

Dust Monitoring Zone Test

Summary

The purpose of this white paper is to provide results derived from testing performed in which a highly stratified stream was introduced into a controlled area. This testing was performed in order to measure the presence of dust particles at varying distances from the sensing rod location, to determine the available scope of the sensing area and the general reliability of Dynamic Induction (“DI”) technology as a measurement tool.

The highly stratified testing results demonstrated that Dynamic Induction™ (“DI”) technology is a more effective tool for monitoring particulate than other available techniques. The results show that a sensor using DI technology can sense particles as they pass near the sensing rod without requiring direct contact with the hardware, providing a much greater monitoring zone than just the width of the rod.

Background

Dynamic Induction™ (“DI”) is a charge based induction technology for monitoring particulate matter (“PM”). The technology senses the voltage induced from particles passing near the probe. Since the technology does not directly monitor the PM mass concentration in the gas stream, site-specific isokinetic sampling data will be required to correlate the sensor’s results to a mass concentration. Site specific conditions can result in different responses.

At this writing it has been utilized in all dust sensor models. These sensors were developed by Dust Company, Inc. (“DustCo”) in partnership with B3 Systems, Inc. (“B3”) to meet the demanding market of dust/particulate monitoring. The Scout is a base model with an analog output and trouble alarm. The Atlas advanced quality assurance (“QA”) with Modbus RTU communications. The Titan is a full featured sensor with advanced QA checks and on-board Modbus RTU and Modbus TCP communications.

Testing Area

In an effort to show the monitoring zone for DI, we needed our testing to meet the following criteria:

- a testing system large enough to fully demonstrate the monitoring zone area
- create a gas stream where the PM concentration would be highly stratified
- PM concentrations to be as consistent as possible during the testing

To meet all of the above criteria, the testing system utilized a 26” ID sheet metal duct that the sensor was mounted to. Cardboard tubes (1-1/2” ID) were stacked and secured inside the metal duct to provide the stratification and the matrix for the results. Each of the tubes were numbered and the coordinates of

the center points recorded. The tubes were placed so that they were approximately two (2) inches away from the Titan sensing probe. The testing system met the first two (2) criteria and was now ready for testing.

The PM feed system took some additional work to obtain a steady feed rate of PM. A line vacuum, driven by compressed air, was used to deliver the PM into each cardboard tube and a small auger feed system was used to feed the PM. But the auger was running at such a slow rate that the auger was only dropping material periodically. Therefore a vibrating tube was devised which took the material discharged from the auger and delivered it to the line vacuum in a very consistent flow rate. The Figure below shows a sketch of the testing system.

