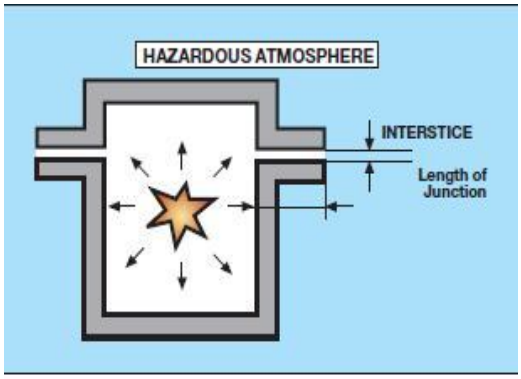
Methods of Protection – Summary

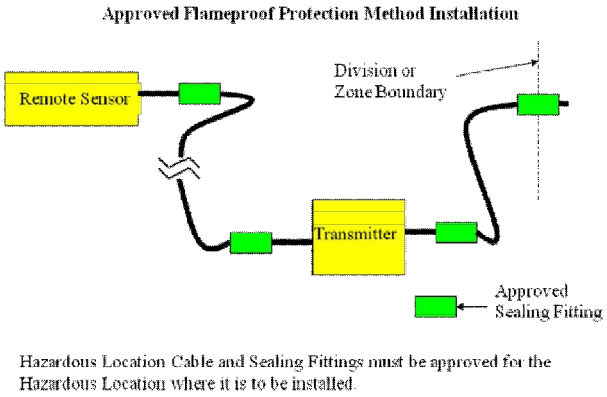
General Principles	Protection Methods	Principle Characteristics	Relevant Standard
Explosion Containment	**Flame-Proof Ex "d"**	Relatively easy to be applied but with specific mechanical requirements. Difficulty in maintenance and checks.	EN 60079-1 (IEC 60079-1)
	Enclosed Break **Ex "nC"**	Similar to Ex "d" except suitable for Zone 2 only.	EN 60079-15 (IEC 60079-15)
Prevention	Non-Sparking Ex "**nA**"	Suitable for non-sparking, low operational temperature devices.	EN 60079-15 (IEC 60079-15)
	Intrinsic Safety Ex "ia"	Suitable for process instrumentation. Does not require a particular enclosure. Economical and easy installation, maintenance and checks. Limited to low power circuits.	EN 60079-11 (IEC 60079-11)
	Intrinsic Safety **Ex "ib"**	Similar to Ex "ia" except for the number of faults to be considered. No North American equivalent.	EN 60079-11 (IEC 60079-11)

Methods of Protection – Summary

General Principles	Protection Methods	Principle Characteristics	Relevant Standard
Segregation	Pressurization Ex “px”, Ex “py”	Suitable for large containers or for working area. Requires specific alarm systems.	EN 60079-2 (IEC 60079-2)
	Pressurization Ex “pz”	Similar to Ex “px” and Ex “py” except suitable for Zone 2 only.	EN 60079-2 (IEC 60079-2)
	Encapsulation Ex “ma”	Suitable for small circuits with good protection characteristics, both mechanical and electrical.	EN 60079-18 (IEC 60079-18)
	Encapsulation Ex “mb”	Similar to Ex “ma” except suitable for Zone 1 and Zone 2 only.	EN 60079-18 (IEC 60079-18)
	Oil-Immersion Ex “o”	Suitable for transformers and where there are moving parts. Generally not very widely used.	EN 50015 (IEC 60079-6)
	Restricted Breathing Ex “nR”	Suitable for housings designed to restrict the ingress of gas.	EN 60079-15 (IEC 60079-15)
	Powder-Filling Ex “q”	Suitable where there are non-moving parts. Present maintenance difficulty. Not very widely used.	EN 50017 (IEC 60079-5)
	Increased Safety Ex “e”	Suitable for non-sparking apparatus during normal functioning (terminals, connections, lamp sockets, motors). Particular construction requirements.	EN 60079-7 (IEC 60079-7)

