Preparation of high precision standards (with ± 1 ppm) using a gravimetric method for measuring atmospheric oxygen

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About ten years ago, Tohjima et al. developed standards for atmospheric O2 measurements using a gravimetric method, with an uncertainty of O2 amount fraction (mole fraction) of 2.9 ppm (k = 1). In order to make a more accurate measurement of atmospheric O2, we have developed more precise standards using a gravimetric method in accordance with ISO 6142:2001. The uncertainty of O2 mole fraction in the standards developed by Tohjima et al. was caused mainly from the process of determining masses of the source gases, pure N2 and O2, which calculated from the masses of a high pressure cylinder before and after filling it with the source gases. We carefully studied factors of uncertainty for weighing the cylinder using our weighing system, in which a new high-precision balance was recently installed in the system. We confirmed the uncertainty for weighing the cylinders was improved significantly from 2.6 mg to 0.8 mg. We also determined the average atomic masses of nitrogen and oxygen in the source gases by measuring precisely the difference of their isotope ratios from the corresponding atmospheric value using an isotope ratio mass spectrometry. The expanded uncertainties for the standards prepared using the new weighing system and the averaged atomic masses were 1.3−1.6 ppm (k = 2). Residuals from the calibration line for O2 mole fractions in standard gases measured by a paramagnetic O2 analyser were less than ±1 ppm.

References

Y. Tohjima et al., preparation of gravimetric standards for measurements of atmospheric oxygen and reevaluation of atmospheric oxygen concentration, J.G.R, 110, doi:10.1029/2004JD005595, 2005.