Evaluation of accuracy of fine particulate matter (PM_{10}) automatic measuring instruments in the air pollution monitoring network

H.H. Kim, S.B. Han, J.Y. Lee, J.B. Park, J.S. Roh, J.S. Jung, and S. Lee

Center for Gas Analysis, Korea Research Institute of Standards and Science, Daejeon 34113, Republic of Korea
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Presenting author email: hhkim@kriss.re.kr

To evaluate the accuracy of fine particulate matter(PM_{10}) automatic measuring instruments in the air pollution monitoring network, a method of evaluation was established through a comparison with results obtained using the standard gravimetric method; the accuracy of PM_{10} automatic measuring instruments was assessed.

More than 90% of PM_{10} automatic measuring instruments in operation under the air pollution monitoring network rely on beta-ray absorption method, while the rest utilize a Tapered Element Oscillating Microbalance method. PM_{10} measuring instruments based on beta-ray absorption are calibrated and assessed using standard films with equivalent values. Because reference materials cannot be created using dust, standard films with equivalent values have been employed as substitutes. This study evaluated the accuracy of PM_{10} measuring instruments, through direct comparisons with results obtained using the gravimetric method,

Three gravimetric-based standard low volume samplers and tested PM_{10} measuring instruments were installed and operated in the test stations. After the first cycle of ten days, measurements obtained from the gravimetric-based standard low volume samplers and PM_{10} measuring instruments were compared and analyzed using linear regression as shown in Fig. 1. Using the results of the first assessment, the gradients and intercepts were analyzed to identify if the instruments were deviating from the standard. Correction factors were applied to such instruments, and measurements were obtained again after a week-long second cycle. A reliability analysis was performed for the PM_{10} measuring instruments in 16 measuring stations over the first and second cycles.

The correction criteria included a gradient of 0.9 – 1.1, an intercept of ±5.0, or an average error rate within 10% of that of gravimetric-based measurements. A comparison of measurements obtained from uncorrected PM_{10} measuring instruments in 16 stations with gravimetric measurements showed that 12 instruments, or 75%, deviated from the standard as shown in Fig. 2. After correcting the instruments and carrying out the second cycle, only three instruments deviated slightly from the standard as shown in Fig. 3.

This study compared measurements obtained using PM_{10} measuring instruments to gravimetric measurements, and found that measurements provided from instruments corrected with standard films had poor reliability.

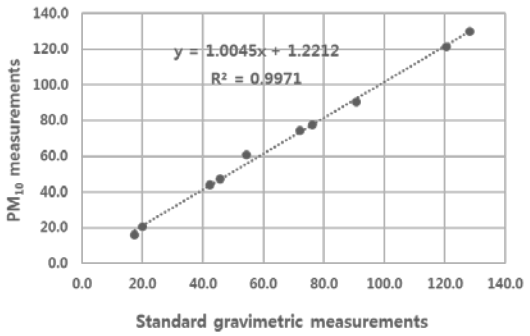

Figure 1. Linear regression result between the gravimetric method versus online PM_{10} measurement

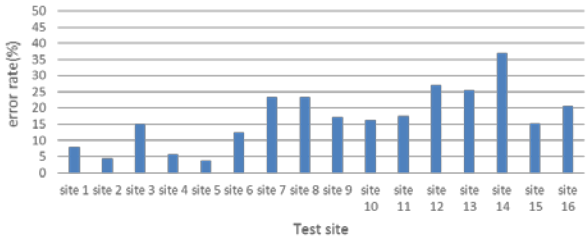

Figure 2. Relative error of online PM_{10} measurement relative to the gravimetric measurement before calibration

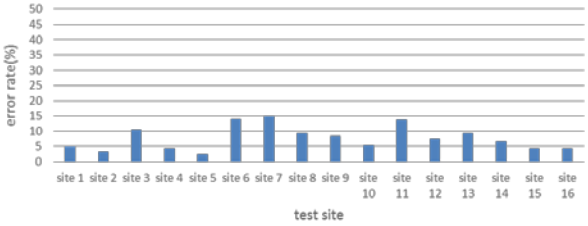

Figure 3. Relative error of online PM_{10} measurement relative to the gravimetric measurement after calibration

These results highlight the need to enhance the reliability of PM_{10} measuring instruments in the air pollution monitoring network using comparisons with the standard gravimetric method.

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EPA, Appendix J to part 50. “Reference method for the determination of particulate matter as PM10 in the Atmosphere.”
ISO 10473, (2000) “Ambient air – Measurement of the mass of particulate matter on a filter medium – Beta-ray absorption method.”