VESDA® VLI by Xtralis™

White Paper

Intelligent Filtration for Aspirating Smoke Detection (ASD)

A Reliable, Cost-effective and Fail-safe Solution for Industrial Applications

Overview

Typically, most industrial applications exhibit relatively high background pollution levels with varying particulate sizes. ASD systems used in these environments must address potential challenges such as nuisance alarms created by the environment, reduced detector life, degradation of smoke sensitivity and be able to provide continuous fail-safe operation. Traditionally, mechanical filtration in ASD systems has long been accepted as the best method to address these challenges. However it comes at a cost and requires a strict maintenance regime thus increasing the total cost of ownership of the smoke detection system.

This white paper introduces a novel technology that combines ASD with intelligent filtration to address the above challenges in a more cost effective manner. It is reliable, available in a single package and above all is a fail-safe method of filtration. With full integration within VESDA VLI – the only ASD product in the market to offer a built-in intelligent filter - it delivers increased value over standard ASD systems and lowest total cost of ownership.

The intelligent filter effectively reduces the level of pollutants from the sampled air before it enters the detection chamber and dramatically extends the detector operational life without compromising its functional integrity. This is achieved by placing the filter in the airflow path before the detection chamber, where it removes a constant proportion of all sizes of airborne particles from the sampled air. It incorporates an innovative airflow splitting and airflow measurement arrangements together with HEPA filtration. The filter is supervised and its loading is constantly monitored using airflow sensors. This enables the detector to intelligently maintain its sensitivity over time.

ASD in Industrial Environments

ASD systems have traditionally been applied in various applications with different environmental conditions. The background levels of airborne particles can vary from one environment to another. For example, in typical industrial applications the air is usually laden with several types of particulates in a larger density, more so than that in an office environment for instance, resulting in higher background pollution. The performance of the ASD system may be compromised in higher background environments, particularly when subjected to prolonged exposure. Examples of industrial applications where high levels of pollution exist are shown in Fig.1 and include paper and textiles mills, processing and manufacturing facilities, coal power stations, mines, steel plants just to name a few. Environmental background pollution can have adverse effects on the smoke detection system resulting in premature failure, compromised performance and increased maintenance requirements.

Generally, in-line filters are used in the ASD pipe network to address this issue where they typically remove particles associated with non-thermal events. In-line filters are based on the principle that dust particles are generally much larger than smoke. Smoke particles may vary in concentration and size depending on the fuel type and combustion conditions. Generally the in-line filter type is chosen according to the type of dust particles present and the type of smoke to be detected in the protected environment. Whilst in-line filters have proven to be effective in addressing high background pollution levels they tend to load over time and will eventually restrict the ASD system airflow. Experience has also shown that loaded in-line filters tend to attenuate smoke long before a reduction in airflow or pressure difference is observed. Therefore regular maintenance and testing is essential to ensure continued reliable performance, which is recommended when in-line filters are used with VESDA detectors.

Operating Principle

The intelligent filter design includes a number of unique and innovative features. As shown in Fig.2, the sampled air entering the detector is measured and then split in to two portions; x% and y%, where x% is much larger than y%. The larger x% portion of the airflow passes through a HEPA filter, which removes all particles from the sampled air resulting in only clean air passing through it. Whereas the smaller y% portion of the airflow passes through the intelligent filter unfiltered. Both x% and y% airflow portions are then recombined, resulting in a much lower particle concentration and hence much lower obscuration than the original sampled air. This effectively reduces the level of pollutants significantly before entering the detection chamber. The total airflow and the unfiltered y% portion of the airflow are measured and their ratio is established in real time. This ratio is equal to the total airflow divided by the unfiltered y% portion of the airflow. This ratio provides a dilution factor which simply represents the dilution of original sampled air when mixed with the clean air. Depending on the dilution factor, the detector intelligently maintains its sensitivity accordingly ensuring consistent and reliable operation over time. The intelligent filter is inherently fail-safe because as its loading increases over time, it effectively allows more smoke in the unfiltered path, hence increasing smoke concentration in the sampled air entering the detection chamber for analysis (i.e. the intelligent filter never blocks). Of equal importance, the intelligent filter generates a maintenance alert when filter replacement is necessary, thus providing a deterministic maintenance regime.

