# OIV-MA-AS323-04A2 Total sulphur dioxide

**Type II method**

## 1. Scope

This method is for the determination of total sulphur dioxide in wine and must.

## 2. Definitions

Total sulphur dioxide is defined as the sum of all of the different forms of sulphur dioxide present in the wine in free form or bound to the wine's constituents.

## 3. Principle

Sulphur dioxide is aspirated by a current of air or nitrogen, and is captured and oxidised by bubbling through a dilute and neutral solution of hydrogen peroxide. The sulphuric acid formed is determined by titration with a standard solution of sodium hydroxide.

The total sulphur dioxide is extracted from the wine by aspiration at high temperature (around 100 °C).

## 4. Reagents and products

1. Pure phosphoric acid at 85% ($\rho_{20}$ = 1.71 g/mL) (CAS no. 7664-38-2)

2. Indicator reagent:

Methyl red (CAS no. 493-52-7) 100 mg ( $\pm$ 1 mg)

Methylene blue (CAS no. 7220-79-3): 50 mg ( $\pm$ 0.5 mg)

Ethanol (≥ 95%) (CAS no. 64-17-5): 50 mL

Make up to 100 mL with water for analytical use. Respect the proportions for the volumes that differ from 100 mL.

Commercial indicator reagents with the same composition may be used.

4.3. 1 M Sodium hydroxide (3.84%) or in anhydrous form (pellets) (CAS no. 1310-73-2)

4.4. 0.01 M Sodium hydroxide solution:

*By way of example:* Dilute 10.0 mL of 1 M sodium hydroxide (4.4) in 1 L of water for analytical use.

If necessary, check the titre of the solution regularly (correction factor to be applied) and keep it away from atmospheric $CO_2$.

4.5. Hydrogen peroxide solution in 3 volumes (= 9.1 g/L = 0.27 mol/L $H_2O_2$), prepared or commercial (e.g. 30% $H_2O_2$: mixture with CAS no. 7722-84-1)

*Note*: A solution of 30% by mass corresponds to a titre of 110 volumes ($\rho_{20} \cong$ 1,11 g/mL), implying the volume of oxygen ideally released per litre of $H_2O_2$ under standard conditions of temperature and pressure, while a solution of 3% by mass ($\rho_{20} \cong$ 1 g/mL) corresponds to a titre of 10 volumes (0.89 mol/L). The preparation thus depends on the commercial solution used, considering that in any case the volume used in the method will be in excess.

**5. Apparatus**

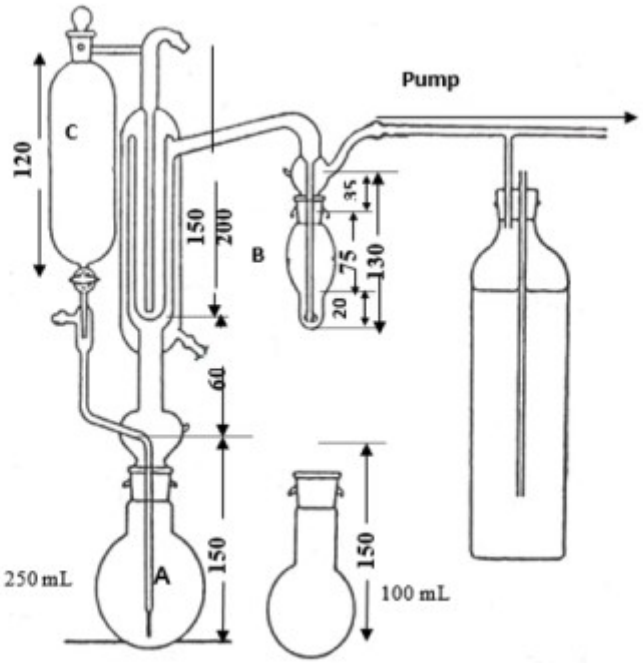
The apparatus to be used should conform to the diagram below, especially with regard to the condenser.

The gas supply tube to bubbler B ends in a small sphere of 1 cm in diameter with 20 holes of 0.2 mm in diameter around its largest horizontal circumference. Alternatively, this tube may end in a sintered glass plate that produces a large number of very small bubbles and thus ensures good contact between the liquid and gaseous phases.

