Structural health monitoring of valves: the SAAMMx-20 project for a new approch to safer valves

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In this presentation, I will speak about…

- Condition Monitoring and Structural Health Monitoring
- Acoustic Emission Method (AE)
- AE Testing during Validation of Systems
- On-Field Applications of AE for Condition Monitoring of Valves
- Case Studies of AE application for Valve SHM
- The SAAMM-x20 System
- Conclusion

Structural Health Monitoring and Condition Monitoring

- The process of implementing detection of changes of geometrical, mechanical, materials properties of a structural system and characterization strategy for engineering structures is referred to as **Structural Health Monitoring** (SHM).

- **Condition monitoring** is the process of monitoring different parameters or condition of machinery (vibration, temperature etc.), in order to identify a significant change which is indicative of a developing fault.

Structural Health Monitoring and Condition Monitoring.

Example of necessity of SHM and CM for real situation:

Two tank and relative accessories (including valves) of the same lot are installed in the same time:

The first system in an Installation on the North Sea and the second one in a refinery in Italy.

They must be re-tested under normative after 10 years, but the stresses are quite different, in term of thermal stresses, etc.

Why perform In-Service Test every 10 Years (Law compliant), if two identical system of same lot are installed in very different situation and are stressed in different manner? Operating situation and environment for even identical equipment items varies sufficiently that each installation must be individually assessed for health & condition also if local law admit inspection period of 10 year.

Acoustic Emission Method

Acoustic Emission

is

the spontaneous release of elastic energy

when

materials undergo deformation

Acoustic Emission Method

Yet another definition:

phenomena

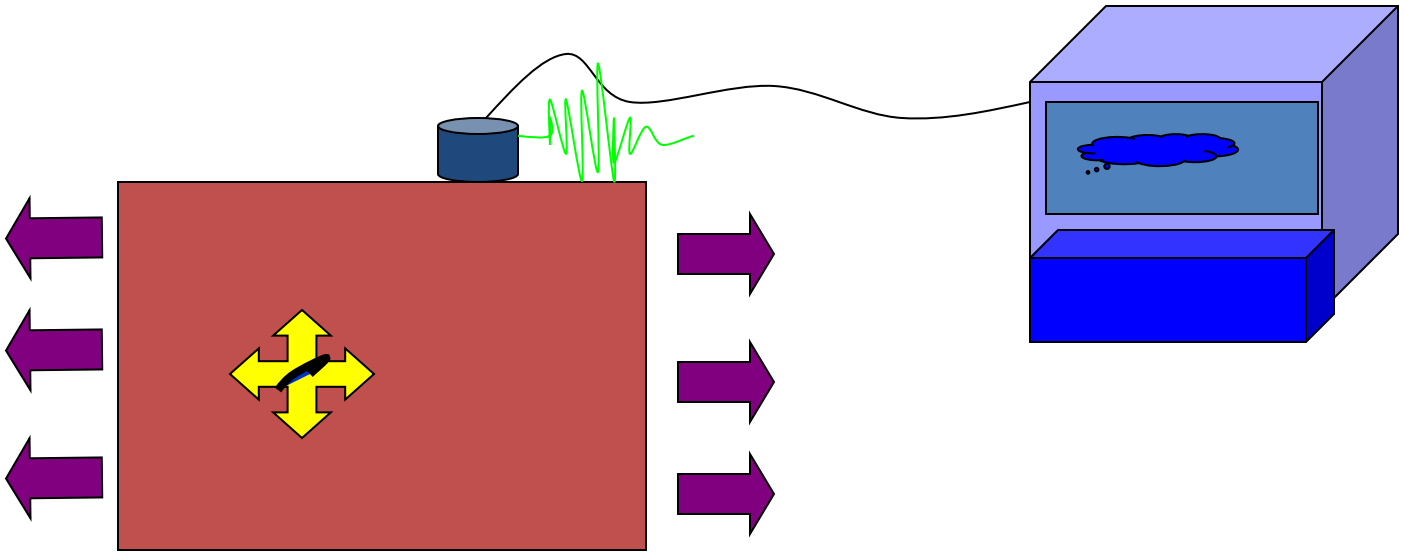
whereby transient elastic waves are generated

by e.g.