Fig.1

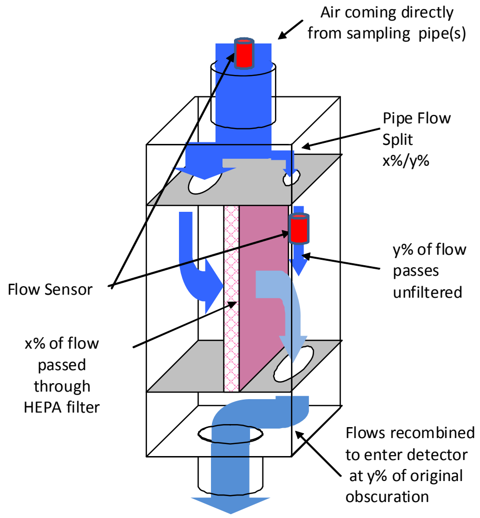


Fig.2

Intelligent Filter in VLI

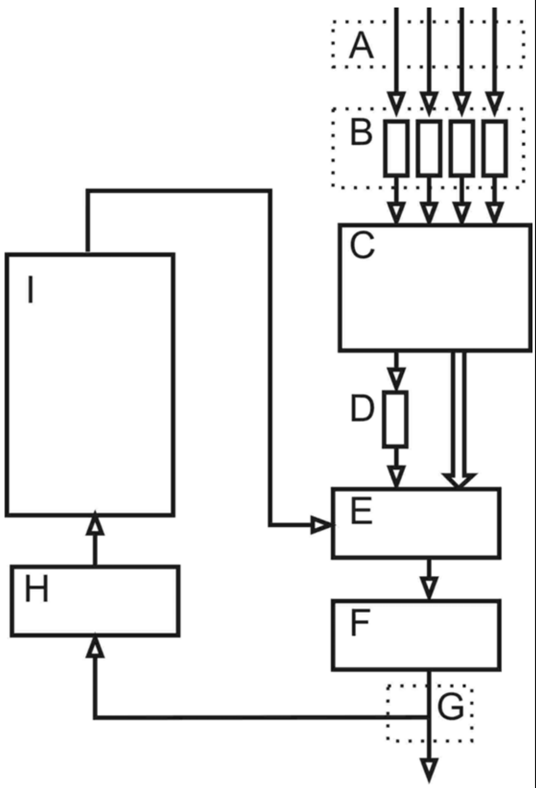
The intelligent filter implementation is best illustrated through its integration in the VESDA VLI detector and with reference to Fig.3. VLI continually samples the air from the protected area via a sampling pipe network (A). Upon entering the detector, the air passes through four ultrasonic airflow sensors (B), then through the intelligent filter (C), where it is split in two pathways. One pathway carries a small portion of the sampled air through a separate ultrasonic airflow sensor (D), while the majority of the sampled air passes through a HEPA filter housed within the intelligent filter. The sampled air then recombines in the manifold (E) and is then passed through to the main aspirator (F). The majority of the sampled air exiting the aspirator is exhausted out of the detector.

A portion of the recombined sampled air is then passed through a sub-sampling probe (G) and secondary foam filter (H). As larger dust particles are unable to pass through the sub-sampling probe and the secondary filter, they are exhausted out of the detector. The net effect of this is safeguarding against nuisance alarms caused by the larger dust particles and other contaminants together with extending the life of the main aspirator (F) and the detection chamber (I). Internal to the detection chamber assembly, a tertiary clean air filter provides clean air to form clean air barriers which protect the optical surfaces from contamination.