The gas flow through the apparatus should be approximately 40 L/h. The bottle situated on the right of the apparatus is intended to restrict the pressure reduction produced by the water pump to 20-30 cm water. In order to regulate the pressure reduction to achieve the proper flow rate, it is preferable to install a flow meter with a semi-capillary tube between the bubbler and the bottle. For the determination of total sulphur dioxide, using a burner (with a 4-5 cm high flame or infrared) allowing for boiling point to be reached very quickly is preferable. Do not place a wire gauze under flask A, but rather a deflector with a 2-4 cm orifice. The pyrogenation of non-volatile matter in the wine on the flask walls is thus avoided.

Use a 250-mL flask for a 50 mL sample and a 100-150 mL flask for a 20 mL sample.

Figure 1 : The dimensions are indicated in millimetres. The internal diameters of the 4 concentric tubes that make up the condenser are 45, 34, 27 and 10 mm




**6. Procedure**

Air- or nitrogen-rinsing the apparatus before each new determination (e.g. for 5 minutes) is recommended. If a blank test is carried out, the colour of the indicator in the neutralised hydrogen peroxide solution at the exit of the gas-supply tube should not change.

Connect the water from the condenser.

In bubbler B of the entrainment apparatus, introduce 2-3 mL hydrogen peroxide solution (4.5) and 2 drops of indicator reagent (4.2), and neutralise with the 0.01 M sodium hydroxide solution (4.4); a neutral pH = green colour.

*Note*: For large sample series, it is also possible to prepare an already neutralised $H_2O_2$ solution before introducing it into the flask. Adapt the concentrations and volumes accordingly, bearing in mind that the oxidative power of the solution must be maintained (reduced shelf life).

Adapt this bubbler to the apparatus.

Transfer 50 mL of sample to flask A if the presumed total $SO_2$ content in the sample is <50 mg/L, and 20 mL of sample if the presumed total $SO_2$ content is ≥ 50 mg/L and attach it to the apparatus.

Introduce 15 mL of phosphoric acid (4.1) into bulb C if the presumed total $SO_2$ content

of the sample is <50 mg/L and 5 mL phosphoric acid (4.1) if the presumed total $SO_2$ content of the sample is □ 50 mg/L.

Open the tap to add the acid to the sample and activate the heat source, while simultaneously starting the gas flow and setting the timer to 15 minutes. Maintain at boiling point for the duration of the gas flow. The entrained total sulphur dioxide is oxidised into sulphuric acid.

After 15 minutes, turn off the heat source, take bubbler B out, and rinse the gas supply tube (via the socket) with water.

Titrate the acid formed by the 0.01 M sodium hydroxide solution (4.4) up to the green bend.

The number of millilitres used is expressed by *n*.

**7. Calculations and expression of results**

The total sulphur dioxide is expressed in milligrams per litre (mg/L), in whole numbers.

Calculations:

Samples low in sulphur dioxide (50 mL sampling): 6.4 *n*

Other samples (20 mL sampling): 16 *n*

**8. Precision**

8.1. Repeatability (r)

Content < 50 mg/L (50 mL sampling), r = 1 mg/L

Content □ 50 mg/L (20 mL sampling), r = 6 mg/L

8.2. Reproducibility (R)

Content < 50 mg/L (50 mL sampling), R = 9 mg/L

Content □ 50 mg/L (20 mL sampling), R = 15 mg/L

**9. Bibliography**

- Paul, F., *Mitt. Klosterneuburg, Rebe u. Wein,* 1958, ser. A, 821.

**Collaborative study**

**1. Scope of application**

An international collaborative study, in accordance with Resolution OIV-OENO 6-2000, for the validation of updates to the methods for the determination of free sulphur dioxide and total sulphur dioxide (OIV-MA-AS323-04A), based on the decision

of the OIV "Methods of Analysis" Sub-Commission, April 2018.

**2. Standard references**

- Update (draft) to the OIV-MA-AS323-04A methods,
- ISO 5725,
- Resolution OIV-OENO 6-2000.