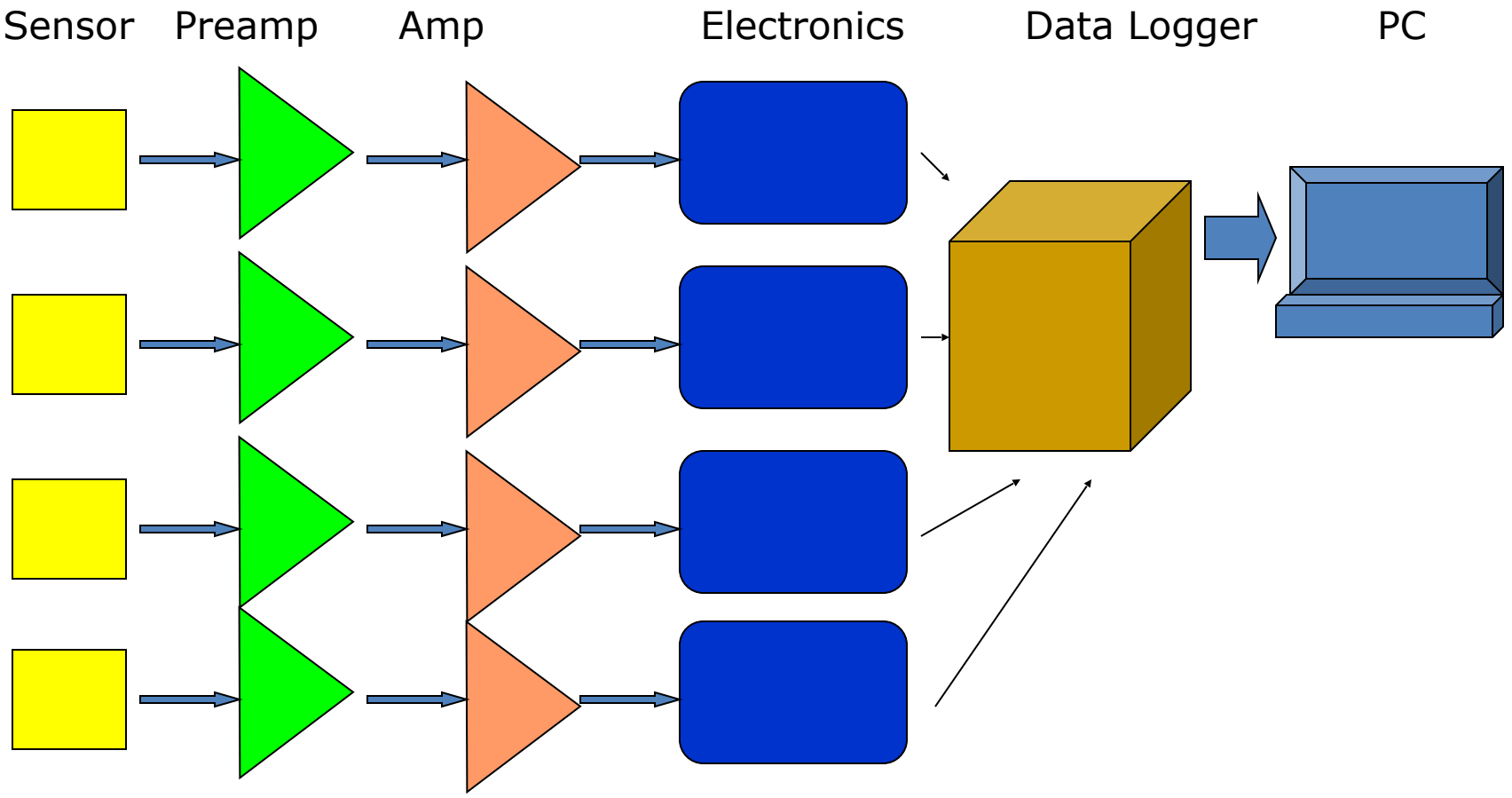
- plastic deformation,
- crack propagation,
- erosion,
- corrosion,
- impact,
- leakage

