AQ-SPEC
Air Quality Sensor Performance Evaluation Center

Sensor Description

Manufacturer/Model:
Igienair Zaack AQI

Pollutants:
$PM_{1.0}$ (only analyzed from field evaluation), $PM_{2.5}$, and PM_{10} mass concentration

Time Resolution:
30-sec

Type: Optical

Additional Information

Field evaluation report:

http://www.aqmd.gov/aq-spec/evaluations/field

Lab evaluation report:

http://www.aqmd.gov/aq-spec/evaluations/laboratory

AQ-SPEC website:

http://www.aqmd.gov/aq-spec

Evaluation Summary

- The accuracy of the Zaack AQI sensors for $PM_{2.5}$ was 67.2% to 80.4% and for PM_{10} was 66.1% to 96.6% in the lab. The Zaack AQI sensors underestimated $PM_{2.5}$ and PM_{10} measurements compared to the T640x and overestimated PM_{10} measurements compared to the APS in the lab.
- The Zaack AQI sensors exhibited high precision for all conc., T/RH combinations for $PM_{2.5}$. Precision for PM_{10} mass conc. cannot be determined due to the inherent variability of the test dust used.
- The Zaack AQI sensors showed moderate intra-model variability for $PM_{2.5}$ and PM_{10} in the lab.
- Data recovery in the field was ~ 100% from the two units tested.
- For $PM_{1.0}$, Zaack AQI sensors showed strong correlations with T640 (R^2: 0.78-0.83), moderate to strong correlations for $PM_{2.5}$ and PM_{10} with BAM and T640 from the field; and very strong correlations with the reference instruments in the laboratory studies ($R^2 > 0.97$ for $PM_{2.5}$ and PM_{10}).
- Two of the same Zaack AQI units were tested both in the field (1st stage of testing) and in the laboratory (2nd stage of testing) against reference PM instruments. The PM sensor in the third Zaack AQI unit malfunctioned.
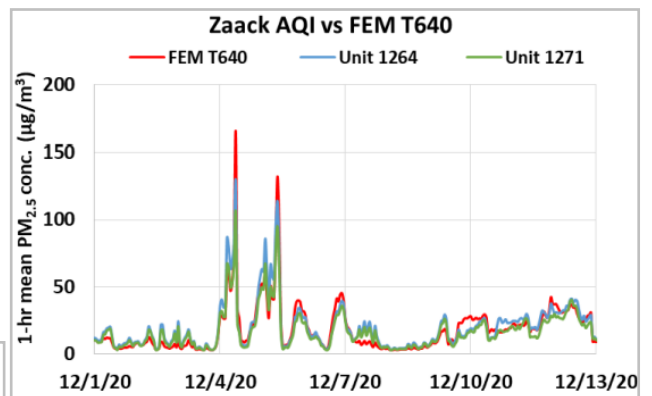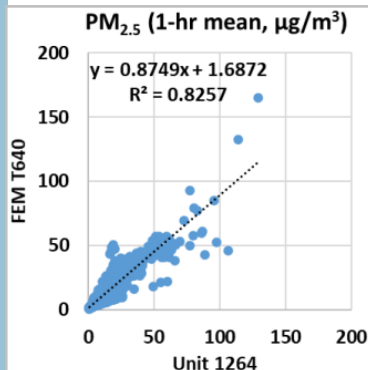
Field Evaluation Highlights

- Deployment period 11/13/2020 - 01/08/2021: the two Zaack AQI sensors showed strong correlations with the $PM_{1.0}$ mass concentration as recorded by T640 and moderate to strong correlations with the corresponding BAM and T640 data for $PM_{2.5}$ and PM_{10} mass conc.

- The units showed data recovery was ~100%.

1-hr mean, all ref. inst.
$PM_{1.0}$: 0.77 < R^2 < 0.83
$PM_{2.5}$: 0.72 < R^2 < 0.83
PM_{10}: 0.69 < R^2 < 0.86

Zaack AQI vs FEM T640

PM$_{2.5}$ (1-hr mean, µg/m³)

$y = 0.8749x + 1.6872$
$R^2 = 0.8257$

Coefficient of Determination (R^2) quantifies how the two sensors followed the $PM_{1.0}$, $PM_{2.5}$, or PM_{10} concentration change by the reference instruments.

An R^2 approaching the value of 1 reflects a near perfect agreement, whereas a value of 0 indicates a complete lack of correlation.

