Installation and Use of a Particulate Matter Sensor for Cartridge Rupture Detection and Predictive Maintenance of an Industrial Filter Unit

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1. Introduction

The filters at Sandvik pneumatically convey metal powders through an atomisation process (Figure 1). These filters can degrade or rupture over time, and maintenance is carried out infrequently, not targeted and time consuming. This can lead to increased emissions and fines. Damaged cartridges can create a hazardous areas. Filter performance is reduced from rupture.
Therefore, a system was required to detect filter breakdown, or rupture before excess particulate is emitted.

2. Aims and Objectives

- Installation of an appropriate sensor technology in a hazardous area.
- PLC interfacing along with appropriate logic to process sensor output data.
- HMI development for operator/maintenance personnel to view data in real time
- Integration of sensor data to site SCADA system for data logging and trend analysis
- PLC, control panel wiring, instrumentation, and cable schedule design drawings, Hazardous Area Descriptive System Document (DSD)
- Development of alarm levels and threshold limits for determining filter rupture.

3. Research

- Electrostatic sensor technology. Operating principle based on the triboelectric effect. [1]
- Laser based particulate sensors [2]
- Hazardous Area ATEX regulation requirements. [3]
- BS EN 60079 – 10 – 2 Classification of Areas: combustible dust atmospheres [4]
- BS EN 60079 – 14: Electrical installations design, selection, and erection [5]
- BS EN IEC 60079 – 25: Intrinsically Safe Electrical Systems [6]

Figure 1. Industrial Filter Unit

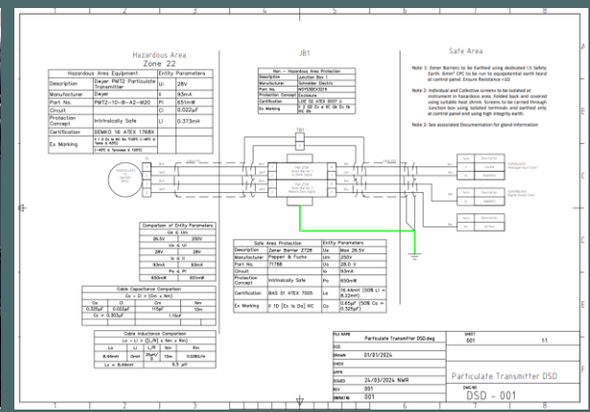

Figure 2. Hazardous Area Circuit Design

Figure 3. Particulate Transmitter

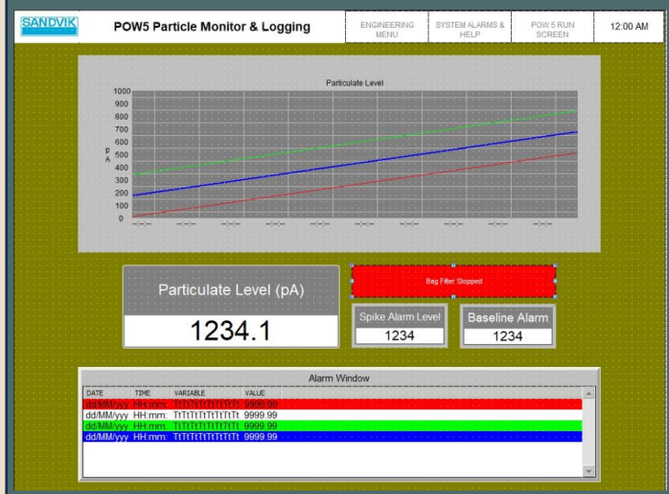

Figure 4. HMI Display

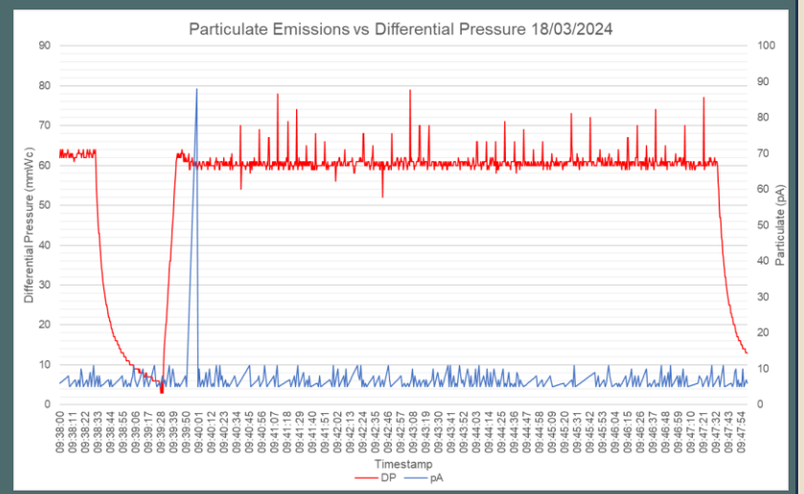

Figure 5. Sensor Output Response

4. Design

- Dwyer PMT2 Electrostatic Probe with 4-20mA output selected. (Figure 3) [7]
- Component selection and Intrinsic safety analysis for the hazardous area (Figure 2)
- PLC logic and alarm settings were configured.
- The HMI design was completed to give information to particulate levels to operators and display alarms (Figure 4)

5. Results

- The overall functionality of the system has achieved the main objectives of the project.
- 166 plant runs monitored, with baseline levels of particulate staying between 5 to 12pA, expected due to relatively new filters.
- Peaks in particulate emissions, during filter startup. (Figure 5)
- Operator HMI displays alarms and trend graph.
- Pulse monitoring not implemented due to filter type. This will be achieved on the next installation.

6. Conclusions & Further Work

- Using galvanic barriers rather than Zener significantly reduces installation complexity
- Reduce instrument range from 1000pA max to 500pA max.
- Install the sensor on an older plant with filters more susceptible to failure, work on this is being carried out.
- Reduce mounting hardware to place electrode on the duct centreline.
- Use the spike and baseline alarms to inhibit filter startup
- Install probes on the inlet to the filter to indicate process losses. May lead to development of yield improvement per run and indicate filter efficiency

References

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[2] Land Ametek, "Opacity and PM Monitoring in Emission Stacks: Application Note," 2009. [Online]. Available: https://www.ametek-land.com/-/media/ameteklandinstruments/documentation/industries/coalpower/ametek_land_opacity_vs_pm_application_note_rev_3_en.pdf. [Accessed 15 10 2023].
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[7] Dwyer Instruments, *"Series PMT2 Particulate Transmitter," FR#444122-00 Datasheet Revision 3,* Michigan City, 2021.