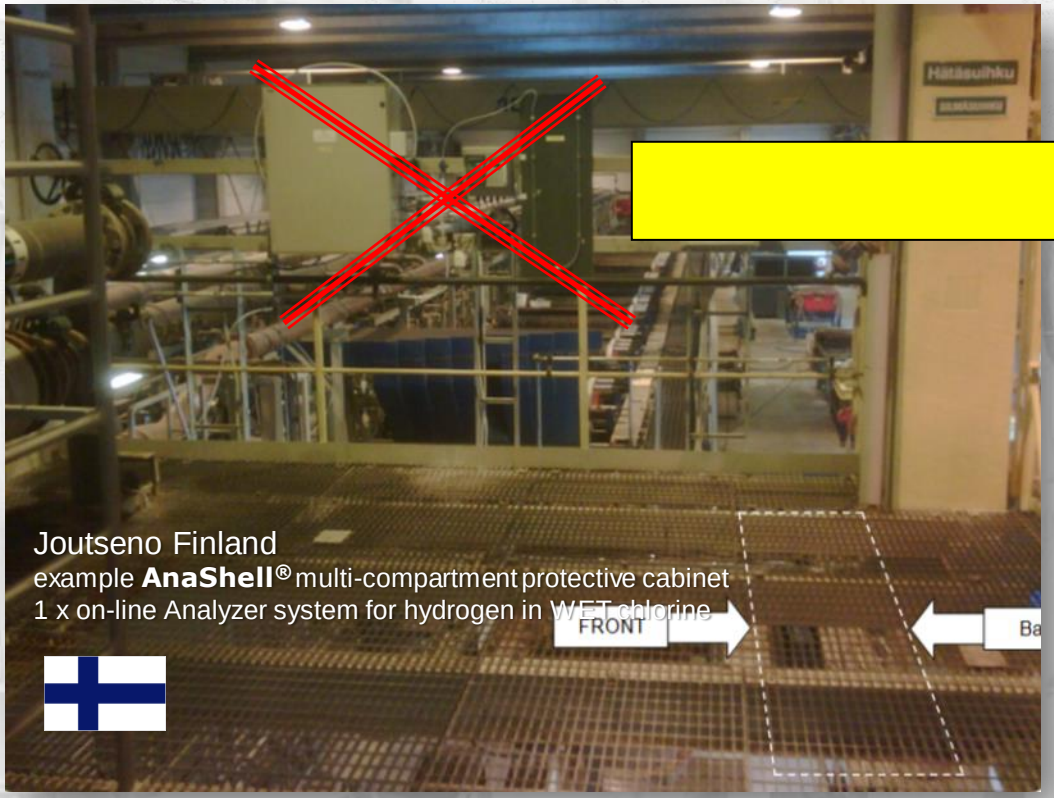
FIELD Example

example **AnaShell®** multi-compartment protective cabinet
1 x on-line Analyzer system for Hydrogen in WET Chlorine
(Multi Wavelength **INFRARED**)

Plant SAFETY Critical Equipment



on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed
Field Example



Joutseno Finland
example **AnaShell®** multi-compartment protective cabinet
1 x on-line Analyzer system for hydrogen in WET chlorine

Plant SAFETY Critical Equipment



WORLD chlorine council

Safety Workshop: Process Safety Management (PSM)

AppliTek

Nov. 14th 2014 Hilton – São Paulo Brazil

www.applitek.com

on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed Field Example

Plant SAFETY Critical Equipment

Joutseno Finland

example **AnaShell®** multi-compartment protective cabinet

1 x on-line Analyzer system for Hydrogen in WET Chlorine

on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed Field Example

Plant SAFETY Critical Equipment

Joutseno Finland
example **AnaShell®** multi-compartment protective cabinet
1 x on-line Analyzer system for Hydrogen in WET Chlorine



on-line FAST determination of Hydrogen (H_2) in WET Chlorine (Cl_2) by Multi-Wavelength INFRARED

The bitterness of poor quality remains long after the sweetness of low price is forgotten, especially for life saving, safety critical equipment

You can only apply Best Available Technology

Safety is not expensive, it is priceless

Plant SAFETY Critical Equipment



WORLD chlorine council

Safety Workshop: Process Safety Management (PSM)

