Text Improvement of CVS Specifications and Dilute Modal Mass Calculation

WLTP-26-05e_rev 1

Introduction

An anomaly in the GTR 15 has been uncovered which is confusing and can also adversely affect the accuracy of the mass calculations for continuous dilute measurements from the CVS.

This was discussed informally with some EU Industry members who agreed that the current wording requires modification

The background is as follows :-

Introduction

Reference : ECE/TRANS/WP.29/GRPE/2019/2

3.2.1.1.4. Flow-weighted arithmetic average concentration calculation

The following calculation method shall only be applied for CVS systems that are not equipped with a heat exchanger or for CVS systems with a heat exchanger that do not comply with paragraph 3.3.5.1. of Annex 5.

When the CVS flow rate, q_{VCVS}, over the test varies by more than ±3 per cent of the arithmetic average flow rate, a flow-weighted arithmetic average shall be used for all continuous diluted measurements including PN:

$$C_e = \frac{\sum_{i=1}^{n} q_{VCVS}(i) \times \Delta t \times C(i)}{V}$$

where:

C_e	is the flow-weighted arithmetic average concentration;
$q_{VCVS}(i)$	is the CVS flow rate at time $t = i \times \Delta t$, m³/min;
$C(i)$	is the concentration at time $t = i \times \Delta t$, ppm;
Δt	sampling interval, s;
V	total CVS volume, m³;
n	is the test time, s.

Introduction

Reference : ECE/TRANS/WP.29/GRPE/2019/2

3.2.1.1.4. Flow-weighted arithmetic average concentration calculation

The following calculation method shall only be applied for CVS systems that are not equipped with a heat exchanger or for CVS systems with a heat exchanger that do not comply with paragraph 3.3.5.1. of Annex 5.

When the CVS flow rate, q_{VCVS}, over the test varies by more than ±3 per cent of the arithmetic average flow rate, a flow-weighted arithmetic average shall be used for all continuous diluted measurements including PN:

$$C_e = \frac{\sum_{i=1}^{n} q_{VCVS}(i) \times \Delta t \times C(i)}{V}$$

where:

C_e	is the flow-weighted arithmetic average concentration;
$q_{VCVS}(i)$	is the CVS flow rate at time $t = i \times \Delta t$, m³/min;
$C(i)$	is the concentration at time $t = i \times \Delta t$, ppm;
Δt	sampling interval, s;
V	total CVS volume, m³;
n	is the test time, s.

Introduction

Reference : ECE/TRANS/WP.29/GRPE/2019/2

3.3.5.1. The method of measuring total dilute exhaust volume incorporated in the constant volume sampler shall be such that measurement is accurate to ±2 per cent under all operating conditions. If the device cannot compensate for variations in the temperature of the mixture of exhaust gases and dilution air at the measuring point, a heat exchanger shall be used to maintain the temperature to within ±6 °C of the specified operating temperature for a PDP CVS, ±11 °C for a CFV CVS, ±6 °C for a UFM CVS, and ±11 °C for an SSV CVS.

At the typical heat exchanger set temperature of 40 deg C, the allowed +/- 11 deg C variation for the CFV-CVS inlet temperature means a potential real time CVS flow variation of +/- 1.8% throughout the test.
The current text specifies that the flow weighted arithmetic average calculation must be used when the real time CVS flow rate exceeds +/- 3% of the arithmetic average CVS flow rate.

Why is there a different specification for the accuracy of the CVS with a compliant heat exchanger (+/- 1.8%) and the flow rate variation (+/- 3%) at which the flow weighted average must be applied ?

This is the anomaly in the current text

Introduction

Reference : ECE/TRANS/WP.29/GRPE/2019/2

In addition, why is the use of the flow weighted average calculation not allowed even if a compliant heat exchanger is installed ?

The real time flow weighted calculation method corrects for the potential +/- 1.8% CVS flow rate variation of a compliant heat exchanger.

Allowing the flow weighted average calculation for all continuous diluted measurements improves the mass measurement accuracy of the CVS method.

Proposal for Text Change

Reference : ECE/TRANS/WP.29/GRPE/2019/2

Delete the anomalous confusing text

3.2.1.1.4. Flow-weighted arithmetic average concentration calculation

The following calculation method shall only be applied for CVS systems that are not equipped with a heat exchanger or for CVS systems with a heat exchanger that do not comply with paragraph 3.3.5.1. of Annex 5.

~~When the CVS flow rate, q_{VCVS}, over the test varies by more than ±3 per cent of the arithmetic average flow rate, a flow-weighted arithmetic average shall be used for all continuous diluted measurements including PN:~~

$$C_e = \frac{\sum_{i=1}^{n} q_{VCVS}(i) \times \Delta t \times C(i)}{V}$$

where:

C_e	is the flow-weighted arithmetic average concentration;
$q_{VCVS}(i)$	is the CVS flow rate at time $t = i \times \Delta t$, m^3/min;
$C(i)$	is the concentration at time $t = i \times \Delta t$, ppm;
Δt	sampling interval, s;
V	total CVS volume, m^3;
n	is the test time, s.

Proposed Text

Reference : ECE/TRANS/WP.29/GRPE/2019/2

Correct the formula

3.2.1.1.4. Flow-weighted arithmetic average concentration calculation

The following calculation method shall be applied for CVS systems that are not equipped with a heat exchanger or for CVS systems with a heat exchanger that does not comply with paragraph 3.3.5.1. of Annex 5.

This flow weighted arithmetic average concentration calculation shall be used for all continuous diluted measurements including PN.

It may be optionally applied for CVS systems with a heat exchanger that complies with paragraph 3.3.5.1 of Annex 5.

$$C_e = \frac{\sum_{i=1}^{n} q_{VCVS}(i) \times \Delta t \times C(i)}{V}$$

where:

C_e	is the flow-weighted arithmetic average concentration;
$q_{VCVS}(i)$	is the CVS flow rate at time $t = i \times \Delta t$, ~~m³/min;~~ m^3/sec
$C(i)$	is the concentration at time $t = i \times \Delta t$, ppm;
Δt	sampling interval, s;
V	total CVS volume, m^3;
n	is the test time, s.

Proposed Text

Reference : ECE/TRANS/WP.29/GRPE/2019/2

Add the option for use of the flow-weighted arithmetic averaging calculation

3.2.1.1.4. Flow-weighted arithmetic average concentration calculation

The following calculation method shall be applied for CVS systems that are not equipped with a heat exchanger or for CVS systems with a heat exchanger that does not comply with paragraph 3.3.5.1. of Annex 5.

This flow weighted arithmetic average concentration calculation shall be used for all continuous diluted measurements including PN.

It may be optionally applied for CVS systems with a heat exchanger that complies with paragraph 3.3.5.1 of Annex 5.

$$C_e = \frac{\sum_{i=1}^{n} q_{VCVS}(i) \times \Delta t \times C(i)}{V}$$

where:

C_e	is the flow-weighted arithmetic average concentration;
$q_{VCVS}(i)$	is the CVS flow rate at time $t = i \times \Delta t$, ~~m^3/min~~; m^3/sec
$C(i)$	is the concentration at time $t = i \times \Delta t$, ppm;
Δt	sampling interval, s;
V	total CVS volume, m^3;
n	is the test time, s.

Thank you
and
any questions ?

les.hill@horiba.com