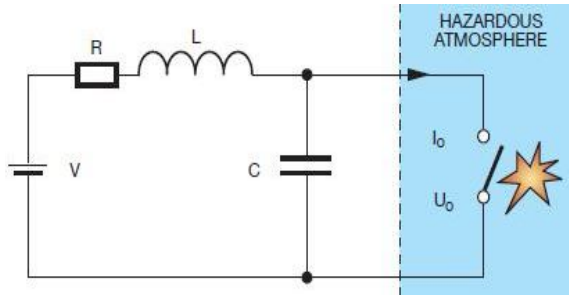
Methods of Protection – Explosion Proof





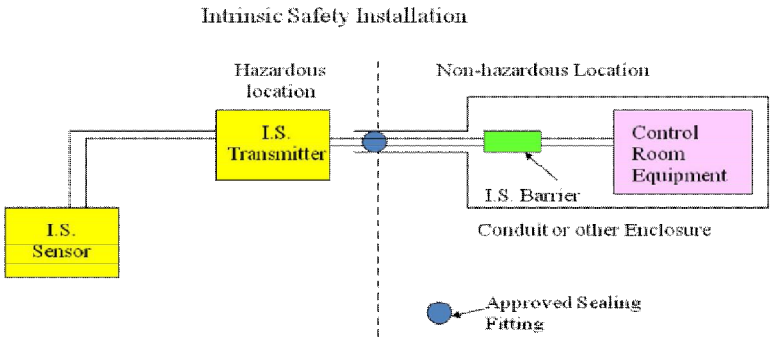
This protection method is based on the explosion containment concept. In this case, the energy source is permitted to come in contact with the dangerous air/gas mixture. Consequently, the explosion is allowed to take place, but it must remain confined in an enclosure built to resist the excess pressure created by an internal explosion, thus impeding the propagation to the surrounding atmosphere.

Methods of Protection – Intrinsically Safe



Schematic of an intrinsically safe circuit

An intrinsically safe circuit is virtually incapable of generating arcs, sparks or thermal effects that are able to ignite an explosion of an explosive atmosphere, both during normal operation and during specific fault conditions



A typical wiring and installation method followed for Intrinsically safe system

Methods of Protection – Comparison

	Safety	Flexibility	Cost of Installation	Cost of Maintenance
Intrinsic Safety	Better	Better	Less	Less
Explosion-proof	=	=	=	=
Purging, or Pressurization	Better	Better	More or Less	Equal

The explosion-proof protection method is the most widely known and has been used in applications for the longest period of time. However, it is generally seen that the intrinsic safety protection method is safer, more flexible and costs less to install and maintain.

Scope of Implementation in Power Plant

1. **Fuel Gas System** - Includes gas receiving station, gas analyzer system, gas compressor station, main shut-off valve, gas relief points, filter and scrubber station, gas pre-heater, gas control valve block, gas safety relief valve, gas flow metering, gas distribution piping, and turbine auxiliaries equipment/compartment.
2. **Ignition Gas System** - Includes propane gas cylinders, piping to ignition burner and combustor, and gas relief points.
3. **Fuel Oil System** -Includes fuel oil tanks, fuel oil unloading and forwarding pump station, fuel oil treatment system, fuel oil metering, fuel oil booster pump and leakage tank, fuel oil control valve block, and fuel oil piping to burners. The fuel oil becomes flammable when heated above its flash point.
4. **Hydrogen Generation Plant**- Electrolyzer , Dryers, and purifier.
5. **Hydrogen Gas for Generator Cooling System** - Includes hydrogen generation plant, hydrogen gas cylinder station, gas unit, seal oil unit, control cubicle, and piping.
6. **Plant Battery System** - Includes battery rooms.
7. **Ammonia System** - Includes storage tanks, pumps, and diked areas.

Scope of Implementation - Fuel Gas

Hazardous Material	Process Equipment	Location/ Ventilation	Source of Leakage	Area class/Division/Group/ AIT	Extent of Classified Area from Leakage Source (NFPA 497)
Fuel Gas (Natural Gas)	Gas Receiving Station	Outdoor / Natural	Possible release due to meters, flange gaskets, or valve	I/2/D/457 C	Within 15 ft in all directions from leakage point
Fuel Gas (Natural Gas)	Gas Compressor Station	If not enclosed/ Natural & If enclosed/ Artificial Forced	Possible release due to meters, flange gaskets, or valve seal	I/2/D/ 457 C	Within 15 ft in all directions & Entire Enclosure
Fuel Gas (Natural Gas)	Safety Valve Gas Relief Point(s)	Outdoor / Natural	Possible release due to overpressure in the system	I/1/D/ 457 C & I/2/D/ 457 C	Within 15 ft in all directions from a release point
Fuel Gas (Natural Gas)	Gas Filter/ Separator & Preheater Station	Outdoor / Natural	Possible release due to meters, flange gaskets, or valve seals	I/2/D/ 457 C	Within 15 ft in all directions from leakage point
Fuel Gas (Natural Gas)	Gas Control Valve Module	Packaged Enclosure / Adequately Ventilated	Possible release due at meters, flange gaskets, or valve seal, or door seals	I/2/D/ 457 C	Entire Enclosure or Building

Scope of Implementation - Fuel Gas Contd.

