

$$x = x_{[\text{emission}]_{\text{meas}}} \cdot \left( \frac{1 - x_{\text{H}_2\text{Oexh}}}{1 - x_{\text{H}_2\text{O}[\text{emission}]_{\text{meas}}}} \right)$$

Eq. 1065.659-1

*Example:*

$$x_{\text{COmeas}} = 29.0 \text{ } \mu\text{mol/mol}$$

$$x_{\text{H}_2\text{OCOmeas}} = 8.601 \text{ mmol/mol} = 0.008601 \text{ mol/mol}$$

$$x_{\text{H}_2\text{Oexh}} = 34.04 \text{ mmol/mol} = 0.03404 \text{ mol/mol}$$

$$x_{\text{CO}} = 29.0 \cdot \left( \frac{1 - 0.03404}{1 - 0.008601} \right)$$

$$x_{\text{CO}} = 28.3 \text{ } \mu\text{mol/mol}$$

[73 FR 37335, June 30, 2008, as amended at 76 FR 57462, Sept. 15, 2011; 79 FR 23804, Apr. 28, 2014]

**§ 1065.660 THC, NMHC, and CH<sub>4</sub> determination.**

(a) *THC determination and initial THC/CH<sub>4</sub> contamination corrections.* (1) If we

require you to determine THC emissions, calculate  $x_{\text{THC}[\text{THC-FID}]_{\text{cor}}}$  using the initial THC contamination concentration  $x_{\text{THC}[\text{THC-FID}]_{\text{init}}}$  from § 1065.520 as follows:

$$x_{\text{THC}[\text{THC-FID}]_{\text{cor}}} = x_{\text{THC}[\text{THC-FID}]_{\text{uncor}}} - x_{\text{THC}[\text{THC-FID}]_{\text{init}}}$$

Eq. 1065.660-1

*Example:*

$$x_{\text{THCuncor}} = 150.3 \text{ } \mu\text{mol/mol}$$

$$x_{\text{THCinit}} = 1.1 \text{ } \mu\text{mol/mol}$$

$$x_{\text{THCcor}} = 150.3 - 1.1$$

$$x_{\text{THCcor}} = 149.2 \text{ } \mu\text{mol/mol}$$

(2) For the NMHC determination described in paragraph (b) of this section, correct  $x_{\text{THC}[\text{THC-FID}]}$  for initial THC contamination using Equation 1065.660-1. You may correct  $x_{\text{THC}[\text{NMHC-FID}]}$  for initial contamination of the CH<sub>4</sub> sample train

using Equation 1065.660-1, substituting in CH<sub>4</sub> concentrations for THC.

(3) For the CH<sub>4</sub> determination described in paragraph (c) of this section, you may correct  $x_{\text{THC}[\text{NMHC-FID}]}$  for initial THC contamination of the CH<sub>4</sub> sample train using Equation 1065.660-1, substituting in CH<sub>4</sub> concentrations for THC.

(b) *NMHC determination.* Use one of the following to determine NMHC concentration,  $x_{\text{NMHC}}$ :

# Environmental Protection Agency

# § 1065.660

(1) If you do not measure CH<sub>4</sub>, you may omit the calculation of NMHC concentrations and calculate the mass of NMHC as described in §1065.650(c)(5).

(2) For nonmethane cutters, calculate  $x_{\text{NMHC}}$  using the nonmethane cutter's penetration fraction ( $PF$ ) of CH<sub>4</sub> and the response factor penetration fraction ( $RFPF$ ) of C<sub>2</sub>H<sub>6</sub> from §1065.365, the response factor ( $RF$ ) of the THC FID to CH<sub>4</sub> from §1065.360, the initial THC contamination and dry-to-

wet corrected THC concentration  $x_{\text{THC[THC-FID]cor}}$  as determined in paragraph (a) of this section, and the dry-to-wet corrected CH<sub>4</sub> concentration  $x_{\text{THC[NMC-FID]cor}}$  optionally corrected for initial THC contamination as determined in paragraph (a) of this section.