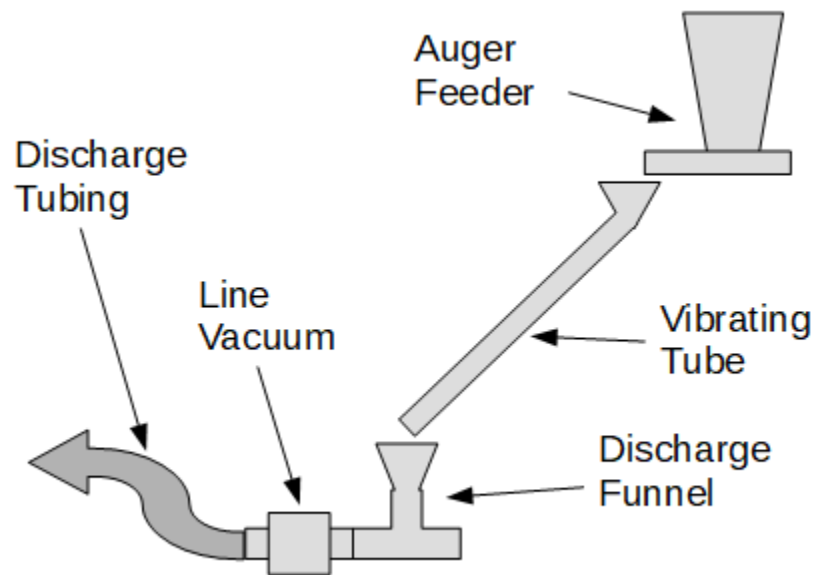


Figure 1: Sketch of PM Delivery System

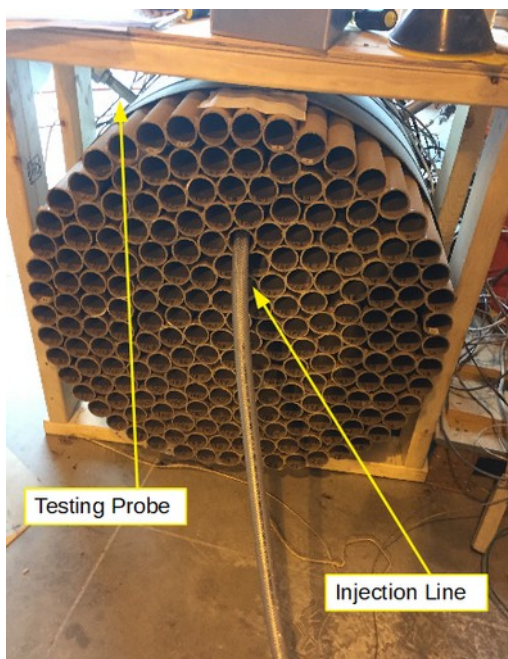


Figure 3: Overview of Testing System

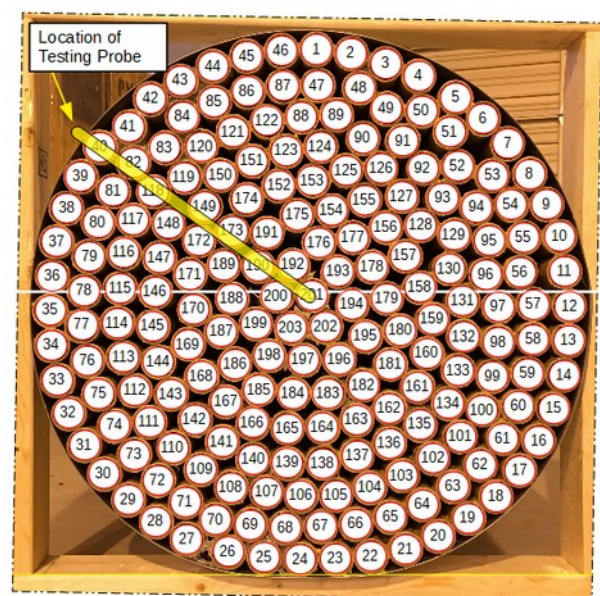


Figure 2: Picture of Numbered Tubes & Sensor Probe Location

It should be noted that the source of PM was baby powder/corn starch purchased from local stores. This material provided several advantages:

- readily available
- consistency (particle size & distribution, particle & bulk densities, flowability, etc.)
- and it did not smell bad (although we were using so little that we could not smell is)

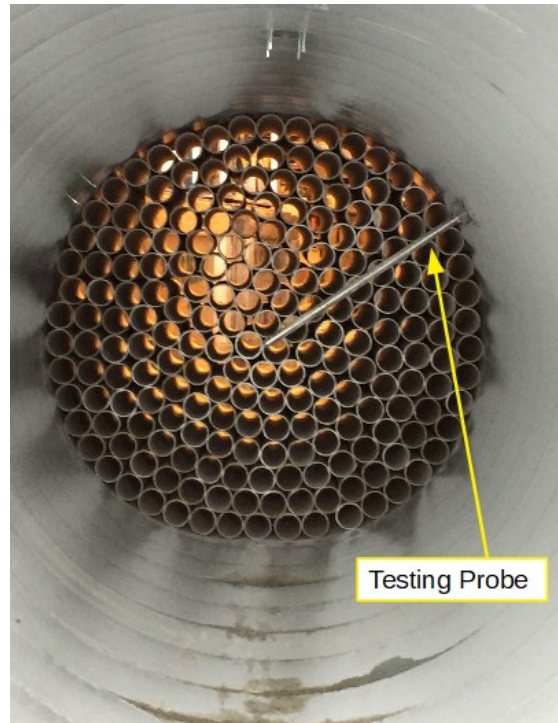


Figure 4: View from inside the testing setup.

Results

Once the testing system was setup and all operations verified, the injection system was placed in a tube for approximately 1 minute. The start and end times for each tube were recorded. When the injection system was removed from a tube, it was held outside the system for 5 – 10 seconds to provide a markers in the data before placing it in the next tube. All dust data was collected at 1-second frequencies by a Sentinel T-1 User interface system. Once the testing was completed, the data was downloaded to a spreadsheet and average values for each tube were created using the last 30 seconds of data for each injection. This data was then compiled for each tube ID and combined with each tube coordinates and the results graphed using gnuPlot.

The following figures provide a visual indication of the signal response and monitoring zone of the Titan's Dynamic Induction technology. Figure 5 provides a view of the side of the rod as if you were looking from the lower-left of the testing platform to the upper right. This view allows you to easily see where the rod ends. The end of the rod does not provide as much surface area for signal induction, therefore the response is reduced.

Figure 6 is a view looking directly at the end of the sensor's rod. This allows you to see that a good signal is detected for large distance either side of the rod. As with all signals, there are transmission losses and therefore less signal reaches the sensing rod. Not all tubes were used for this testing, however we were still detecting dust signals in every tube used. This includes the ones on the very edge and off the end of the rod. There was never a non-detected reading from any tube.