Hazardous Material	Process Equipment	Location/ Ventilation	Source of Leakage	Area class/Division/Group /AIT	Extent of Classified Area from Leakage Source (NFPA 497)
Fuel Gas (Natural Gas)	Gas Control Valve Module Relief Point	Gas Turbine Building/ Enclosure Roof	Exhaust Vent	I/1/D/457 C	Within 18 ft radius from vent and 3 ft vertical from vent
Fuel Gas (Natural Gas)	(HRSG) Supplemental Gas-Firing Duct Burner System	Outdoor / Natural	Possible release due to failure at flange gaskets or valve seal (abnormal)	I/1/D/457 C	15 ft radius from burner front, valve, and connections to burner grids
Fuel Gas (Natural Gas)	Fuel Gas Drain Tank	Outdoor / Natural (Above Ground)	Possible release due to failure at valve seal (abnormal)	I/1/D/457 C & I/2/D/ 457 C	Within 5 ft radius from relief valve and 10 ft radius from vent or relief valve
Fuel Gas (Natural Gas)	Fuel Gas Drain Tank	Outdoor / Natural (Under Ground)	Possible release due to failure at instruments, flange gaskets, or valve seal	I/1/D/ 457 C & I/2/D/ 457 C	Within 5 ft radius from relief valve and 15 ft radius all around

Scope of Implementation - Fuel Oil

Hazardous Material	Process Equipment	Location/ Ventilation	Source of Leakage	Area class/Division/ Group/AIT	Extent of Classified Area from Leakage Source (NFPA 497)
Fuel Oil	Fuel Oil Unloading & Pump Station	Outdoor Oil Unloading Shelter/ Natural	Possible release due to failure at oil transfer pipe coupling at the oil delivery truck	I/2/D/ 257 C	3 ft from the edge of the device extending in all directions and up to 18 inches above floor or grade level extending to a distance of 10 ft horizontally
Fuel Oil	Fuel Oil Tank	Outdoor Oil Tank Farm / Natural	Possible release of gas vapor from vent and sample points	I/1/D/ 257 C & I/2/D/ 257 C	Inside tank and within 5 ft in all directions from a point of discharge Beyond 5 ft but within 10 ft in all directions from a point of discharge
Fuel Oil	Fuel Oil Forwarding Station	Oil Tank Farm Area/ Adequately Ventilated	Possible release due to failure at valve seal (abnormal)	Non-classified if handled at less than the flash point temperature & I/2/D if handled at greater than the flash point temperature	Entire Compartment / Enclosure
Fuel Oil	Fuel Oil Control Valve Block	Turbine Auxiliary Equipment Compartment / Adequately Ventilated	Possible release due to failure at valve seal (abnormal)		Entire Compartment /Enclosure

Scope of Implementation – Ignition & H2 Gas

Hazardous Material	Process Equipment	Location/ Ventilation	Source of Leakage	Area class/Division/Group/AIT	Extent of Classified Area from Leakage Source (NFPA 497)
Ignition Gas (Propane Gas)	Ignition Gas Cabinet	Turbine Auxiliary Equipment Area	Possible release due to failure at valve seal (abnormal)	I/2/D/ 450 C	Entire Cabinet
Hydrogen Gas	Hydrogen Plant	Electrolyzer, Liquid separator, Purifier and Drier / Enclosed Roof	Possible release due to failure of valve seal, gaskets, vents and sample point.	I/2/B/520 C	Within 15 ft in all directions from a point of discharge
Hydrogen Gas	Hydrogen Gas Storage Cylinders	Outdoors / Natural	Possible release from valve packing, flange gasket, and relief valves vented or system overpressure	I/2/B/520 C	Within 15 ft in all directions from a point of discharge
Hydrogen Gas	Hydrogen Manifold Equipment	Under Turbine Generator (TG) Pedestal – Open Bay / Adequately Ventilated	Possible release due to leaks in screwed joints	I/2/B/520 C	15 ft horizontal and vertical radius from leak source