The intelligent filter is constantly monitored for loading using the ultrasonic airflow sensor in the unfiltered path (D). The arrangement of the four ultrasonic airflow sensors at the detector air inlets (B) and the separate ultrasonic airflow sensor in the unfiltered path (D) allows the detector to measure the split of the airflow ratio within the intelligent filter and hence determine the dilution factor. When smoke passes through the detection chamber (I), it creates light scatter which is detected by the sensor circuitry. The sampled air is measured, and the detector reports smoke levels according to the dilution factor determined by the airflow sensors (B and D). Air is exhausted from the detector and may be vented back into the protected area. The detector maintains its sensitivity proportionally in line with the dilution factor, thus ensuring consistent and reliable operation.

Industrial environments have a continuous presence of contaminants in the sampled air, causing loading of the HEPA filter used within the intelligent filter (C), which in turn changes the dilution factor over time as determined by the airflow sensors (B and D). Typically, for a well-maintained pipe network, the airflow through the pipe inlets (B) remains relatively constant, whereas the airflow through the unfiltered path (D) increases with an increase of the HEPA filter loading. The increased unfiltered airflow (D) provides a fail-safe operation as smoke concentration through the detection chamber (I) is guaranteed to increase.

VLI further safe-guards against nuisance alarms through an operator controlled clean air zero function. This feature introduces clean air into the detection chamber through an internal mechanism followed by taking a reading of the chamber background. This in-field clean air reading is then offset against the actual smoke readings, to further safeguard against nuisance alarms and maintain absolute smoke detection consistently.



A	Pipe Inlets
B	Ultrasonic flow sensors
C	Intelligent filter
D	Ultrasonic flow sensors
E	Manifold
F	Aspirator
G	Sampling probe
H	Secondary filter
I	Detection chamber

Fig.3

Performance

The VLI intelligent filter uses a MEGALAM MX HEPA filter, which provides low pressure drop, higher airflow rate, longer operating life and guaranteed operation over the specified VLI sampled air temperature (-20^{o}C to 60^{o}C, -4^{o}F to 140^{o}F).

Fig.4 illustrates the pressure drop across intelligent filter for different airflow rates when used in VLI. Since the pressure drop is very low even at higher airflow rates, the intelligent filter does not impose unnecessary load on system pressure and airflow performance, hence maintaining adequate transport time.

For correct operation of the intelligent filter it is crucial that the HEPA filter within the intelligent filter is highly efficient in removing all pollutants from the sampled air. This includes non-smoke as well as smoke particles which typically range from 0.1um to more than 10um. The efficiency of the HEPA filter is characterised by its ability to remove these particles. Fig.5 shows the efficiency of the MEGALAM MX HEPA filter used in VLI intelligent filter. As shown, it is more than 99% efficient for the shown particle sizes from 0.1um to more than 7.5uM.

The efficiency of HEPA filter determines the accuracy of the dilution factor. With close to 100% efficiency the HEPA filter does not allow any significant particulate matter to pass through it, hence when the filtered and the unfiltered airflow portions are recombined, an accurate determination of the dilution factor is made through an accurate measurement of the airflow ratio. As the HEPA filer loading increases over time, whilst its efficiency is unaffected, the filtered airflow portion reduces and the unfiltered airflow portion increases, which in turn changes the dilution factor, hence allowing the detector to maintain consistent sensitivity.

For a new intelligent filter the typical airflow ratio is 5:1, hence a dilution factor of five (5). This dilution factor reduces as the HEPA filter within the intelligent filter is loaded over time. In the context of VLI, the loading effect is defined as the blocking of the HEPA filter over a period of time and its impact on smoke detection performance. Typical loading of the HEPA filter within the intelligent filter and its effect on the dilution factor is shown in Fig.6. It demonstrates a reduction in the dilution factor when continuously exposed to background level of 0.05%obs/m (0.015%obs/ft), which is typical of many industrial applications. As seen in Fig.6, at this background level it has been proven through empirical testing that the dilution factor will reduce to three (3) from five (5) in two (2) years. A dilution factor of three (3) is a typical value when filter replacement is required. Similarly, through empirical testing, it has been proven that at a dilution factor of three (3) the overall effect on detector pressure and airflow is within the detector airflow fault thresholds. This demonstrates that the loading of the intelligent filter down to a dilution factor of three (3) does not impact transport time or smoke detection performance. Also combining the dilution factor with smoke hours VLI automatically raises a maintenance alert to replace the intelligent filter, hence providing predictive maintenance.