EN1330-9

Theoretical Basis of AE Method



With More AE Sensors…

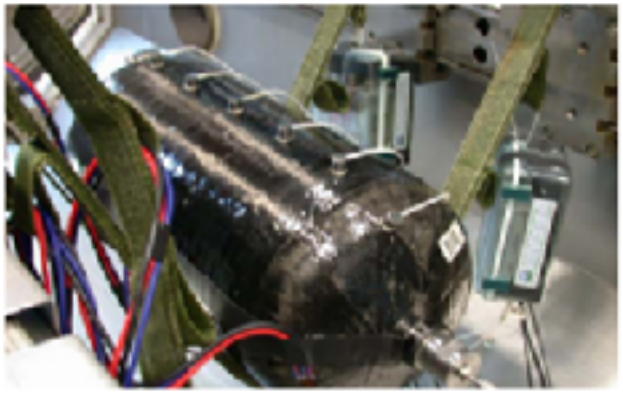


Possible Application of AE Methodology

Leak detection in burried pipes

A few more examples of AE and its applications

Testing of concrete structures



Test of composite pressure vessel

Large pressure vessel test

AE Testing during Validation of System

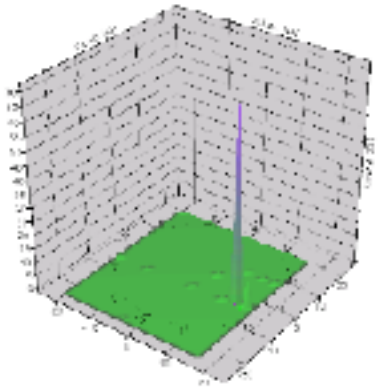
Acoustic Emission Testing need only to 'Stress' the Structure to generate, identify, localize and evaluate the signals received during stress change.

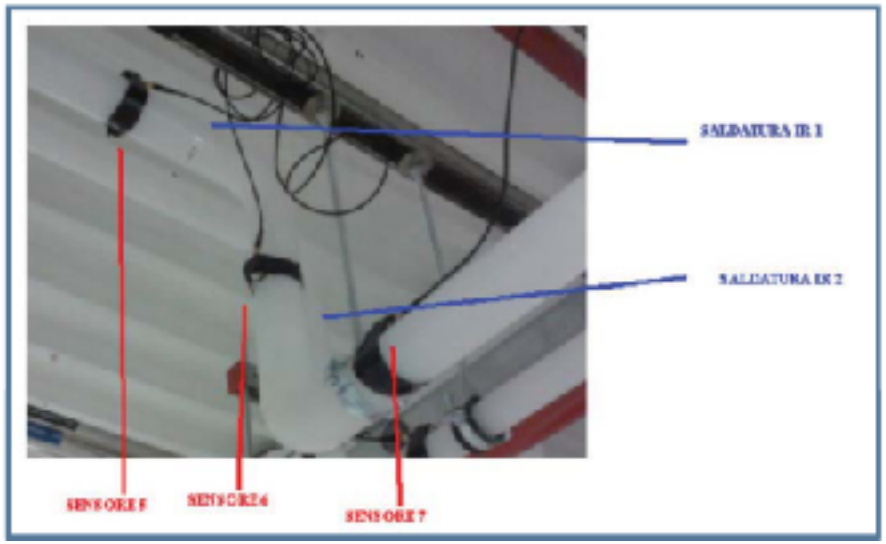
Why don't use AE during normal Stress that we apply in validation phase of the Structure?