Scope of Implementation –H2 & Ammonia Gas

Hazardous Material	Process Equipment	Location/ Ventilation	Source of Leakage	Area class/Division/Group/AIT	Extent of Classified Area from Leakage Source (NFPA 497)
Hydrogen Gas	Hydrogen Cooled Generator	Turbine Building /Adequately Ventilated	Hydrogen oil seals	I/2/B/520 C	Within 5 ft in all directions from a point of Leakage source
Hydrogen Gas	Hydrogen Seal Oil Unit		Possible release due to failure at meters, flange gaskets, or valve seals	I/2/B/520 C	
Hydrogen Gas	Hydrogen Gas Relief Points/Seal Units	Outdoor Above TG Building Roof	Gas Vents	I/1/B/520 C	Within 1\5 ft in all directions from a point of Leakage
Hydrogen Gas	Plant Direct Current System Batteries	Battery Room/Adequately ventilated	Hydrogen gas during battery charging cycle. Failure of continuously operated Exhaust Fan	Non-Classified	Exhaust fan failure alarm to DCS
Anhydrous Ammonia	Tank and Vaporizer	Outdoor Storage Tank and Diked Area	Ammonia concentration in air are not likely to exceed 16% by volume	Non-Classified	Ammonia detection alarm to DCS

Implementation by Lanco – Power project

Lanco has implemented Electrical and Instrumentation devices as per area classification in Solar Power Project – Solar Panel Manufacturing Facility (Polysilicon plant)

This facility is having mixed solutions approach with Explosion proof as well Intrinsic safety. Some salient figures are represented below.

- **800 Nos : Intrinsically Safe PTs/DPTs/LTs**
- **300 Nos : Intrinsically safe TTs**
- **100 Nos : Explosion Proof Coriolis and Metal Tube Flow meters**
- **400 Nos : Intrinsically safe control and on/off valves.**
- **5000 Nos: Intrinsically Safe I/Os along with Safety barriers**
- **100 KM of Intrinsically safe single and multi pair cables**
- **150 Nos: Explosion proof gas detectors**
- **8 Nos. Explosion proof CCTV camera and 50 Nos. PA speakers**
- **200 Explosion proof JB, 15 Purged panels located in classified zone.**

Implementation by Lanco – Power project

With strong focus on the safety of the plant and people, Lanco has identified similar areas which are classified zones in coal and gas based power plants, where there are scope of further strengthening the safety by using proper electrical installation techniques as per the guidelines presented in this paper.

A mixed approach is adopted with explosion proof, intrinsically safe and pruge type solutions being optimally chosen based on cost of installation, maintenance cost and available safety.

A team of experienced professional conduct such exercise at the beginning of both Gas and Coal based power plant, in order to identify any additional equipment or area which has been added specific to that project.

Thanks

SINTROL

Sintrol Dust Monitors

Emission Monitoring Solutions Based on Triboelectric Principle

Karl Ehrström

SINTROL

Dust control with a difference

Contents

- Introduction – Legislation & problems
- Theory – Triboelectric technology
- Technical solutions
- Applications
- Conclusions

Emission Measurement Regulations

Environmental standards are becoming increasingly more stringent and enforced

1995: NTPC Environment Policy

- Proactive approach to environment
- Adoption of latest technologies for continual environmental improvement

2006: National Environment Policy

- Ministry of Environment and Forests passed first major comprehensive environment plan.
- NTPC involved in the drafting of this policy.

2011: All NTPC power stations certified for ISO 14001 and OSHAS 18001

Regulations on environmental control are getting more stringent, not less!

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Dust control with a difference

Today, most people believe opacity is the only option.

- **Challenges:**
  - **Investment costs**
  - **Installation difficulties**
  - **Vibration**
  - **Maintenance interval**
  - **Calibration difficulties**

Triboelectric emission monitors offer an alternative solution.

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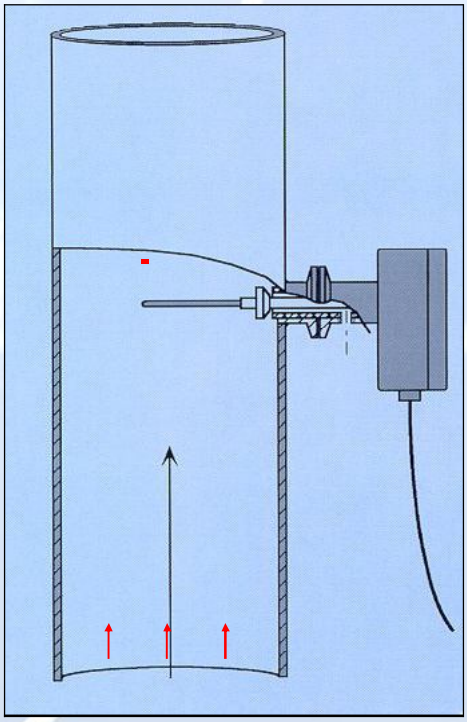
Dust control with a difference

