Laboratory Evaluation

Elitech Temtop P20

DRAFT

South Coast AQMD

AQ-SPEC
Air Quality Sensor Performance Evaluation Center

Background

Three **Elitech Temtop P20 (hereinafter Temtop P20)** sensors (unit IDs: Unit 1, Unit 2, Unit 3) were field-tested at the South Coast AQMD Rubidoux fixed ambient monitoring station (08/26/2020 to 10/21/2020) under ambient environmental conditions. Following field testing, Unit 1 was unable store data while powered and was excluded from any laboratory data analysis. The two remaining units (unit IDs: Unit 2 and Unit 3) were evaluated in the South Coast AQMD Sensor Environmental Testing Chamber 2 (SENTEC-2) under controlled artificial aerosol concentration/size range, temperature, and relative humidity.

Temtop P20 (*2 units tested*):
- Particle sensor: optical; non-FEM (PMJG200, Temtop)
- Each unit reports: $PM_{2.5}$ (μg/m^3), Temperature and Relative Humidity
- Unit cost: ~$70
- Time resolution: 5-min
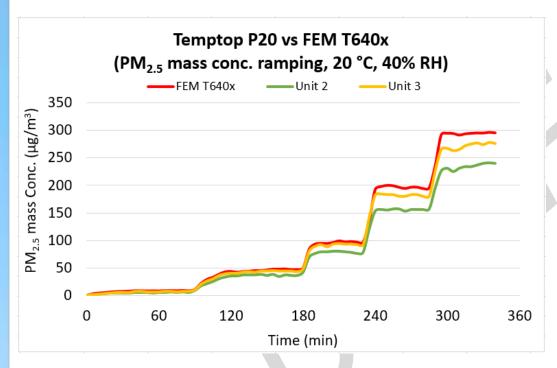- Unit IDs: Unit 1 (excluded from lab tests since it stopped storing data), Unit 2 and Unit 3

T640x (reference method)
- Optical particle counter
- FEM $PM_{2.5}$ and FEM PM_{10}
- Uses proprietary algorithms to calculate total $PM_{1.0}$, $PM_{2.5}$ and PM_{10} mass conc. from particle number measurements
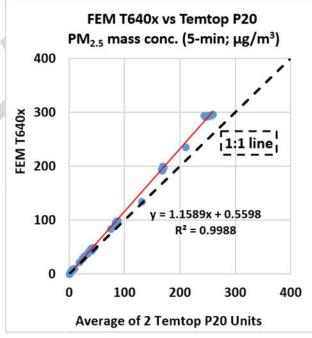- Cost: ~$21,000
- Time resolution: 1-min

Temtop P20 vs FEM T640x (PM$_{2.5}$)

Coefficient of Determination

Temtop P20 vs FEM T640x
(PM$_{2.5}$ mass conc. ramping, 20 °C, 40% RH)

FEM T640x vs Temtop P20
PM$_{2.5}$ mass conc. (5-min; µg/m^3)

$y = 1.1589x + 0.5598$
$R^2 = 0.9988$

1:1 line

- The Temtop P20 sensors tracked well with the concentration variation as recorded by the FEM T640x in the concentration range of 0 - ~300 µg/m^3.

- The Temtop P20 sensors showed very strong correlations with the FEM T640x PM$_{2.5}$ mass conc. ($R^2 > 0.99$)

Temtop P20 vs FEM T640x PM$_{2.5}$ Accuracy

- Accuracy (20 °C and 40% RH)

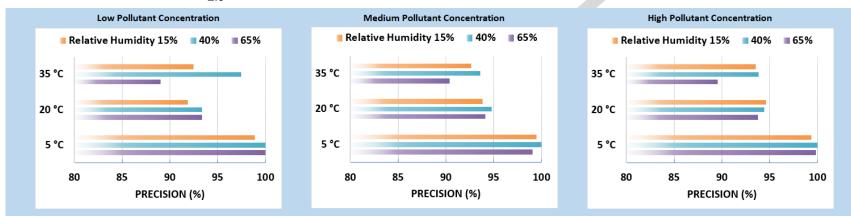| Steady State #	Sensor Mean (μg/m³)	FEM T640x (μg/m³)	Accuracy (%)
1	6.1	9.0	67.7
2	39.8	47.8	83.2
3	85.6	98.2	87.2
4	168.4	196.0	85.9
5	257.0	295.9	86.8

- The Temtop P20 sensors underestimated the measured concentration compared to the FEM T640x PM$_{2.5}$ mass concentration at 20 °C and 40% RH. The Temtop P20 sensors experienced consistently high accuracy (~90%) for all tested PM concentrations compared to the reference T640x for the entirety of test except for the two lowest tested concentrations in which the Temtop P20 sensors had around ~70-80% accuracy compared to reference values.

Temtop P20: Data Recovery and Intra-Model Variability

- Data recovery for PM$_{2.5}$ mass concentrations from both tested units was 100%
- Moderate PM$_{2.5}$ measurement variations were observed between the two Temtop P20 units
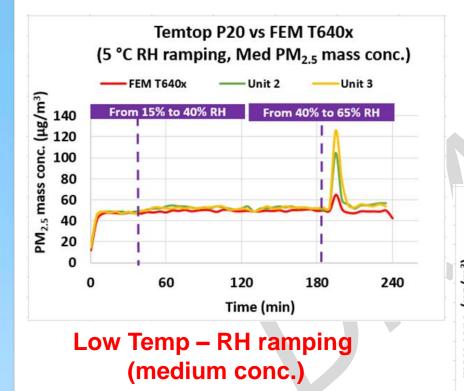
Temtop P20 PM$_{2.5}$: Precision

- Precision (Effect of PM$_{2.5}$ conc., Temperature and Relative Humidity)
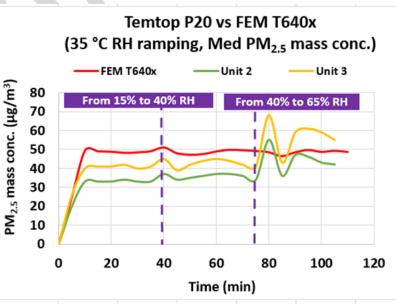

- Overall, the Temtop P20 sensors showed high precision (>~90%) for all the combinations of low, medium and high PM$_{2.5}$ conc., T, and RH.

- Temtop P20 precision is highest during low temperature tests.

Temtop P20 PM$_{2.5}$: Climate Susceptibility

Low Temp – RH ramping
(medium conc.)

High Temp – RH ramping
(medium conc.)

Discussion

- **Accuracy**: The Temtop P20 sensors experienced consistently high accuracy (~90%) for all tested PM concentrations compared to the reference T640x for the entirety of test except for the two lowest tested concentrations in which the Temtop P20 sensors had around ~70-80% accuracy compared to reference values.

- **Precision**: The Temtop P20 sensors showed high precision (>~90%) for all the combinations of low, medium and high $PM_{2.5}$ conc., T, and RH.

- **Intra-model variability**: Moderate intra-model variability was observed among the Temtop P20 sensors.

- **Data Recovery:** Data recovery for $PM_{2.5}$ mass concentration was 100% for all units

- **Coefficient of Determination**: The Temtop P20 sensors showed very strong correlation/linear response with the corresponding FEM T640x $PM_{2.5}$ measurement data ($R^2 > 0.99$).

- **Climate susceptibility**: At higher temperatures, the sensors underestimated the $PM_{2.5}$ concentrations more compared to the coldest temperature; the sensors showed some small spiked concentration changes at RH change points, especially at 65% RH.