AppliTek

Nov. 14th 2014 Hilton – São Paulo Brazil

www.applitek.com

on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed Field Example

Yokkaichi,Japan

example **AnaShell®** multi-compartment protective cabinet

1 x on-line Analyzer system for Hydrogen in WET Chlorine



on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed
Field Example
Repeat Order

Yokkaichi,Japan
example **AnaShell®** multi-compartment protective cabinet
1 x on-line Analyzer system for Hydrogen in WET Chlorine

Plant SAFETY Critical Equipment



on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed

Field Example

Repeat Order

Canada
example **AnaShell®** multi-compartment protective cabinet
1 x on-line Analyzer system for Hydrogen in WET Chlorine
(Multi Wavelength **INFRARED**)

Plant SAFETY Critical Equipment



on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed
Field Example

Banten, Indonesia
ASC PHASE –V Expansion Project
AnaShell® multi compartment protective cabinet
1 x on-line Analyzer system for Hydrogen in WET Chlorine

Plant SAFETY Critical Equipment



WORLD chlorine council

Safety Workshop: Process Safety Management (PSM)

AppliTek

Nov. 14th 2014 Hilton – São Paulo Brazil

www.applitek.com

on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed

Field Example

Plant SAFETY Critical Equipment

Russian Federation

IKRA Project

AnaShell® multi compartment protective cabinet

2 x on-line Analyzer system for Hydrogen in WET Chlorine



WORLD chlorine council

Safety Workshop: Process Safety Management (PSM)

AppliTek

Nov. 14th 2014 Hilton – São Paulo Brazil

www.applitek.com

on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed

Field Example

Repeat Order

Plant SAFETY Critical Equipment

Geismar, LA, USA
AnaShell® multi compartment protective cabinet
3 x on-line Analyzer system for Hydrogen in WET Chlorine
(Multi Wavelength **INFRARED**)



on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed

Field Example

Repeat Order

Geismar, LA, USA
AnaShell® multi compartment protective cabinet
3 x on-line Analyzer system for Hydrogen in WET Chlorine
(Multi Wavelength **INFRARED**)



WORLD chlorine council

Safety Workshop: Process Safety Management (PSM)

AppliTek

Nov. 14th 2014 Hilton – São Paulo Brazil

www.applitek.com

on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed

Field Example

Repeat Order

Plant SAFETY Critical Equipment

Geismar, LA, USA

AnaShell® multi compartment protective cabinet

3 x on-line Analyzer system for Hydrogen in WET Chlorine



WORLD chlorine council

Safety Workshop: Process Safety Management (PSM)

AppliTek

Nov. 14th 2014 Hilton – São Paulo Brazil

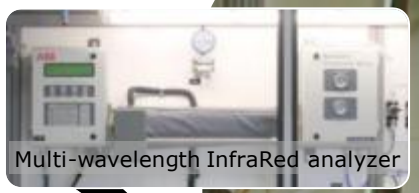
www.applitek.com

on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed

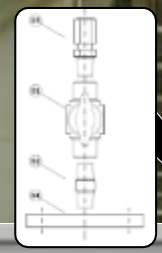
Manual Stream Selection

❷

Vortex Cooler



Multi-wavelength InfraRed analyzer



Heat Shrink Sample Bundle Entry

typical ± 10 m (32 ft)

Thermostatically controlled electrically traced thick wall PFA insulated sample bundle

Logic Control

Height = 2 m (6 ft 56)

AT-11153

AnaShell®
AppliTek
double compartment
corrosion resistant
insulated protected
cabinet
IP56 / NEMA 4X

Salt Washing
Water Removal
Salt Filtration
UV reaction ($H_2 + Cl_2 \rightarrow 2HCl$)
Pressure Control
Flow Control
Sample Aspiration
Flame Arrestor Protection

Electrical Compartment 1
height = 2 m (6 ft 56)
Width = 1 m (3 ft 28)
Depth = 0 m 5 (1 ft 64)

Analytical Compartment 2
height = 2 m (6 ft 56)
Width = 2 m (6 ft 56)
Depth = 0 m 5 (1 ft 64)

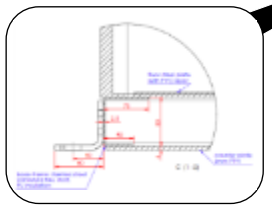
Width = 3 m (9 ft 84)