- Pressure Test of Metallic Tank
- Pressure Test of Reinforced Fiber Tank
- Thermal Cycles
- Fatigue Cycle

On-Field Applications of AE for Condition Monitoring

- Piping , Valves and Systems Monitoring
  - EN 15857 – ASME V art. 11 & 13
  - E1211 - 12 Standard Practice for **Leak Detection** and Location Using Surface- Mounted **Acoustic Emission** Sensors , **acoustic emission**, continuous monitoring,…
  - Condition Monitoring
  - Leak, corrosion, fiber breakage, etc.





On-Field Applications of AE for Condition Monitoring

Condition Monitoring

Figure 4. Summary of problem areas on Unit 2 HRH horizontal line 4

Location for Priority A; Location for Priority B; Location for priority C

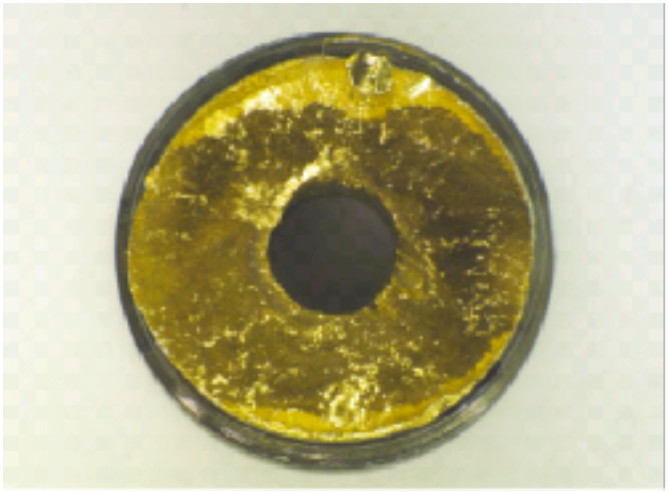
1° Case Study for AE application to Valve Monitoring

We need to avoid this situation:

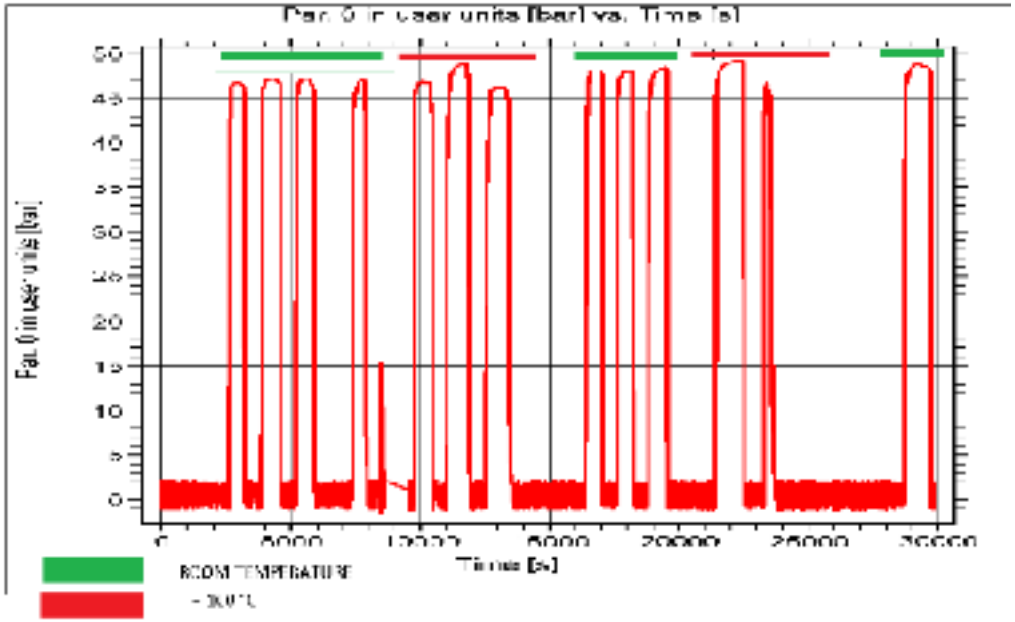
This Picture show a SCC in the valve

of the Oxigen Gas Cylinder at 200 Bar

and rupture after critical thickness reduction.