(i) Use the following equation for penetration fractions determined using an NMC configuration as outlined in §1065.365(d):

$$x_{\text{NMHC}} = \frac{x_{\text{THC[THC-FID]cor}} - x_{\text{THC[NMC-FID]cor}} \cdot RF_{\text{CH4[THC-FID]}}}{1 - RFPF_{\text{C2H6[NMC-FID]}} \cdot RF_{\text{CH4[THC-FID]}}}$$

Eq. 1065.660-2

Where:

$x_{\text{NMHC}}$  = concentration of NMHC.

$x_{\text{THC[THC-FID]cor}}$  = concentration of THC, initial THC contamination and dry-to-wet corrected, as measured by the THC FID during sampling while bypassing the NMC.

$x_{\text{THC[NMC-FID]cor}}$  = concentration of THC, initial THC contamination (optional) and dry-to-wet corrected, as measured by the NMC FID during sampling through the NMC.

$RF_{\text{CH4[THC-FID]}}$  = response factor of THC FID to CH<sub>4</sub>, according to §1065.360(d).

$RFPF_{\text{C2H6[NMC-FID]}}$  = nonmethane cutter combined ethane response factor and penetration fraction, according to §1065.365(d).

Example:

$x_{\text{THC[THC-FID]cor}} = 150.3 \mu\text{mol/mol}$

$x_{\text{THC[NMC-FID]cor}} = 20.5 \mu\text{mol/mol}$

$RFPF_{\text{C2H6[NMC-FID]}} = 0.019$

$RF_{\text{CH4[THC-FID]}} = 1.05$

$$x_{\text{NMHC}} = \frac{150.3 - 20.5 \cdot 1.05}{1 - 0.019 \cdot 1.05}$$

$x_{\text{NMHC}} = 131.4 \mu\text{mol/mol}$

(ii) For penetration fractions determined using an NMC configuration as

outlined in section §1065.365(e), use the following equation:

$$x_{\text{NMHC}} = \frac{x_{\text{THC[THC-FID]cor}} \cdot PF_{\text{CH4[NMC-FID]}} - x_{\text{THC[NMC-FID]cor}}}{PF_{\text{CH4[NMC-FID]}} - PF_{\text{C2H6[NMC-FID]}}}$$

Eq. 1065.660-3

Where:

$x_{\text{NMHC}}$  = concentration of NMHC.

$x_{\text{THC[THC-FID]cor}}$  = concentration of THC, initial THC contamination and dry-to-wet cor-

rected, as measured by the THC FID during sampling while bypassing the NMC.

§ 1065.660

40 CFR Ch. I (7–1–14 Edition)

$PF_{CH4[NMC-FID]}$  = nonmethane cutter  $CH_4$  penetration fraction, according to § 1065.365(e).

$x_{THC[NMC-FID]cor}$  = concentration of THC, initial THC contamination (optional) and dry-to-wet corrected, as measured by the THC FID during sampling through the NMC.

$PF_{C2H6[NMC-FID]}$  = nonmethane cutter ethane penetration fraction, according to § 1065.365(e).

*Example:*

$x_{THC[THC-FID]cor} = 150.3 \mu\text{mol/mol}$   
 $PF_{CH4[NMC-FID]} = 0.990$

$x_{THC[NMC-FID]cor} = 20.5 \mu\text{mol/mol}$   
 $PF_{C2H6[NMC-FID]} = 0.020$

$$x_{NMHC} = \frac{150.3 \cdot 0.990 - 20.5}{0.990 - 0.020}$$

$x_{NMHC} = 132.3 \mu\text{mol/mol}$

(iii) For penetration fractions determined using an NMC configuration as

outlined in section § 1065.365(f), use the following equation:

$$x_{NMHC} = \frac{x_{THC[THC-FID]cor} \cdot PF_{CH4[NMC-FID]} - x_{THC[NMC-FID]cor} \cdot RF_{CH4[THC-FID]}}{PF_{CH4[NMC-FID]} - RFPF_{C2H6[NMC-FID]} \cdot RF_{CH4[THC-FID]}}$$

Eq. 1065.660-4

Where:

$x_{NMHC}$  = concentration of NMHC.

$x_{THC[THC-FID]cor}$  = concentration of THC, initial THC contamination and dry-to-wet corrected, as measured by the THC FID during sampling while bypassing the NMC.

