Transmitted by the Informal group on Gaseous Fuelled Vehicles (GFV)

Informal document No. **GRPE-64-06**
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Proposal for amendments to Documents

ECE-TRANS-WP29-GRPE-2012-07
and
ECE-TRANS-WP29-GRPE-2012-06

The text reproduced below was prepared by the Chair of the informal group on Gaseous Fuelled Vehicles (GFV) to correct a measurement error contained in docs. ECE-TRANS-WP29-GRPE-2012-06 (R83) and ECE-TRANS-WP29-GRPE-2012-07 (R.115) when weighing method and G25 reference fuel are used. The modifications to the original English text are marked in bold for new or strikethrough for deleted characters.

I. Proposal

Annex 6B of doc. ECE-TRANS-WP29-GRPE-2012-07 Paragraph 2., amend to read:

2. Calculation of the CNG energy ratio

The fuel consumption value shall be calculated from the emissions of hydrocarbons, carbon monoxide, and carbon dioxide determined from the measurement results assuming that only CNG is burned during the test.

The CNG ratio of the energy consumed in the cycle is then determined as follows:

$G_{CNG} = M_{CNG} * \underline{\mathbf{cf}\ *} 100/(FC_{mean} * dist * d) * 100\%$

Where:

G_{CNG}: the CNG energy ratio;

M_{CNG}: the CNG mass consumed during the cycle (kg);

FC_{mean}: the mean fuel consumption calculated in accordance with paragraph. 6.2.2.4.3.2.;

dist: distance travelled during the cycle (km);

d: density d=0.654kg/m^3

cf: correction factor, assuming the following values:

cf = 1	**in case of G_{20} reference fuel**
cf = 0.78	**in case of G_{25} reference fuel**

Annex 12 Appendix 2 of doc. ECE-TRANS-WP29-GRPE-2012-06 Paragraph 2., amend to read:

2. Calculation of the CNG energy ratio

The fuel consumption value shall be calculated from the emissions of hydrocarbons, carbon monoxide, and carbon dioxide determined from the measurement results assuming that only CNG is burned during the test.

The CNG ratio of the energy consumed in the cycle is then determined as follows:

$G_{CNG} = M_{CNG} * \underline{\mathbf{cf}\ *} 100/(FC_{norm} * dist * d)$

Where:

G_{CNG}: the CNG energy ratio;

M_{CNG}: the CNG mass consumed during the cycle (kg);

FC_{norm}: the fuel consumption calculated in accordance with Paragraph 1.4.3., letter (c), of Annex 6 to Regulation No. 101;

dist: distance travelled during the cycle (km);

d: density d = 0.654kg/m^3

cf: correction factor, assuming the following values:

cf = 1	**in case of G_{20} reference fuel**
cf = 0.78	**in case of G_{25} reference fuel**

II. Justification

Documents ECE-TRANS-WP29-GRPE-2012-07 (referring to R115) and ECE-TRANS-WP29-GRPE-2012-06 (referring to R83) introduce the calculation of NG/biomethane energy ratio during a type I cycle by weighing the NG/biomethane mass consumed. The formulas introduced respectively in Annex 6B (ECE-TRANS-WP29-GRPE-2012-07) and Annex 12 - Appendix 2 (ECE-TRANS-WP29-GRPE-2012-06) are affected by an error when G_{25} reference fuel is used. The error is due to the presence of inert gas (N_2) in the G_{25} reference fuel, varying from 12 to 16% in molar fraction units.

This proposal describes a modification to previous formulas in order to take into account the presence of inert gas and providing the correct energy ratio. When G_{25} reference fuel is used, its composition is known and the mass of inert gas in it can be calculated.

R83 fixes the allowed ranges for both CH_4 molar fraction and N_2 molar fraction in G_{25} reference fuel. If we assume x_{CH4} the molar fraction of CH_4 and x_{N2} the molar fraction of N_2, we have:

$x_{CH4} = n_{CH4} / n_{TOT}$ (for G_{25}: $0.84 \leq x_{CH4} \leq 0.88$)

$x_{N2} = n_{N2} / n_{TOT}$ (for G_{25}: $0.12 \leq x_{N2} \leq 0.16$)

where:

n_{CH4} *is the number of moles of* CH_4

n_{N2} *is the number of moles of* N_2

n_{TOT} *is the total number of moles*

Since the mass of CH_4 and N_2 expressed in grams can be calculated as follows:

$m_{CH4} = n_{CH4} * PM_{CH4}$

$m_{N2} = n_{N2} * PM_{N2}$

where:

PM_{CH4} *is the molar mass of* CH_4 *= 16.042 g/mol*

PM_{N2} *is the molar mass of* N_2 *= 28.02 g/mol*

Combining previous equations:

$m_{CH4} = x_{CH4} * n_{TOT} * PM_{CH4}$

$m_{N2} = x_{N2} * n_{TOT} * PM_{N2}$

The weighing process will measure the total mass of G25 m_{TOT}:

$m_{TOT} = m_{CH4} + m_{N2}$

$m_{TOT} = n_{TOT} * (x_{CH4} * PM_{CH4} + x_{N2} * PM_{N2})$

but for the calculation of the energy ratio only the mass of CH_4 should be used. Thus the weighing process will overestimate the mass by a factor:

$m_{TOT} / m_{CH4} = (x_{CH4} * PM_{CH4} + x_{N2} * PM_{N2}) / (x_{CH4} * PM_{CH4})$

or vice versa the measured mass must be reduced by a factor:

$cf = m_{CH4} / m_{TOT} = (x_{CH4} * PM_{CH4}) / (x_{CH4} * PM_{CH4} + x_{N2} * PM_{N2})$

According to the allowed range for N_2 content, this correction factor will also vary:

- from 0.75, in case of minimum quantity of CH_4 (0.84) and maximum quantity of N_2 (0.16),

- to 0.8, in case of maximum quantity of CH_4 (0.88) and minimum quantity of N_2 (0.12)

Thus a mean value of 0.78 can be adopted for G_{25} reference fuel.