DIP-tube

Process Valve by Customer

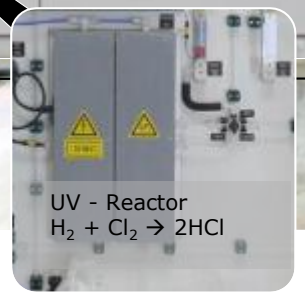
STOP Main Chlorine Header

- **Selective** measurement for H_2
- Calibration **Matrix - independable**
- **Fast Response** (T90 < 30 seconds)
- **Shows Good results @ Plant Start-up**
- **Best Available Technology**
- **Field Proven** – High Up-time



Lifting / Mounting Support

Condensate Drain Pump



UV - Reactor
$H_2 + Cl_2 \rightarrow 2HCl$

Water Condensation



WORLD chlorine council

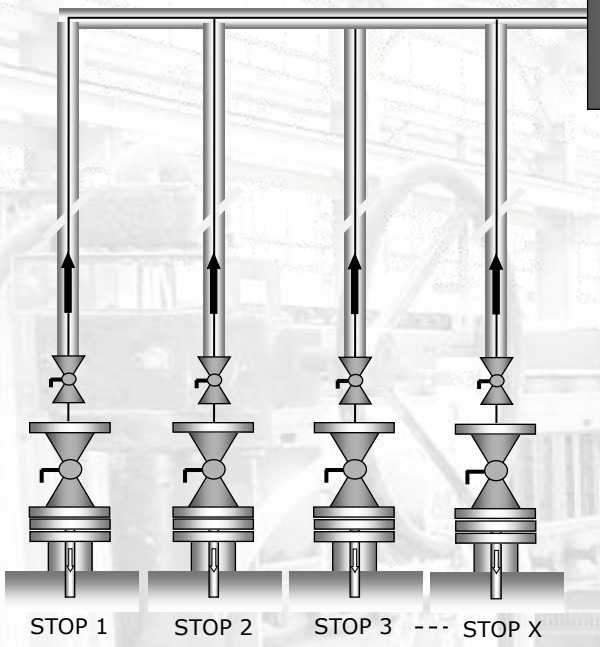
Safety Workshop: Process Safety Management (PSM)

AppliTek

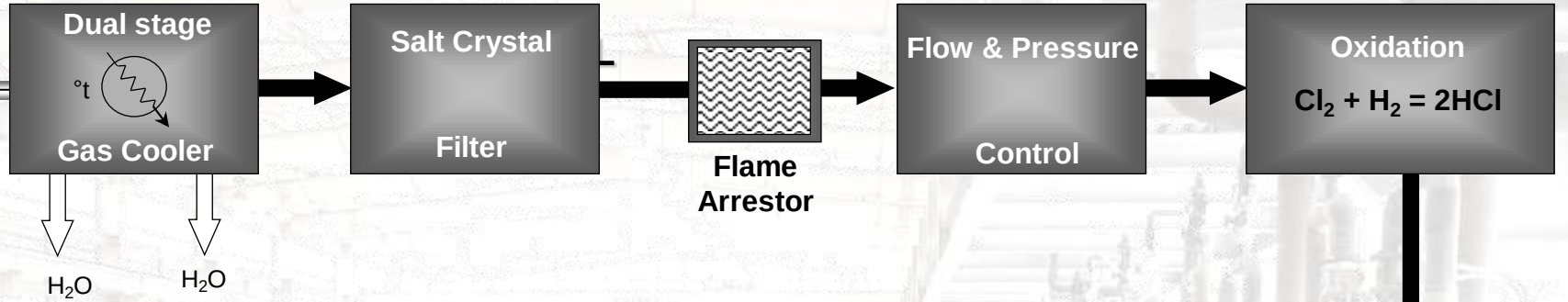
Nov. 14th 2014 Hilton – São Paulo Brazil