$PF_{CH4[NMC-FID]}$  = nonmethane cutter  $CH_4$  penetration fraction, according to § 1065.365(f).

$x_{THC[NMC-FID]cor}$  = concentration of THC, initial THC contamination (optional) and dry-to-wet corrected, as measured by the THC FID during sampling through the NMC.

$RFPF_{C2H6[NMC-FID]}$  = nonmethane cutter  $CH_4$  combined ethane response factor and penetration fraction, according to § 1065.365(f).

$RF_{CH4[THC-FID]}$  = response factor of THC FID to  $CH_4$ , according to § 1065.360(d).

*Example:*

$x_{THC[THC-FID]cor} = 150.3 \mu\text{mol/mol}$   
 $PF_{CH4[NMC-FID]} = 0.990$

$x_{THC[NMC-FID]cor} = 20.5 \mu\text{mol/mol}$   
 $RFPF_{C2H6[NMC-FID]} = 0.019$

$RF_{CH4[THC-FID]} = 0.980$

$$x_{NMHC} = \frac{150.3 \cdot 0.990 - 20.5 \cdot 0.980}{0.990 - 0.019 \cdot 0.980}$$

$x_{NMHC} = 132.5 \mu\text{mol/mol}$

(3) For a GC-FID, calculate  $x_{NMHC}$  using the THC analyzer's response factor ( $RF$ ) for  $CH_4$ , from § 1065.360, and the

initial THC contamination and dry-to-wet corrected THC concentration  $x_{THC[THC-FID]cor}$  as determined in paragraph (a) of this section as follows:

$$x_{\text{NMHC}} = x_{\text{THC}[\text{THC-FID}]_{\text{cor}}} - RF_{\text{CH}_4[\text{THC-FID}]} \cdot x_{\text{CH}_4}$$

## Eq. 1065.660-5

Where:

$x_{\text{NMHC}}$  = concentration of NMHC.

$x_{\text{THC}[\text{THC-FID}]_{\text{cor}}}$  = concentration of THC, initial THC contamination and dry-to-wet corrected, as measured by the THC FID.

$x_{\text{CH}_4}$  = concentration of CH<sub>4</sub>, dry-to-wet corrected, as measured by the GC-FID.

$RF_{\text{CH}_4[\text{THC-FID}]}$  = response factor of THC-FID to CH<sub>4</sub>.

Example:

$x_{\text{THC}[\text{THC-FID}]_{\text{cor}}} = 145.6 \mu\text{mol/mol}$

$RF_{\text{CH}_4[\text{THC-FID}]} = 0.970$

$x_{\text{CH}_4} = 18.9 \mu\text{mol/mol}$

$x_{\text{NMHC}} = 145.6 - 0.970 \cdot 18.9$

$x_{\text{NMHC}} = 127.3 \mu\text{mol/mol}$

(c) *CH<sub>4</sub> determination.* Use one of the following methods to determine CH<sub>4</sub> concentration,  $x_{\text{CH}_4}$ :

(1) For nonmethane cutters, calculate  $x_{\text{CH}_4}$  using the nonmethane cutter's penetration fraction (*PF*) of CH<sub>4</sub> and the response factor penetration fraction (*RFPF*) of C<sub>2</sub>H<sub>6</sub> from §1065.365, the response factor (*RF*) of the THC FID to CH<sub>4</sub> from §1065.360, the initial THC contamination and dry-to-wet corrected THC concentration  $x_{\text{THC}[\text{THC-FID}]_{\text{cor}}}$  as determined in paragraph (a) of this section, and the dry-to-wet corrected CH<sub>4</sub> concentration  $x_{\text{THC}[\text{NMC-FID}]_{\text{cor}}}$  optionally corrected for initial THC contamination as determined in paragraph (a) of this section.

(i) Use the following equation for penetration fractions determined using an NMC configuration as outlined in §1065.365(d):

$$x_{\text{CH}_4} = \frac{x_{\text{THC}[\text{NMC-FID}]_{\text{cor}}} - x_{\text{THC}[\text{THC-FID}]_{\text{cor}}} \cdot RFPF_{\text{C}_2\text{H}_6[\text{NMC-FID}]}}{1 - RFPF_{\text{C}_2\text{H}_6[\text{NMC-FID}]} \cdot RF_{\text{CH}_4[\text{THC-FID}]}}$$

## Eq. 1065.660-6

Where:

$x_{\text{CH}_4}$  = concentration of CH<sub>4</sub>.