**3. Protocol**

A total of 20 samples were prepared using homogeneous volumes of 10 wines from various wine regions in France and Portugal. Each sample was made up twice (the second as a blind duplicate), according to the double-blind principle.

The samples were prepared between 18 and 20 June 2018, then shipped without delay to the participating laboratories.

| Sample no. | Blind duplicate no. | Nature of sample |
|---|---|---|
| A | 1-14 | Dry white wine |
| B | 2-16 | Dry white wine |
| C | 3-19 | Dry rosé wine |
| D | 4-12 | Dry rosé wine |
| E | 5-20 | Dry red wine |
| F | 6-18 | Dry red wine |
| G | 7-11 | Dry red wine |
| H | 8-15 | White liqueur wine |
| I | 9-17 | Red liqueur wine |
| J | 10-13 | Red liqueur wine |

The analyses were carried out simultaneously by all participating laboratories between 16 and 20 July 2018. Samples were kept in refrigerated cabinets by all laboratories between the date of reception and the date of analysis, according to the protocols sent.

The following laboratories provided their results:

| Laboratory | City | Country |
|---|---|---|
| Estación de Viticultura e Enoloxía de Galicia | Leiro (Ourense) | Spain |
| Laboratorio arbitral agroalimentario | Madrid | Spain |
| ASAE | Lisbon | Portugal |
| SCL Montpellier | Montpellier Cdex 5 | France |
| HBLA und BA für Wein- und Obstbau | Klosterneuburg | Austria |
| Laboratorio de Salud Pública | Madrid | Spain |
| Laboratorio Agroambiental de Zaragoza | Zaragoza | Spain |
| Laboratoire SCL Bordeaux | Pessac Cedex - CS 98080 | France |
| Unione Italiana Vini Servizi | Verona | Italy |
| Laboratorio Agroalimentario de Valencia | Burjassot (Valencia) | Spain |
| Agroscope | Nyon | Switzerland |
| Laboratoires Dubernet | Montredon des Corbières | France |
| Laboratoire Dioenos Rhône | Orange | France |
| Laboratoire Natoli | Saint Clément de Rivière | France |

NB: The order of laboratories in the table does not correspond with the order in the following tables, in order to preserve the anonymity of results.

**4. Free sulphur dioxide**

4.1. Free $SO_2$ data

| Free $SO_2$ (mg/L) | A | | B | | C | | D | | E | | F | | G | | H | | I | | J | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample | 1 | 14 | 2 | 16 | 3 | 19 | 4 | 12 | 5 | 20 | 6 | 18 | 7 | 11 | 8 | 15 | 9 | 17 | 10 | 13 |
| Labo 3 | | | 31 | 36 | 18 | 18 | 21 | 23 | 20 | 18 | 6 | 6 | 20 | 17 | 5 | 6 | | | | |
| Labo 5 | | | 37 | 35 | 21 | 24 | 24 | 25 | 20 | 20 | 8 | 7 | 20 | 20 | 3 | 4 | | | | |
| Labo 6 | 4 | 1 | 38 | 33 | 21 | 20 | 20 | 26 | 19 | 20 | 7 | 6 | 21 | 19 | 7 | 8 | 1 | 3 | 1 | 1 |
| Labo 7 | 1 | 1 | 37 | 40 | 20 | 22 | 24 | 26 | 20 | 22 | 9 | 8 | 20 | 23 | 8 | 8 | 2 | 1 | 1 | 1 |
| Labo 8 | | | 31 | 32 | 18 | 19 | 23 | 22 | 22 | 20 | 6 | 7 | 19 | 20 | 5 | 3 | 1 | 1 | | |
| Labo 9 | | | 35 | 34 | 23 | 19 | 25 | 24 | 21 | 24 | | | 17 | 17 | | | | | | |
| Labo 10 | 2 | 1 | 35 | 34 | 20 | 21 | 24 | 24 | 22 | 21 | 9 | 8 | 21 | 20 | 7 | 7 | 2 | 2 | 1 | 1 |
| Labo 11 | 0 | 0 | 33 | 30 | 17 | 11 | 22 | 16 | 16 | 21 | 6 | 4 | 15 | 19 | 6 | 3 | 1 | 1 | 0 | 0 |
| Labo 15 | | | 15 | 19 | 15 | 13 | 18 | 20 | 8 | 16 | 6 | 5 | 8 | 15 | 5 | 5 | | | | |
| Labo 17 | 0 | 0 | 37 | 38 | 24 | 26 | 28 | 28 | 26 | 23 | 8 | 8 | 24 | 22 | 7 | 7 | 1 | 2 | 0 | 0 |
| Labo 18 | 0 | 4 | 33 | 31 | 21 | 11 | 23 | 27 | 15 | 19 | 6 | 4 | 9 | 20 | 3 | 4 | 1 | 1 | 0 | 0 |
| Labo 20 | 0 | 0 | 32 | 32 | 20 | 19 | 21 | 21 | 29 | 21 | 8 | 8 | 20 | 18 | 12 | 4 | 1 | 1 | 0 | 0 |
| Labo 21 | 2 | 1 | 33 | 38 | 19 | 15 | 25 | 22 | 19 | 21 | 6 | 6 | 19 | 20 | 8 | 7 | 2 | 1 | 0 | 0 |