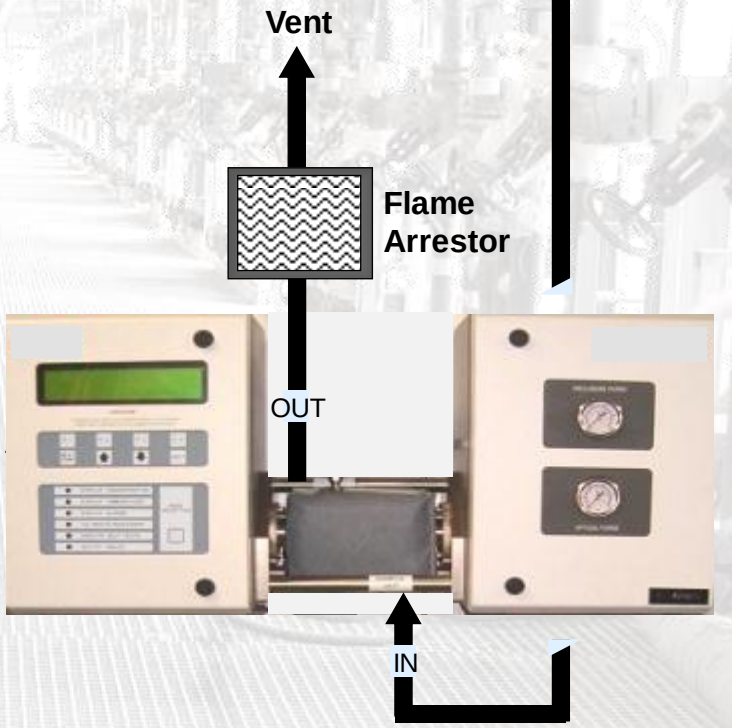
www.applitek.com

on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed



Sample Take Off Probes with dip-tube





ModuPlex® MANUAL Multiple Stream Control



on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed
Field Example

Rayong, Thailand
AnaShell® multi-compartment protective cabinet
1 x on-line Analyzer system for H_2 in WET Chlorine
(Multi Wavelength **INFRARED**)

Plant SAFETY Critical Equipment



WORLD chlorine council

Safety Workshop: Process Safety Management (PSM)

AppliTek

Nov. 14th 2014 Hilton – São Paulo Brazil

www.applitek.com

on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed Field Example

Plant SAFETY Critical Equipment

Rayong, Thailand

AnaShell® multi-compartment protective cabinet

1 x on-line Analyzer System for H_2 in WET Chlorine

(Multi Wavelength **INFRARED**)



WORLD chlorine council

Safety Workshop: Process Safety Management (PSM)

AppliTek

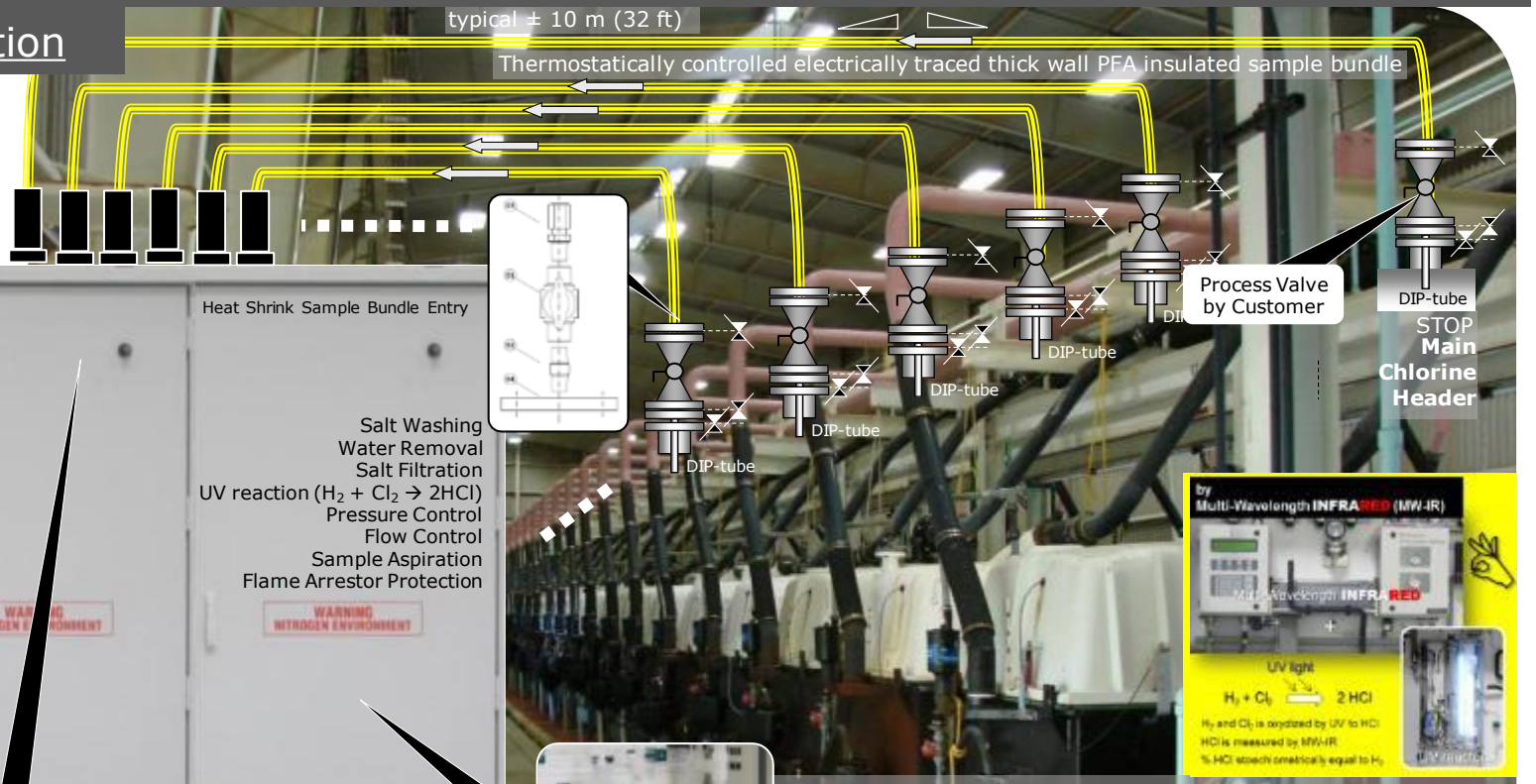
Nov. 14th 2014 Hilton – São Paulo Brazil