$x_{\text{THC}[\text{NMC-FID}]_{\text{cor}}}$  = concentration of THC, initial THC contamination (optional) and dry-to-wet corrected, as measured by the NMC FID during sampling through the NMC.

$x_{\text{THC}[\text{THC-FID}]_{\text{cor}}}$  = concentration of THC, initial THC contamination and dry-to-wet corrected, as measured by the THC FID during sampling while bypassing the NMC.

$RFPF_{\text{C}_2\text{H}_6[\text{NMC-FID}]}$  = the combined ethane response factor and penetration fraction of the nonmethane cutter, according to §1065.365(d).

$RF_{\text{CH}_4[\text{THC-FID}]}$  = response factor of THC FID to CH<sub>4</sub>, according to §1065.360(d).

Example:

$x_{\text{THC}[\text{NMC-FID}]_{\text{cor}}} = 10.4 \mu\text{mol/mol}$

$x_{\text{THC}[\text{THC-FID}]_{\text{cor}}} = 150.3 \mu\text{mol/mol}$

$RFPF_{\text{C}_2\text{H}_6[\text{NMC-FID}]} = 0.019$

$RF_{\text{CH}_4[\text{THC-FID}]} = 1.05$

$$x_{\text{CH}_4} = \frac{10.4 - 150.3 \cdot 0.019}{1 - 0.019 \cdot 1.05}$$

$x_{\text{CH}_4} = 7.69 \mu\text{mol/mol}$

(ii) For penetration fractions determined using an NMC configuration as

outlined in §1065.365(e), use the following equation:

$$x_{\text{CH}_4} = \frac{x_{\text{THC}[\text{NMC-FID}]\text{cor}} - x_{\text{THC}[\text{THC-FID}]\text{cor}} \cdot PF_{\text{C}_2\text{H}_6[\text{NMC-FID}]}}{RF_{\text{CH}_4[\text{THC-FID}]} \cdot (PF_{\text{CH}_4[\text{NMC-FID}]} - PF_{\text{C}_2\text{H}_6[\text{NMC-FID}]})}$$

Eq. 1065.660-7

Where:

$x_{\text{CH}_4}$  = concentration of  $\text{CH}_4$ .

$x_{\text{THC}[\text{NMC-FID}]\text{cor}}$  = concentration of THC, initial THC contamination (optional) and dry-to-wet corrected, as measured by the NMC FID during sampling through the NMC.

$x_{\text{THC}[\text{THC-FID}]\text{cor}}$  = concentration of THC, initial THC contamination and dry-to-wet corrected, as measured by the THC FID during sampling while bypassing the NMC.

$PF_{\text{C}_2\text{H}_6[\text{NMC-FID}]}$  = nonmethane cutter ethane penetration fraction, according to §1065.365(e).

$RF_{\text{CH}_4[\text{THC-FID}]}$  = response factor of THC FID to  $\text{CH}_4$ , according to §1065.360(d).

$PF_{\text{CH}_4[\text{NMC-FID}]}$  = nonmethane cutter  $\text{CH}_4$  penetration fraction, according to §1065.365(e).

Example:

$x_{\text{THC}[\text{NMC-FID}]\text{cor}} = 10.4 \mu\text{mol/mol}$

$x_{\text{THC}[\text{THC-FID}]\text{cor}} = 150.3 \mu\text{mol/mol}$

$PF_{\text{C}_2\text{H}_6[\text{NMC-FID}]} = 0.020$

$RF_{\text{CH}_4[\text{THC-FID}]} = 1.05$

$PF_{\text{CH}_4[\text{NMC-FID}]} = 0.990$

$$x_{\text{CH}_4} = \frac{10.4 - 150.3 \cdot 0.020}{1.05 \cdot (0.990 - 0.020)}$$

$x_{\text{CH}_4} = 7.25 \mu\text{mol/mol}$

(iii) For penetration fractions determined using an NMC configuration as

outlined in §1065.365(f), use the following equation:

$$x_{\text{CH}_4} = \frac{x_{\text{THC}[\text{NMC-FID}]\text{cor}} - x_{\text{THC}[\text{THC-FID}]\text{cor}} \cdot RFPF_{\text{C}_2\text{H}_6[\text{NMC-FID}]}}{PF_{\text{CH}_4[\text{NMC-FID}]} - RFPF_{\text{C}_2\text{H}_6[\text{NMC-FID}]} \cdot RF_{\text{CH}_4[\text{THC-FID}]}}$$

Eq. 1065.660-8

Where:

$x_{\text{CH}_4}$  = concentration of  $\text{CH}_4$ .