1° Case Study for AE application to Valve Monitoring



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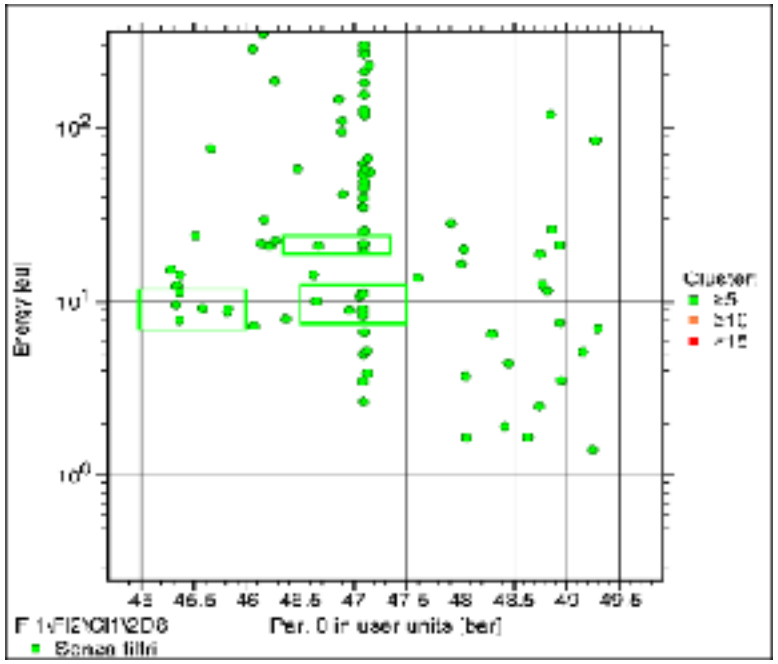
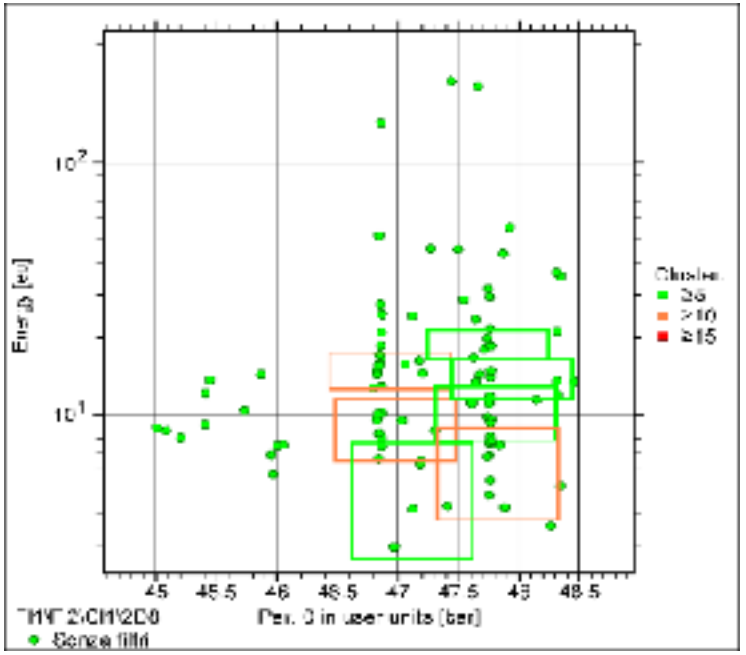