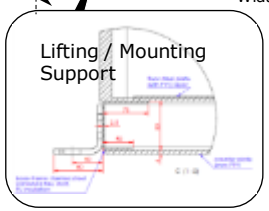
www.applitek.com

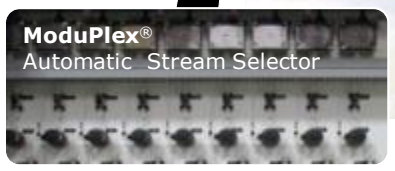
on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed

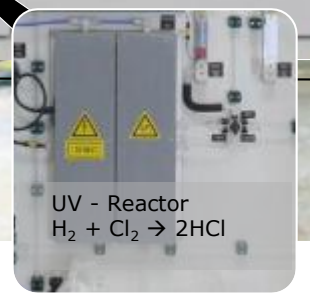
ModuPlex® Automatic Stream Selection

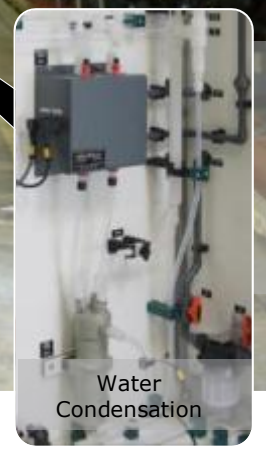
❸











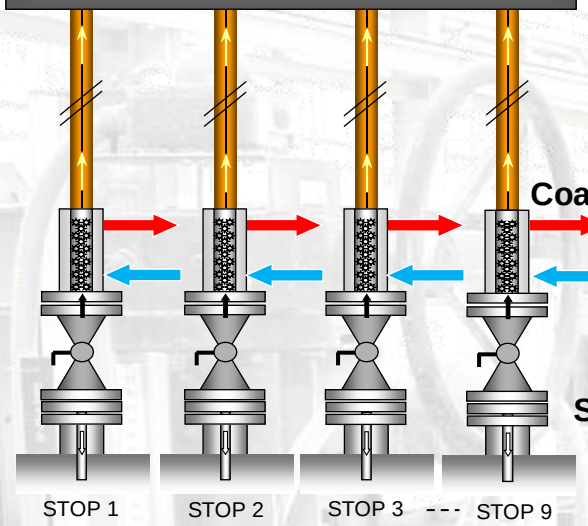
- **Selective** measurement for H_2
- Calibration **Matrix - independable**
- **Fast Response** (T90 < 30 seconds)
- **Shows Good results @ Plant Start-up**
- **Best Available Technology**
- **Field Proven** – High Up-time



on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength INFRARED

ModuPLEX® Stream Selection → **Dual stage Gas Cooler** (°t) → **Salt Crystal Filter** → **Flame Arrestor** → **Flow & Pressure Control** → **Oxidation** $Cl_2 + H_2 = 2HCl$