$x_{\text{THC}[\text{NMC-FID}]\text{cor}}$  = concentration of THC, initial THC contamination (optional) and dry-to-wet corrected, as measured by the NMC FID during sampling through the NMC.

$x_{\text{THC}[\text{THC-FID}]\text{cor}}$  = concentration of THC, initial THC contamination and dry-to-wet corrected, as measured by the THC FID during sampling while bypassing the NMC.

$RFPF_{\text{C}_2\text{H}_6[\text{NMC-FID}]}$  = the combined ethane response factor and penetration fraction of the nonmethane cutter, according to §1065.365(f).

$PF_{\text{CH}_4[\text{NMC-FID}]}$  = nonmethane cutter  $\text{CH}_4$  penetration fraction, according to §1065.365(f).

$RF_{\text{CH}_4[\text{THC-FID}]}$  = response factor of THC FID to  $\text{CH}_4$ , according to §1065.360(d).

Example:

$x_{\text{THC}[\text{NMC-FID}]\text{cor}} = 10.4 \mu\text{mol/mol}$

$x_{\text{THC}[\text{THC-FID}]\text{cor}} = 150.3 \mu\text{mol/mol}$

$RFPF_{\text{C}_2\text{H}_6[\text{NMC-FID}]} = 0.019$

$$PF_{CH_4[NMC-FID]} = 0.990$$

$$RF_{CH_4[THC-FID]} = 1.05$$

$$x_{CH_4} = \frac{10.4 - 150.3 \cdot 0.019}{0.990 - 0.019 \cdot 1.05}$$

$$x_{CH_4} = 7.78 \mu\text{mol/mol}$$

(2) For a GC-FID,  $x_{CH_4}$  is the actual dry-to-wet corrected  $CH_4$  concentration as measured by the analyzer.

[76 FR 57462, Sept. 15, 2011]

**§ 1065.665 THCE and NMHCE determination.**

(a) If you measured an oxygenated hydrocarbon's mass concentration, first calculate its molar concentration in the exhaust sample stream from which the sample was taken (raw or di-

luted exhaust), and convert this into a  $C_1$ -equivalent molar concentration. Add these  $C_1$ -equivalent molar concentrations to the molar concentration of non-oxygenated total hydrocarbon (NOTHC). The result is the molar concentration of total hydrocarbon equivalent (THCE). Calculate THCE concentration using the following equations, noting that Eq. 1065.665-3 is required only if you need to convert your oxygenated hydrocarbon (OHC) concentration from mass to moles:

$$x_{THCE} = x_{NOTHC} + \sum_{i=1}^N (x_{OHCi} - x_{OHCi-init})$$

Eq. 1065.665-1

$$x_{NOTHC} = x_{THC[THC-FID]_{cor}} - \sum_{i=1}^N ((x_{OHCi} - x_{OHCi-init}) \cdot RF_{OHCi[THC-FID]})$$

Eq. 1065.665-2

$$x_{OHCi} = \frac{\frac{m_{dexhOHCi}}{M_{OHCi}}}{\frac{m_{dexh}}{M_{dexh}}} = \frac{n_{dexhOHCi}}{n_{dexh}}$$

Eq. 1065.665-3

Where:

$x_{THCE}$  = The sum of the  $C_1$ -equivalent concentrations of non-oxygenated hydrocarbons, alcohols, and aldehydes.

$x_{NOTHC}$  = The sum of the  $C_1$ -equivalent concentrations of NOTHC.

$x_{OHCi}$  = The  $C_1$ -equivalent concentration of oxygenated species  $i$  in diluted exhaust, not corrected for initial contamination.