Results left blank were rendered non-quantifiable (< limit of quantification).

Result removed by the COCHRAN test at 5%

Result removed by the GRUBBS test at 5%

4.2. Free $SO_2$ results

| Free $SO_2$ (mg/L) | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| No. of laboratories selected | 7 | 9 | 11 | 10 | 10 | 12 | 11 | 11 | 9 | 8 |
| No. of repetitions | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Min. | 0 | 31.5 | 14 | 19 | 17 | 5 | 17 | 3.5 | 1 | 0 |
| Max. | 2.5 | 38.5 | 25 | 28 | 24.5 | 8.5 | 23 | 8 | 2 | 1 |
| Mean | 0.9 | 34.2 | 19.8 | 23.4 | 20.6 | 6.8 | 19.6 | 5.7 | 1.4 | 0.4 |
| Standard deviation | 0.98 | 2.67 | 2.91 | 2.46 | 2.04 | 1.31 | 1.77 | 1.72 | 0.42 | 0.52 |
| Repeatability variance | 0.79 | 1.67 | 2.59 | 1.20 | 2.60 | 0.58 | 2.23 | 0.82 | 0.39 | 0.00 |
| Inter-laboratory standard deviation | 0.98 | 2.67 | 2.91 | 2.46 | 2.04 | 1.31 | 1.77 | 1.72 | 0.42 | 0.52 |
| Reproducibility variance | 1.35 | 7.97 | 9.76 | 6.64 | 5.46 | 2.00 | 4.25 | 3.38 | 0.37 | 0.27 |
| Repeatability standard deviation | 0.89 | 1.29 | 1.61 | 1.10 | 1.61 | 0.76 | 1.49 | 0.90 | 0.62 | 0.00 |
| r limit | 2.48 | 3.61 | 4.51 | 3.07 | 4.51 | 2.14 | 4.18 | 2.53 | 1.75 | 0.00 |
| Repeatability %CV (k=2) | 191 | 8 | 16 | 9 | 16 | 23 | 15 | 32 | 90 | 0 |
| Reproducibility standard deviation | 1.16 | 2.82 | 3.12 | 2.58 | 2.34 | 1.41 | 2.06 | 1.84 | 0.61 | 0.52 |
| R limit | 3.25 | 7.90 | 8.75 | 7.22 | 6.54 | 3.96 | 5.78 | 5.15 | 1.70 | 1.45 |
| Reproducibility %CV (k=2) | 250 | 16 | 32 | 22 | 23 | 42 | 21 | 64 | 87 | 276 |
| Horwitz $PRSD_R$ (%) | 16.18 | 9.40 | 10.21 | 9.95 | 10.15 | 12.00 | 10.22 | 12.30 | 15.23 | 18.55 |
| Horwitz $s_R$ | 0.15 | 3.22 | 2.02 | 2.33 | 2.09 | 0.81 | 2.00 | 0.70 | 0.21 | 0.07 |
| Horwitz R | 0.42 | 9.10 | 5.71 | 6.59 | 5.91 | 2.29 | 5.67 | 1.99 | 0.60 | 0.20 |
| Horwitz Ratio | 7.64 | 0.87 | 1.53 | 1.10 | 1.11 | 1.73 | 1.02 | 2.58 | 2.84 | 7.37 |