H_2O H_2O



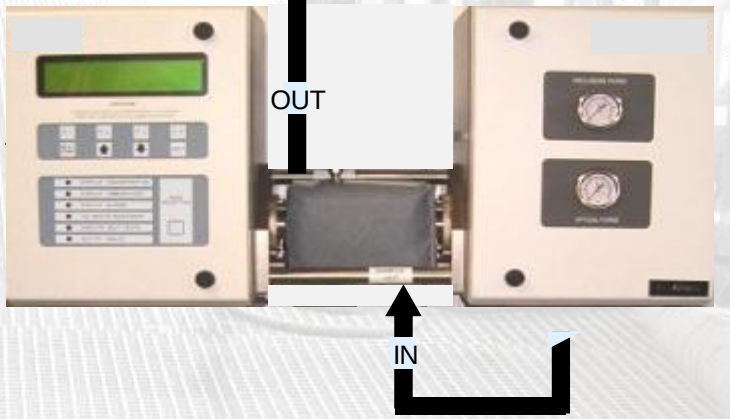
Sample take-off PROBE's with DIP-Tubes

WET Chlorine Headers

Vent

Flame Arrestor

Multi-Wavelength INFRARED ANALYZER



Alarm

4 – 20mA

% HCl stoechiometrically equal to H_2

ModuPlex® AUTOMATIC Multiple Stream Control



on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed Field Example

example **AnaShell®** multi-compartment protective cabinet
4 x on-line Analyzer system for Hydrogen in WET Chlorine
(multiple Wavelength **INFRARED**)
Including NEW **ModuPLEX®** Multiple Stream Control

Plant SAFETY Critical Equipment



WORLD chlorine council

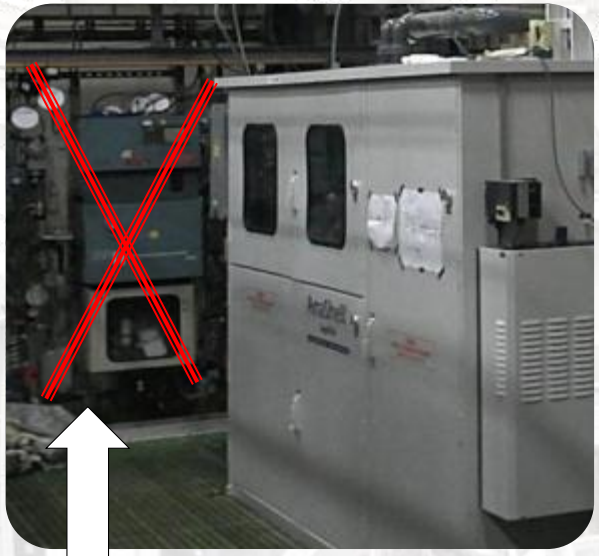
Safety Workshop: Process Safety Management (PSM)

AppliTek

Nov. 14th 2014 Hilton – São Paulo Brazil

www.applitek.com

on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed Field Example



Plant SAFETY Critical Equipment

2 pc **AnaShell®** multi-compartment protective cabinets
1 x on-line Analyzer system for Hydrogen in WET Chlorine
by multi-Wavelength **INFRARED**)
1 x on-line Analyzer system for Oxygen in WET Chlorine
(alternating pressure PARAMAGNETIC analyzer)



WORLD chlorine council

Safety Workshop: Process Safety Management (PSM)

AppliTek

Nov. 14th 2014 Hilton – São Paulo Brazil

www.applitek.com

on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed
Field Example

Jubail, Saudi Arabia
AnaShell® multi-compartment protective cabinet
1 x on-line Analyzer system for H_2 in WET Chlorine

