

This paper describes an improved method for preparing synthetic gas mixtures of oxygen in artificial air by gravimetry (weighing). The use of a new mass comparator in the automatic weighing system and a thorough uncertainty evaluation allows for a suite of mixtures that have exceptionally low uncertainties. These have been verified with high level analytical methods that show a very good consistency within the suite and with other/previous high level standard mixtures. Nevertheless there are some principal comments and specific issues that need to be revised. I therefore recommend resubmission after major revisions.

#### General comments

The metrics and terminology lack to some extent concordance with international recommendations, standards and good practice. Even if some quantity and unit 'habits' are well established in atmospheric science, they are not to be taken as a role model because they are very often source of misunderstanding and misconception. Some examples are given in the following points:

1. The use of 'mole fraction' as a quantity denomination is depreciated and should be replaced by 'amount (of substance) fraction' or 'molar fraction'. Derived quantities should be defined by quantities and not by units (mole is a unit). Angles can be defined as 'length ratios' and not as 'meter ratios'. A mass fraction is not called gram fraction either. 'Mixing ratio' or 'atomic weight' are established use of quantity denominations but misleading because they mean 'molar fraction' and 'atomic mass' ! Further literature is ISO 80000-9, IUPAC gold book, T. Cvitas, metrologia 2003.
2. The use of the unit ppm for  $\mu\text{mol}/\text{mol}$  is also depreciated because it is not obvious if it is a relative or absolute unit. Please keep  $\mu\text{mol}/\text{mol}$ , it is not that long.
3. The definition of  $\delta$  ( $\text{O}_2/\text{N}_2$ ) in 'per meg' is misleading because it contains the factor  $10^6$  (equations 1 to 4). All indications in 'per meg' are redundant but need a mention of the standard. We would prefer to omit this notation or use it correctly. See also Coplen (DOI: 10.1002/rcm.5129) Note 7 page 2541 and Milton et al. (DOI: 10.1002/rcm.836)

The aspects of pressure dependent adsorption and desorption of analytes inside the pressurised cylinders is not discussed but may be relevant for interpreting results of certain gases (carbon dioxide).

The issue of analytical interference when comparing standards to real air samples is not discussed but may also be relevant (water-issue).

#### Specific comments:

Page 1, line 3: Replace mole fraction by molar fraction (throughout the text)

Page 1, line 4: Correct name Matsumoto

Page 1, line 10: Omit per meg information in the abstract without introduction and replace ppm by  $\mu\text{mol}/\text{mol}$

Page 2 line 2: omit (per meg) and ' $\times 10^6$ ' and in equations 2 to 4)

Page 2 line 24: use linear calibration function instead of calibration line (all instances)

Page 2 line 31: word order: ... have not yet been ...

Page 2 line 33: Replace weight measurement by mass measurement (you indicate mg which is the unit of mass and not N which would be the unit of weight (gravitational force))

Page 3 line 2: ... were validated ...

Page 3 line 26: the expression of 'gravimetric cylinder' is misleading (further instances). In fact it is the cylinder containing the gravimetrically prepared mixture. Be clear in describing the procedure.

Page 3 line 36: ... were traced to the International ...

Page 4 line 14: these may not be ratios of CO<sub>2</sub> to Ar but molar fractions?

Page 6 line 8: ... factors of uncertainty...

Page 6 line 24: Sentence difficult to understand. Please rephrase

Page 12 line 6: Why are the ratios absolute? Is there a convention to reference to AIST

Table 1 last column: the isotope ratios should be expressed as ...= (x.xxx ± y.yyy) ‰

Table 2 is hardly readable. Please rearrange for better reading.

Table 5 title: The indicated numbers represent ratios not fractions

Figure 5 a: The x-axis concerns also Ar/N<sub>2</sub>.