Theory

From Phenomenon to Signal

From phenomenon to signal



Measuring principle

When solid particles impact an isolated metal probe, or pass nearby, they emit charge to the probe

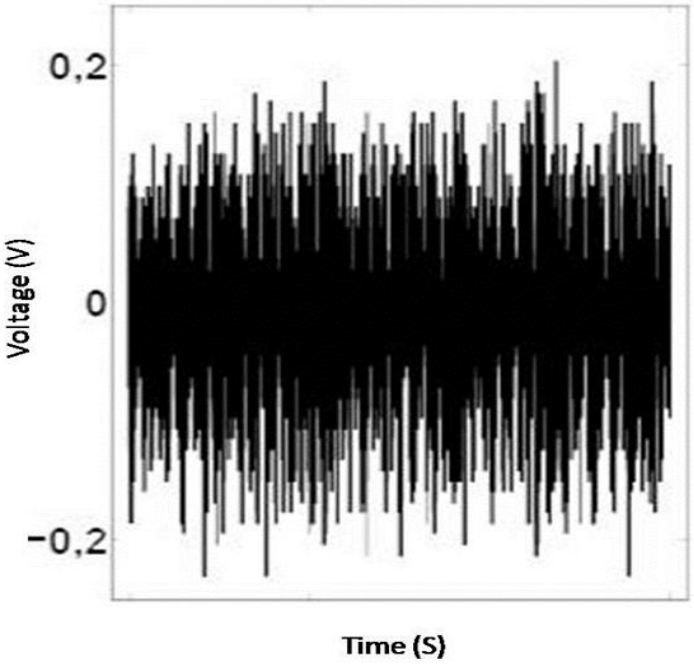
The charge is amplified and converted to an output signal proportional to dust concentration

Evolution of Triboelectric Monitors

- Traditional Triboelectric Monitors (DC based)
  - Output generated thru DC signal
  - Mainly the particles that made contact with the probe would generate signal
  - Created readings that were not accurate and reliable
  - Signal effected greatly by e.g. temperature and velocity changes

- New Generation Monitors (AC based)
  - Output is determined through an analysis of AC and DC signals
  - Monitor receives a signal from both the particles that hit the probe and particles that pass nearby
  - Provides accurate and reliable measurements; complying to EN14181
  - Greatly decreased the effects of changes in temperature drift and velocity changes

From phenomenon to signal

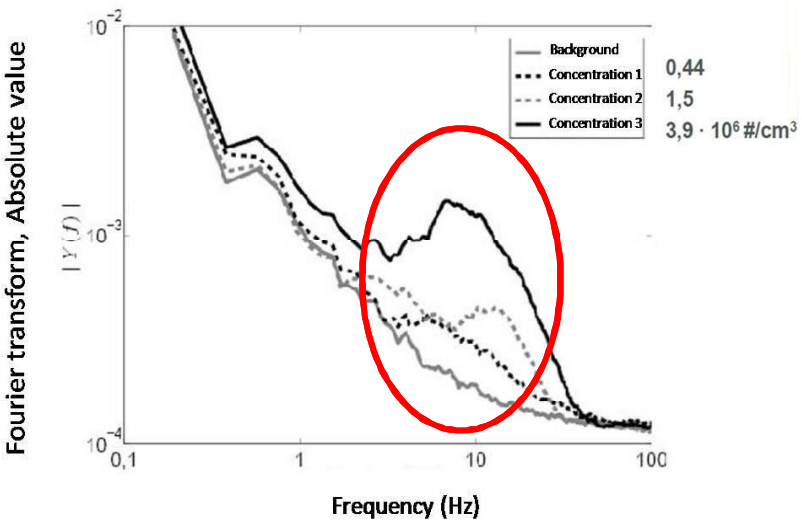


Starting point: Raw signal

- Time spectrum
- Unclear
- A lot of disturbance
- Combination of various frequencies

- Impossible to use as it is
- Signal processing needed

From phenomenon to signal



Step 1: Frequency evaluation

-Transition from time spectrum to the frequency spectrum
- Fourier transform makes this possible.
- Result: Possibility to find out the relevant frequencies for dust monitoring

Step 2: Choosing the correct frequency

- Background signal is devided in all frequencies
- Dust creates a peak at a certain freaquency band

Step 3: Filtration

- Choosing the proper frequency range.
- Result: Spectrum which contains only valuable frequency information.

Step 4: Return to time spectrum

- Inverse Fourier transform
- Result: Time spectrum which contains only information coming from Dust particles.

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Dust control with a difference

Technical

Benefits for use in Heavy Industrial Environments