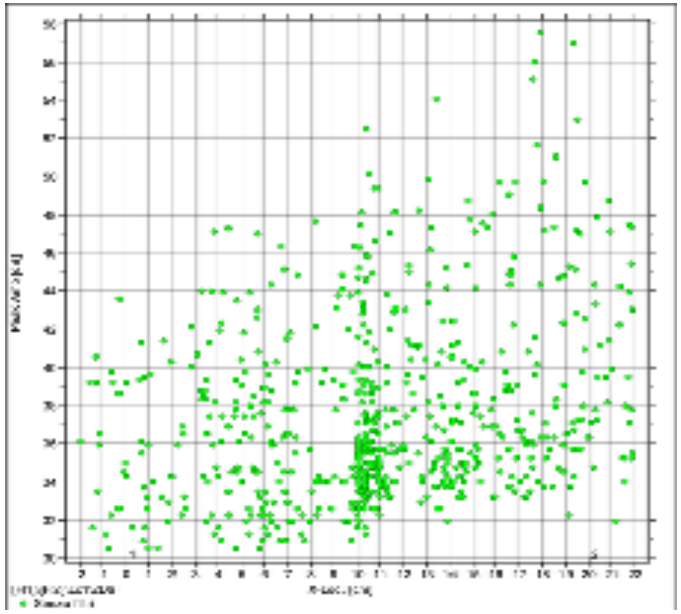
Clusters generated by good valve and table of parameters of the burst included in each cluster



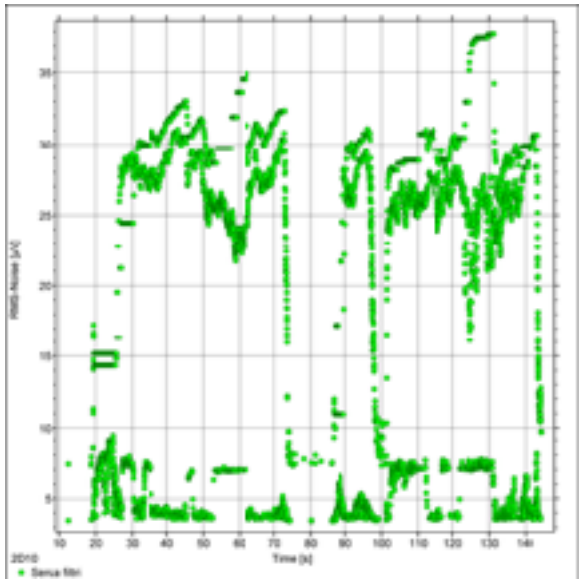
Clusters generated by damaged valve and table of parameters of the burst included in each cluster

2° Case Study for AE application to Valve Monitoring

- **EA activities that a buried valve show in the area in which is present on teh body a vertical crack of about 150 mm, without leak. The goal of test is to verify if crack is propagating further and to study possibility to detect and localize cracks in buried valves**

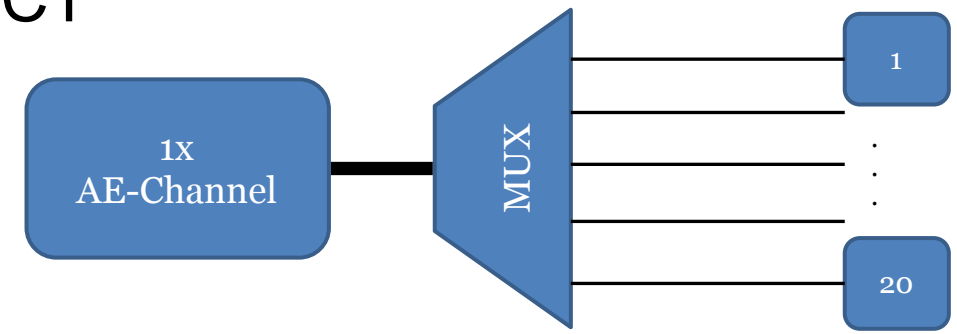


Event localization during 20 Hours of acquisition



Background noise in dB and RMS of the valve during the Open/Close Cycle

THE SAAMM-x20 PROJECT



- 20 Multiplexed AE and HART Inputs
- Measures: RMS; Peak and Activity
- Interface: RS485 for Industrial Standard Environments
- Open Command Interface for Customer Application
- Power Consumption: < 10 W
- Fanless Cooling
- Compatible to all Vallen Preamps and Sensors - also ISAFE