Laboratory Evaluation Highlights

Accuracy (PM$_{2.5}$)

$$A\,(\%) = 100 - \frac{|\bar{X}-\bar{R}|}{\bar{R}} * 100$$

Steady state #	Sensor Mean (µg/m³)	FEM T640x (µg/m³)	Accuracy (%)
1	7.72	11.33	68.1%
2	38.71	50.39	76.8%
3	80.38	100.01	80.4%
4	113.99	145.62	78.3%
5	196.22	291.82	67.2%

Accuracy was evaluated by a concentration ramping experiment at 20 °C and 40%. The sensor's readings at each ramping steady state are compared to the reference instrument.

A negative % means sensors' overestimation by more than two fold. The higher the positive value (close to 100%), the higher the sensor's accuracy.

Precision (PM$_{2.5}$)

100% represents high precision.
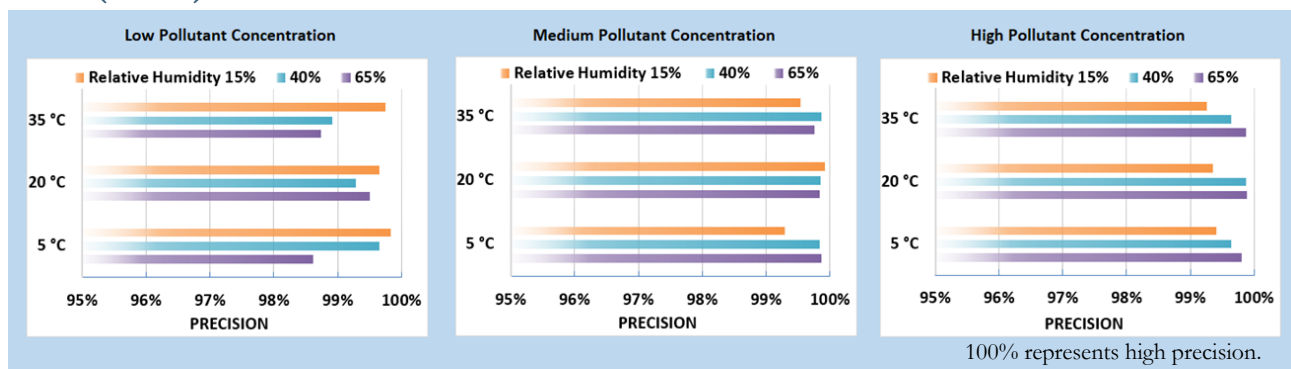
Sensor's ability to generate precise measurements of PM$_{2.5}$ concentration at low, medium, and high pollutant levels were evaluated under 9 combinations of T and RH, including extreme weather conditions like cold and dry (5 °C and 15%) cold and humid (5 °C and 65%), hot and humid (35 °C and 65%), or hot and dry (35 °C and 15%).

Coefficient of Determination
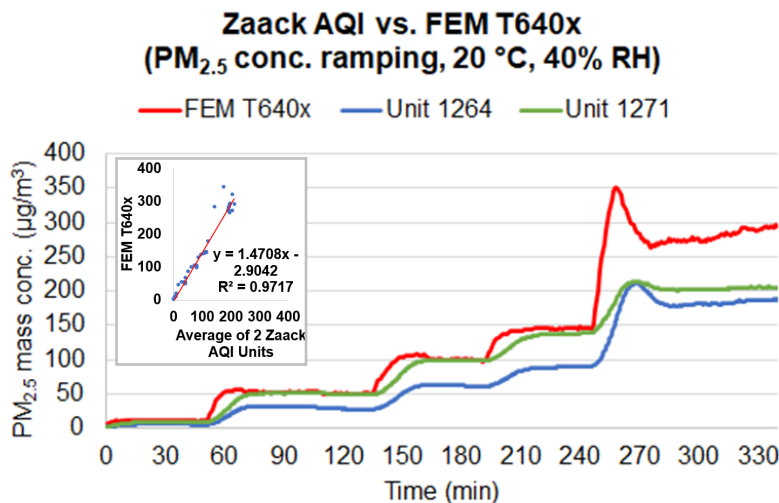
The Zaack AQI sensors showed very strong correlations with the corresponding FEM PM$_{2.5}$ data (R² > 0.97) at 20 °C and 40% RH. At the time of testing, the reference monitor did not report PM$_{1.0}$. For conc. ramping experiments of PM$_{10}$, please see the lab report.

Climate Susceptibility

From the laboratory studies, temperature and relative humidity had minimal effect on the Zaack AQI sensors' precision. However, the sensors' response was affected by the temperature and relative humidity.

Observed Interferents

N/A