Response of Inexpensive Particulate Matter Sensors Following Aerosol Exposure and Sensor Cleaning

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Background

The use of inexpensive sensors to assess airborne concentrations of particulate matter (PM) in the workplace has become more popular due to their ability to rapidly provide data over potentially broader areas and time periods when compared to traditional devices. Little is known about how these sensors respond after being used in environments with high PM concentrations.

Objectives

- Evaluate effect of aerosol exposure in both a field and laboratory setting on the response of active and passive inexpensive PM sensors to zero air
- Evaluate if cleaning may lead to response recovery

Methods

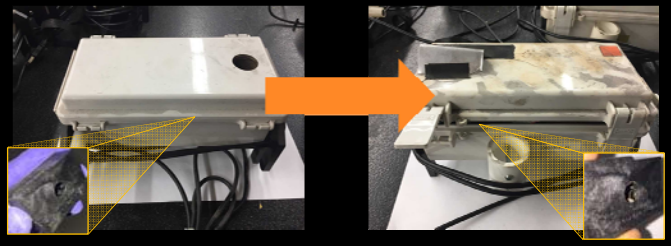
Sensor Exposure

1. Place previously unused passive (Sharp GP, $12, Sharp Electronics) and active (Sharp DN, $21, Sharp Electronics) PM sensors in inexpensive hazard monitors
2. Expose three passive and two active sensors to PM from welding and machining of metal parts in a facility over time periods ranging from four months to two months
3. Expose additional three passive and three active sensors to fine test dust aerosolized in a laboratory chamber
4. Measure cumulative mass concentration by time that sensors were exposed to using filter-corrected data from a pDR-1000 (Thermo Fisher Scientific) for field sensors and gravimetric measurements for laboratory sensors

Sensor Cleaning

- Clean all sensors with canned compressed air, then clean interior pieces with alcohol wipes
- Add intermediate cleaning with alcohol wetted q-tip between above steps for laboratory sensors
- Evaluate change in sensor response to zero air within a laboratory chamber

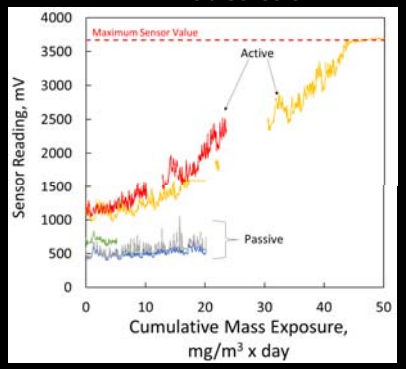
Results



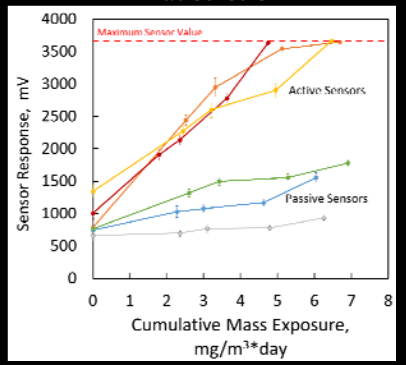
Sensor Exposure

- Active sensors deployed between 2 and 4 months, Laboratory test aerosol generation occurred over 76 minutes
- Response of active and passive sensors to zero air increased with cumulative aerosol exposure
- All active sensors reached maximum response value (3660mV)
- Active sensor response increase occurred more rapidly than passive sensors increase as shown by steeper slope

Field Sensors



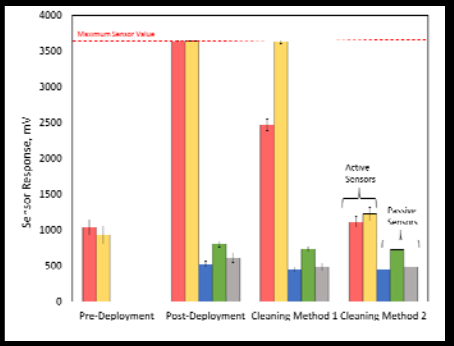
Lab Sensors



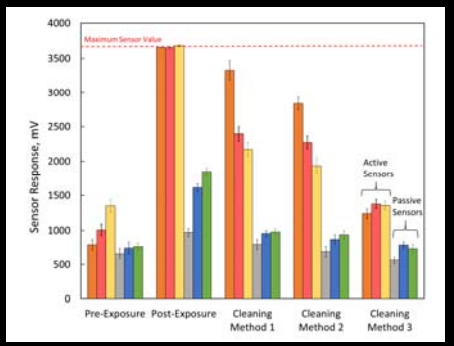
Sensor Cleaning

- 67% drop in active field sensor response to zero air between post-deployment and final clean. 59% drop for active lab sensors over same time. Passive field sensors dropped 15% while lab sensors dropped 51%
- On average, active and passive sensor response after cleaning higher than pre-exposure
- Opening of a sensor leads to change in response itself, may partially explain why the passive sensor response after cleaning was lower than initial pre-exposure response

Field Sensors



Lab Sensors



Conclusions

- Sensor response increase occurs more rapidly for active than passive sensors
- The optics of inexpensive active and passive Sharp PM sensors become dirty over time causing an increase in their response
- Sensor cleaning after exposure resulted in some recovery of response but did not return the response to pre-exposure levels; opening sensor independently affects response

Acknowledgements

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