THE SAAMM-x20 PROJECT

SAAMM x20 is an abbreviation for "**S**tand **A**lone **A**E **M**onitoring **M**ultiplexer with **20** channels"

Each channel can be configured individually, but always just **one channel** can be set active for measurement (one out of 20 inputs)!

It is designed for use in a wide range of long term acoustic emission monitoring purposes where machine or structural conditions are changing slowly

Some of the typical applications of the SAAMM are

- Valve leak detection
- Turbine and gear box monitoring
- Machinery monitoring

THE SAAMM-x20 PROJECT

General features:

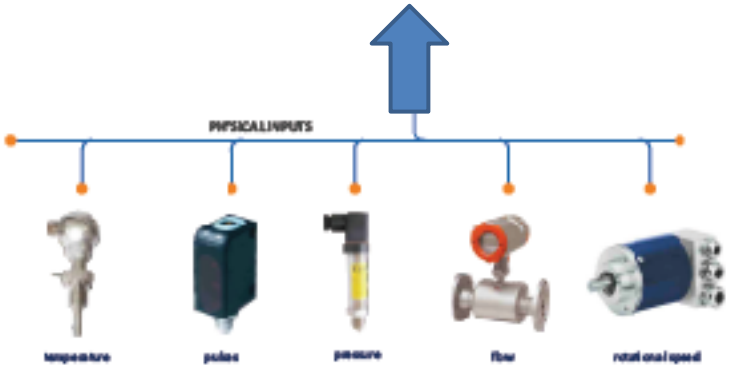
- **Multiplexed AE channels**
  - +28 V ghost voltage for connecting AE sensors with integrated or external amplifier
- **Multiplexed HART® Interfaces**
  - HART® installation can be done without system interrupt
  - no need to open the 4 – 20 mA loop for installation
- **RS-486 industrial communication interface for**
  - data transfer
  - setup and control
  - firmware update
- **Power supply**
  - 24 V_{DC} power supply
  - power consumption < **10 W**
- **Programmable power on default setup** for all channels
- Many "on the fly" selectable **digital band pass filters** (see chapter 1.1 – Digital Filter List)
- **RMS and APK**
  - Floating Point RMS calculation
- **Display** providing information regarding status and setup information
- **Rotary switch** for manual status info selection (option for installation)
- Connectors
  - BNC connector panel, to install up to 20 AE-Sensors
  - Terminal field for connecting up to 20 HART® channels
  - Power connector for +24 V_{DC} / 1 A
  - Socket for RS 485 communication interface

THE SAAMM-x20 PROJECT

Controls Outputs

Ethernet, WiFi, GSM Networks

AE SENSORS



Remote Acquisition&Control

HART protocol

Conclusions

Condition Monitoring through AE realize a rapid, low-cost, high accuracy and real-time method also for complex petrochemical plant.

State-of-Art Technology (wireless, GPS, etc…) are utilized to increase performance of the acquisition system.

The possibility of understanding and managing the AE signals coming from valves, whether captured locally or remotely, provides the plant operator with a new assessment tool. This can support maintenance planning and increased reliability

AE with SAAMM-x20 is a powerful and well recognised tool that give real time evaluation and evolution of the damage and can be appreciated in the valve reliability through integration of dedicated sensors in the critical area of the system.

Questions?

THANK YOU FOR YOUR PARTICIPATION