Causes of Instability in the Relative Abundance of the Major Constituents of Reference Air in High-Pressure Tanks

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Long-term measurements of $\delta(O_2/N_2)$ and $\delta(Ar/N_2)$ made with an isotope ratio mass spectrometer (IRMS) on a single working tank against a reference tank show variability over time scales ranging from hours to months, creating significant artifacts at the per meg level that impact the overall measurement quality of the system. While some of this variability is a result of instrument performance and drift, the majority of it is due to gas handling issues that cause fractionation of oxygen and argon relative to nitrogen, and to real changes in the relative composition of reference air within the tanks. Previous work has shown that measures such as storing tanks horizontally, keeping them thermally insulated, or equipping them with a diptube reduces the amount of fractionation substantially, though not completely. As part of an ongoing effort to understand the causes of instability in reference tanks, a suite of experiments were conducted to systematically isolate the factors contributing to this instability. These experiments included the use of a thermally-isolated "Y" to direct air from a single tank to two different regulators, the comparison of single- and dual-stage regulators, and different approaches to mechanically mix the air within the tank itself.