Both Figures 5 & 6 are represented in Figure 7 & 8. Figure 7 is a map view of the signal response with iso-signal lines added. Figure 8 has the signal response map overlaid with the testing tubes.

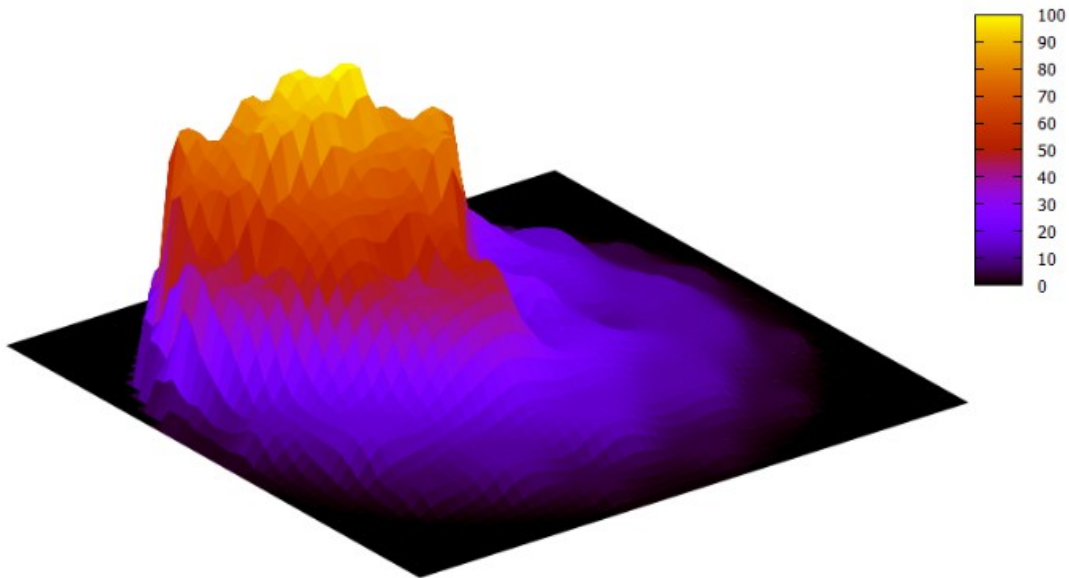


Figure 5: Signal Response looking at the side of the rod