Plant SAFETY Critical Equipment

using *NEW* **ModuPlex®** stream selector
(multiple (19) streams !)



on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed
Field Example

Jubail, Saudi Arabia
AnaShell® multi-compartment protective cabinet
1 x on-line Analyzer system for H_2 in WET Chlorine

using *NEW* **ModuPlex®** stream selector
(multiple (19) streams !)



on-line FAST determination of hydrogen (H_2) in WET chlorine (Cl_2) by Multi-Wavelength InfraRed
Field Example

Plant SAFETY Critical Equipment

Brasil
AnaShell® multi-compartment protective cabinet
1 x on-line Analyzer system for H_2 in WET Chlorine
(Multi Wavelength **INFRARED**)

"You can also belong to the right club of believers in AppliTek!"

David Laurier, CEO AppliTek

For Info on AppliTek



- Headquarters & manufacturing: Belgium (Flanders region)
- Established manufacturer of on-line (automatic) analyzers
- System Integrator for several industries
- Wholly-privately owned company, non stock listed
- Represented in 100+ countries

- **2015: 30 years of experience in on-line analysis**



WORLD chlorine council

Safety Workshop: Process Safety Management (PSM)

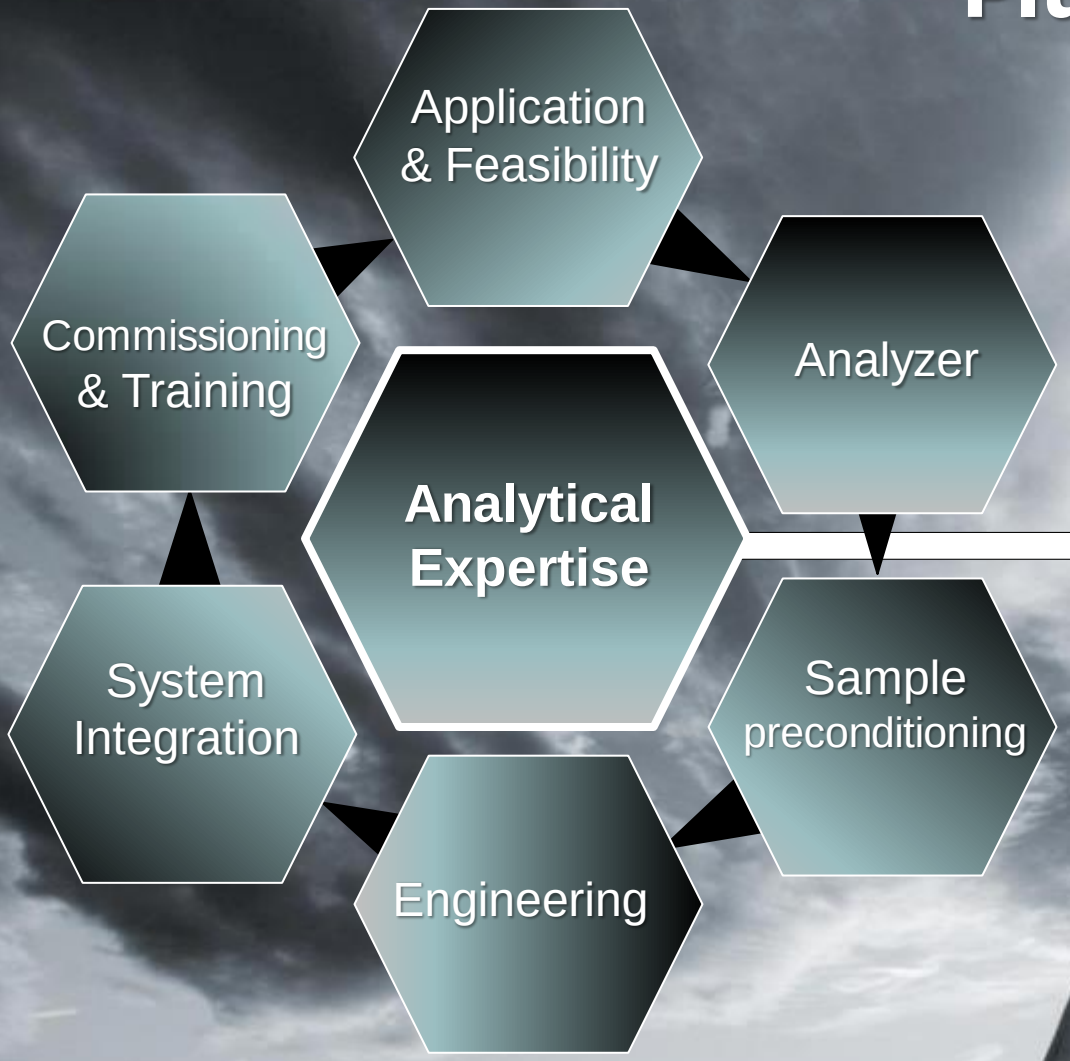
AppliTek

Nov. 14th 2014 Hilton – São Paulo Brazil

www.applitek.com

a complete solution for a measuring problem

Plug – Play – Educate - Service



- Colorimetry
- Ionometry
- Titration
- Voltammetry
- Spectrometry (UV, IR, NIR, XRF, Raman)
- Chromatography
- Respirometry
- Bio monitoring



WORLD chlorine council

Safety Workshop: Process Safety Management (PSM)

AppliTek

Nov. 14th 2014 Hilton – São Paulo Brazil

www.applitek.com

Application Laboratory

- Advice of best analysis method
- In-house feasibility studies
- Application development.
- Danger Assessment Studies
- In-house customer & product training

Application & Feasibility



Production of wide-range wet chemical on-line Analyzers

Analyzer



Process Analyzers:

- titration
- ionometry
- colorimetry

Dedicated-series Water Analyzers

TONI®, TOPHO®, AppliTOC®, AppliCOD®, Ra-BOD®, Ra-TOX®

Single Parameter series Analyzers