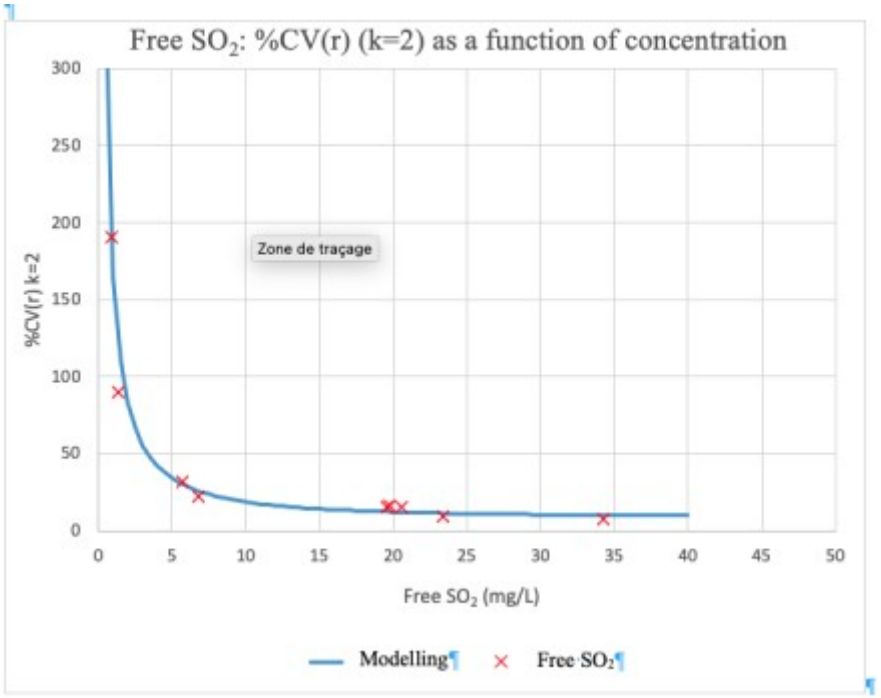



Figure 1: Modelling of the repeatability coefficient of variation, %CV(r) (k=2), as a function of the concentration, C:

