

Importance of temperature calibration for the Sunset Laboratory carbon analyzer: NIOSH and IMPROVE temperature protocols

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Abstract

The Sunset Laboratory Dual-Optical Carbon Analyzer, which simultaneously measures transmission and reflectance signals, is widely used in thermal-optical analysis of particulate matter samples. Most often, it is used to measure total carbon (TC), organic carbon (OC), and elemental carbon (EC) fractions, but also the thermal sub-fractions of OC and EC for source identification purposes. Previous studies (1, 2) have showed that the sample (filter) temperature and front oven temperature measured by the thermocouple (setpoint temperature) can differ by 10 to 50 °C. Hence, that temperature disagreement can substantially affect the OC/EC split and further influence the OC and EC concentrations. Since temperature precision in thermal-optical analysis is highly desired, Sunset Laboratory developed a temperature calibration procedure for the temperature sensor built into the front oven of the instrument. That procedure significantly reduced the temperature differences between the setpoint and the sample (filter) temperature, thus providing more confidence in the results. In addition, this method also improves inter-laboratory comparisons. Our experiments thoroughly investigated and clearly showed the need for temperature calibration of each Sunset Carbon Analyzer to obtain more accurate filter temperatures, improve comparability of OC and EC fractions and sub-fractions, and make the method more reliable in source apportionment studies.

Temperature calibrations were performed at NIOSH 5040 and IMPROVE operating conditions to determine the filter/setpoint temperature relationships for both methods. The measured temperatures and the differences between the setpoint and filter temperatures for both methods were investigated. Along with those results, the differences between TC, OC, and EC fractions, as well as OC and EC sub-fractions, before and after temperature calibration for both analysis protocols were also investigated.

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