Heavy Metal Analyzers

VPA®

Toxicity / Microbiology analyzers

AppliTox® | EZ-ATP®



Engineering

- In-house CAD ExPert team
- In-house Ex Proof (ATEX/NEC) ExPert team
- In-house Software/PLC expert team
- Cost planning
- Basic & Detail engineering

Sample Preconditioning

Engineering



System Integration

- in-house quality & safety control
- Flexible changes of scope of supply
- Project & Site Management
- FAT prior to shipment
- Fully equipped workshop



"Works good, looks good."

AppliTek State of the Art Analytical Solutions

System Integration Through Analytical Expertise



WORLD chlorine council

Safety Workshop: Process Safety Management (PSM)

AppliTek

Nov. 14th 2014 Hilton – São Paulo Brazil

www.applitek.com

AnaShell® concept

NEC 505 / ATEX



20 years Field Proven on All Continents

AnaShell® concept

NEC 505 / ATEX



AnaShell® concept

Enclosure Protection by vacuum to scrubber



Successful both in Desert & Artic Locations

AnaShell® shelter concept



System Integration through Analytical Expertise

State of the Art
Analytical Solutions

Expertise in stainless steel / monel / hastelloy c

(Swagelok | Parker | Gyrolok)

“Works good, Looks Good”



System Integration trough Analytical Expertise

PVDF / Kynar™ / PFA / Teflon™

“Works good, Looks Good”





- Site Acceptance Test (SAT)
- Start up / Test runs
- Operator / Product training
- Maintenance (contracts)
- Periodic preventive checks

Commissioning & Training

Commissioning / After Sales Service



AppliTek REFERENCES ?

OXY
Formosa Plastics
AsahiKASEI
SOLVAY
VINYTHAI
GE
Uhde ThyssenKrupp
Toyo Engineering Corporation
ALBEMARLE CORPORATION
TESSENDERLO GROUP
صدف sadaf
AGC
Mexichem
AkerSolutions
Olin CHLOR ALKALI PRODUCTS
Snolana ANWIL GROUP
ROKITA
JGC JGC CORPORATION
ADITYA BIRLA GROUP
FLUOR
AKZO NOBEL
canexus
ShinEtsu
ERCO Worldwide
Technip
carbocloro
ASC AGC Group
Vinnolit Leadership in PVC
INEOS
ppg
BASF
سابك sabic
BC BorsodChem
JGC INDONESIA
MUSTANG
UHDENORA A JOINT COMPANY OF UHDE & GRUPPO DE NORA
ORICA

WWW.ENGEZER.COM.BR

21.3445-8120

COMERCIAL@ENGEZER.COM.BR