$$\%CV(r) = \sqrt{\frac{165.55^2}{C^2} + 9^2}$$

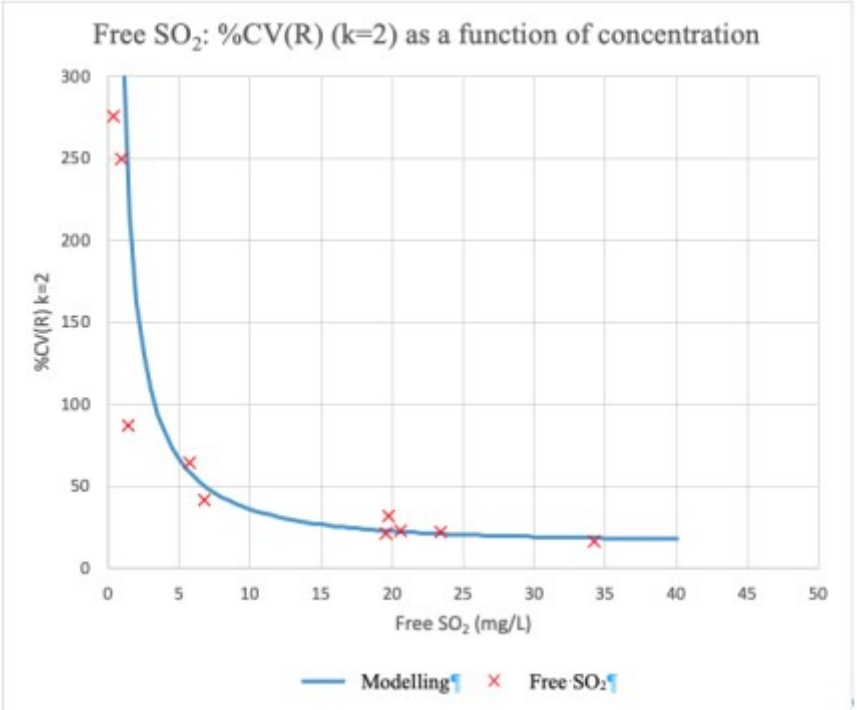



Figure 2: Modelling of the inter-laboratory reproducibility coefficient of variation, %CV(R) (k=2), as a function of concentration, C:

$$\%CV(r) = \sqrt{\frac{323.6^2}{C^2} + 16^2}$$

5. Total sulphur dioxide

5.1. Total $SO_2$ data

| Total $SO_2$ (mg/L) | A | | B | | C | | D | | E | | F | | G | | H | | I | | J | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Sample | 1 | 14 | 2 | 16 | 3 | 19 | 4 | 12 | 5 | 20 | 6 | 18 | 7 | 11 | 8 | 15 | 9 | 17 | 10 | 13 |
| Labo 3 | | | 128 | 127 | 72 | 73 | 128 | 131 | 61 | 59 | 28 | 28 | 57 | 56 | 102 | 102 | 47 | 45 | | |
| Labo 5 | | | 122 | 121 | 68 | 71 | 112 | 114 | 42 | 53 | 22 | 22 | 51 | 42 | 102 | 101 | 35 | 34 | | |
| Labo 6 | | 1 | 128 | 131 | 72 | 72 | 126 | 131 | 53 | 54 | 22 | 20 | 42 | 49 | 98 | 99 | 31 | 34 | 3 | 1 |
| Labo 7 | 3 | 3 | 131 | 131 | 70 | 74 | 130 | 131 | 54 | 59 | 26 | 23 | 46 | 48 | 106 | 101 | 37 | 40 | 1 | 1 |
| Labo 8 | 2 | 1 | 125 | 127 | 72 | 72 | 129 | 128 | 58 | 57 | 22 | 23 | 46 | 45 | 97 | 99 | 42 | 39 | 1 | 1 |

| | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Labo 9 | | | 120 | 128 | 77 | 75 | 132 | 108 | 71 | 59 | 21 | 25 | 44 | 47 | 110 | 99 | 38 | 48 | | |
| Labo 10 | 2 | 2 | 130 | 130 | 74 | 76 | 130 | 130 | 61 | 61 | 28 | 32 | 55 | 56 | 103 | 104 | 43 | 44 | 3 | 4 |
| Labo 11 | 4 | 3 | 119 | 125 | 71 | 74 | 118 | 118 | 39 | 40 | 18 | 21 | 45 | 41 | 89 | 94 | 26 | 38 | 2 | 2 |
| Labo 14 | 3 | 3 | 129 | 128 | 72 | 72 | 127 | 129 | 58 | 58 | 32 | 29 | 50 | 49 | 102 | 101 | 42 | 41 | 3 | 4 |
| Labo 15 | | | 134 | 136 | 76 | 78 | 134 | 136 | 60 | 58 | 39 | 27 | 52 | 61 | 110 | 106 | 51 | 50 | | |
| Labo 17 | 3 | 3 | 134 | 132 | 82 | 76 | 136 | 133 | 59 | 50 | 24 | 23 | 46 | 44 | 107 | 105 | 35 | 38 | 0 | 0 |
| Labo 18 | 5 | 3 | 130 | 129 | 78 | 73 | 133 | 133 | 62 | 59 | 29 | 32 | 58 | 52 | 105 | 105 | 50 | 48 | 2 | 2 |
| Labo 20 | 1 | 1 | 128 | 131 | 72 | 74 | 130 | 130 | 58 | 56 | 26 | 28 | 48 | 45 | 98 | 93 | 41 | 43 | 0 | 0 |
| Labo 21 | | 0 | 124 | 125 | 69 | 72 | 124 | 126 | 45 | 51 | 19 | 20 | 42 | 42 | 97 | 97 | 35 | 34 | 0 | 1 |

Results left blank were rendered non-quantifiable (< limit of quantification).