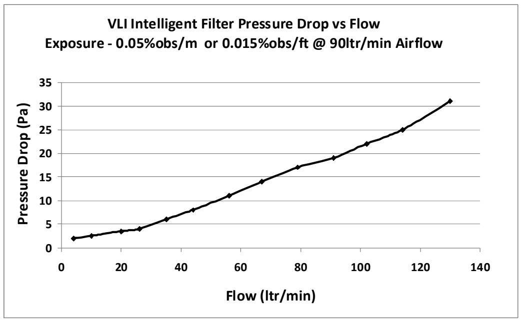


Fig.4

Size[um]	Concentration [Particles/L]		Efficiency
	Before	After	
0.100-0.120	161350	904	99.44%
0.120-0.150	237354	1493	99.37%
0.150-0.200	324553	2550	99.21%
0.200-0.250	284970	2363	99.17%
0.250-0.350	444915	3795	99.15%
0.350-0.450	372199	2102	99.44%
0.450-0.600	272204	1225	99.55%
0.600-0.750	126084	435	99.65%
0.750-1.000	157159	576	99.63%
1.000-1.500	80105	274	99.66%
1.500-2.000	55371	134	99.76%
2.000-3.000	2892	13	99.55%
3.000-4.500	10	0	100.00%
4.500-6.000	0	0	100.00%
6.000-7.500	0	0	100.00%
7.500+	0	0	100.00%
Total	**2519167**	**15863**	**99.37%**

Fig.5

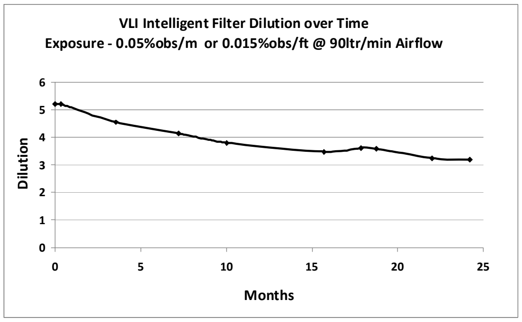


Fig.6

Summary

Very early warning smoke detection in industrial applications requires special attention. Aspirating Smoke Detection (ASD) systems such as VESDA VLI, coupled with intelligent filtration, provide a reliable method of achieving very early warning fire detection at a lower total cost of ownership. Intelligent filtration of the air sample before it passes through the aspirator and detection chamber not only prolongs detector life but also ensures that the detector sensitivity remains unaffected, thereby providing guaranteed and reliable early detection of a fire. The innovative airflow splitting and measurement techniques employed in the intelligent filter maintain absolute smoke detection and ensure consistent performance over time. This paper has outlined the key benefits of employing intelligent filtration in industrial applications. When integrated within the VLI detector it provides a surgical solution that addresses the unique pollution challenges in industrial applications in a cost-effective, reliable and fail-safe manner.

About Us

Xtralis is a leading global provider of powerful, early warning fire detection and security solutions that prevent disasters by giving users time to respond before life, critical infrastructure or business continuity is compromised.

We protect more than 40,000 customer sites in 100 countries, including billions in assets belonging to the world's top governments and businesses.

Our solutions include VESDA® by Xtralis and ICAM™ by Xtralis – flexible fire and gas detection, ADPRO® by Xtralis – outdoor and enterprise security, and ASIM® by Xtralis – traffic detection.

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