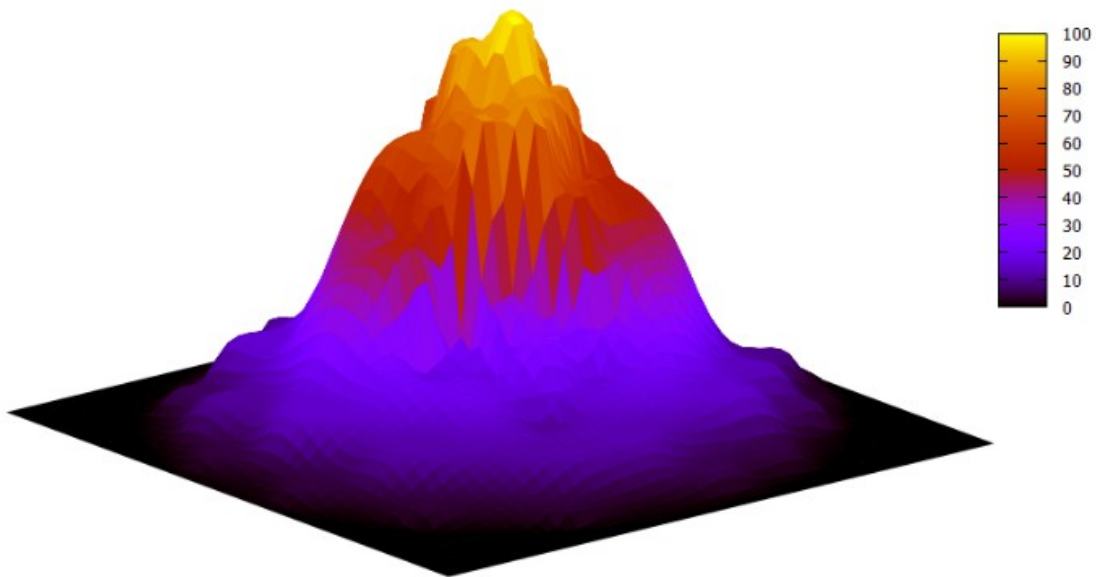


Figure 6: Signal Response looking directly at the end of the rod

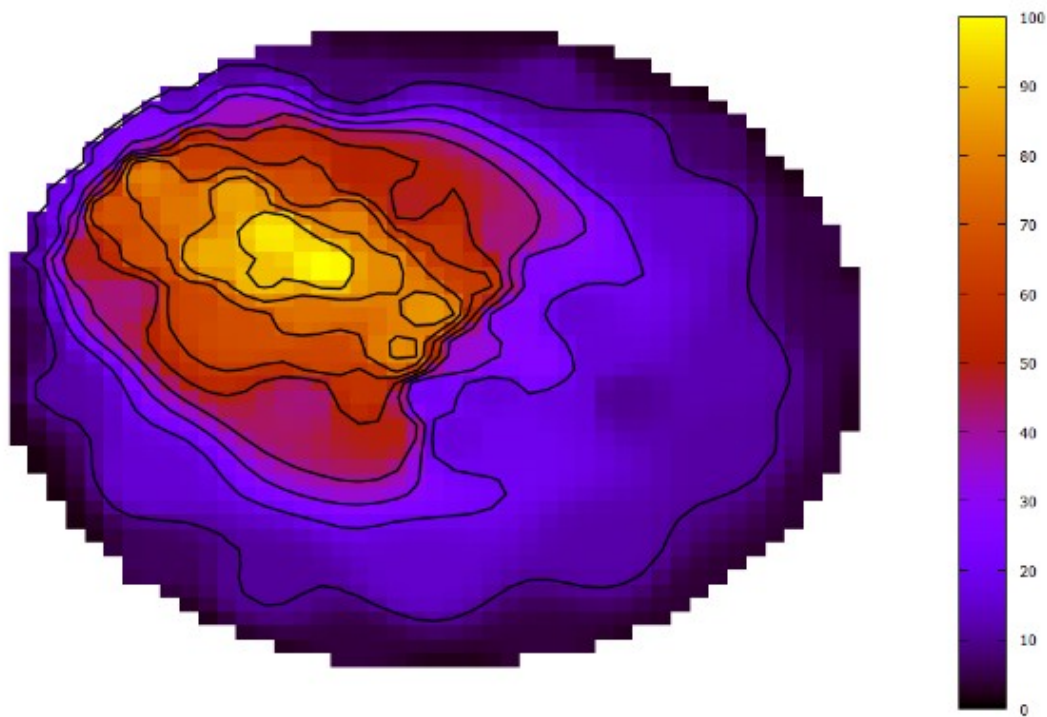


Figure 7: Signal Response with iso lines

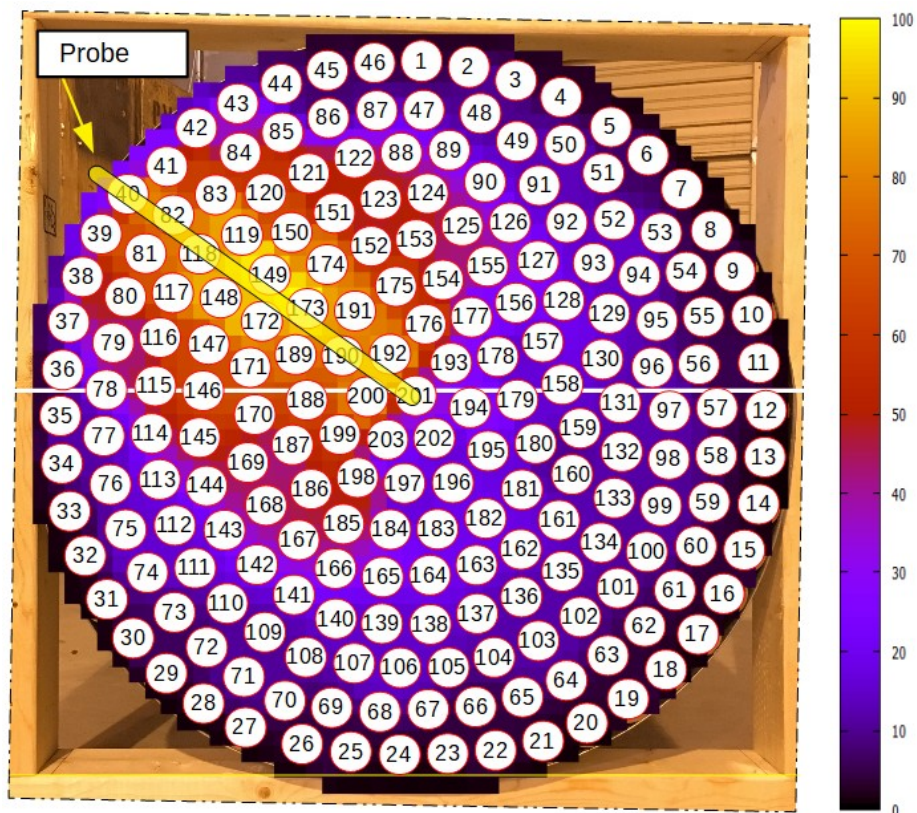


Figure 8: Signal Response overlaying the testing matrix