Result removed by the COCHRAN test at 5%

Result removed by the GRUBBS test at 5%

5.2. Total $SO_2$ results

| Total $SO_2$ (mg/L) | A | B | C | D | E | F | G | H | I | J |
|---|---|---|---|---|---|---|---|---|---|---|
| No. of laboratories selected | 7 | 12 | 13 | 13 | 8 | 13 | 10 | 13 | 12 | 9 |
| No. of repetitions | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Min. | 1 | 121.5 | 69.5 | 113 | 53.5 | 19.5 | 42 | 91.5 | 32.5 | 0 |
| Max. | 3.5 | 135 | 77 | 135 | 61 | 30.5 | 56.5 | 108 | 50.5 | 3.5 |
| Mean | 2.4 | 128.8 | 73.0 | 128.0 | 58.3 | 24.7 | 47.6 | 100.9 | 40.8 | 1.5 |
| Standard deviation | 0.93 | 3.63 | 2.20 | 6.24 | 2.42 | 4.04 | 4.89 | 4.61 | 5.80 | 1.35 |
| Repeatability variance | 0.14 | 1.46 | 3.27 | 2.35 | 1.44 | 3.04 | 2.30 | 3.96 | 2.21 | 0.17 |
| Inter-laboratory standard deviation | 0.93 | 3.63 | 2.20 | 6.24 | 2.42 | 4.04 | 4.89 | 4.61 | 5.80 | 1.35 |

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Reproducibility variance | 0.94 | 13.93 | 6.49 | 40.11 | 6.57 | 17.84 | 25.03 | 23.28 | 34.72 | 1.90 |
| Repeatability standard deviation | 0.38 | 1.21 | 1.81 | 1.53 | 1.20 | 1.74 | 1.52 | 1.99 | 1.49 | 0.41 |
| r limit | 1.1 | 3.4 | 5.1 | 4.3 | 3.4 | 4.9 | 4.2 | 5.6 | 4.2 | 1.1 |
| Repeatability %CV (k=2) | 31 | 2 | 5 | 2 | 4 | 14 | 6 | 4 | 7 | 54 |
| Reproducibility standard deviation | 0.97 | 3.73 | 2.55 | 6.33 | 2.56 | 4.22 | 5.00 | 4.82 | 5.89 | 1.38 |
| R limit | 2.7 | 10.5 | 7.1 | 17.7 | 7.2 | 11.8 | 14.0 | 13.5 | 16.5 | 3.9 |
| Reproducibility %CV (k=2) | 80 | 6 | 7 | 10 | 9 | 34 | 21 | 10 | 29 | 184 |
| Horwitz $PRSD_R$ (%) | 14.00 | 7.70 | 8.39 | 7.71 | 8.68 | 9.87 | 8.95 | 7.99 | 9.16 | 15.05 |
| Horwitz $s_R$ | 0.34 | 9.92 | 6.13 | 9.86 | 5.06 | 2.44 | 4.26 | 8.06 | 3.73 | 0.23 |
| Horwitz R | 0.96 | 28.05 | 17.33 | 27.90 | 14.31 | 6.91 | 12.04 | 22.80 | 10.56 | 0.64 |
| Horwitz Ratio | 2.82 | 0.37 | 0.41 | 0.64 | 0.50 | 1.71 | 1.16 | 0.59 | 1.56 | 6.04 |

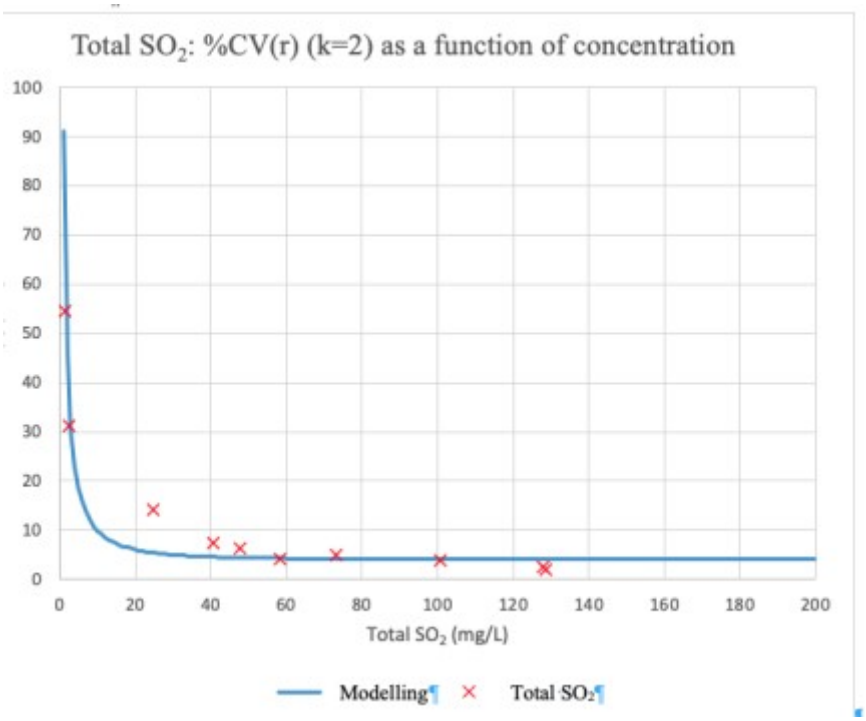



Figure 3: Modelling of the repeatability coefficient of variation, %CV(r) (k=2), as a function of concentration, C:

$$\%CV(r) = \sqrt{\frac{91^2}{C^2} + 4^2}$$

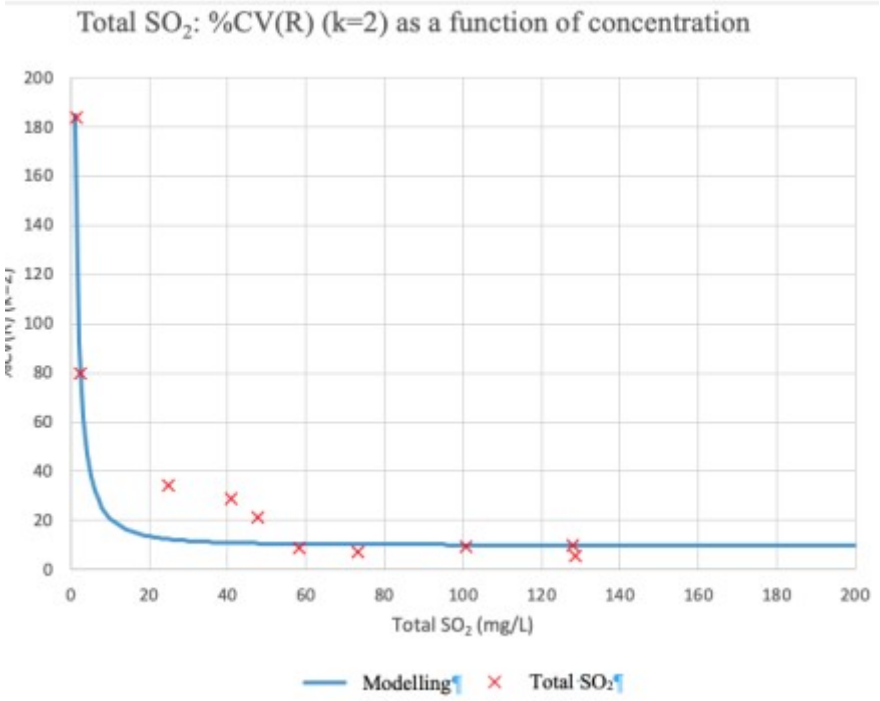



Figure 4: Modelling of the inter-laboratory reproducibility coefficient of variation, $\%CV_R$ (k=2), as a function of concentration, C:

$$\%CV(r) = \sqrt{\frac{184.9^2}{C^2} + 10^2}$$