dryer and at the concentration measurement, $x_{H2O[emission]meas}$, is higher than the amount of water at the flow meter, x_{H2Oexh}, set $x_{H2O[emission]meas}$ equal to x_{H2Oexh}. If you use a sample dryer upstream of storage media, you must be able to demonstrate that the sample dryer is removing water continuously (*i.e.*, x_{H2Oexh} is higher than $x_{H2O[emission]meas}$ throughout the test interval).

(c) For a concentration measurement where you did not remove water, you may set $x_{H2O[emission]meas}$ equal to x_{H2Oexh}. You may determine the amount of water at the flow meter, x_{H2Oexh}, using any of the following methods:

(1) Measure the dewpoint and absolute pressure and calculate the amount of water as described in §1065.645.

(2) If the measurement comes from raw exhaust, you may determine the amount of water based on intake-air humidity, plus a chemical balance of fuel, intake air, and exhaust as described in §1065.655.

(3) If the measurement comes from diluted exhaust, you may determine the amount of water based on intake-air humidity, dilution air humidity, and a chemical balance of fuel, intake air, and exhaust as described in §1065.655.

(d) Perform a removed water correction to the concentration measurement using the following equation:

$$x = x_{[emission]meas} \cdot \left[\frac{1 - x_{H2Oexh}}{1 - x_{H2O[emission]meas}} \right] \quad \text{Eq. 1065.659-1}$$

Example:

x_{COmeas} = 29.0 µmol/mol
$x_{H2OCOmeas}$ = 8.601 mmol/mol = 0.008601 mol/mol
x_{H2Oexh} = 34.04 mmol/mol = 0.03404 mol/mol

$$x_{CO} = 29.0 \cdot \left[\frac{1 - 0.03404}{1 - 0.008601} \right]$$

x_{CO} = 28.3 µmol/mol

[73 FR 37335, June 30, 2008, as amended at 76 FR 57462, Sept. 15, 2011]

§1065.660 THC, NMHC, and CH_4 determination.

(a) *THC determination and initial THC/CH_4 contamination corrections.* (1) If we require you to determine THC emissions, calculate $x_{THC[THC-FID]cor}$ using the initial THC contamination concentration $x_{THC[THC-FID]init}$ from §1065.520 as follows:

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

Eq. 1065.660-1

Example:

$x_{THCuncor}$ = 150.3 µmol/mol
$x_{THCinit}$ = 1.1 µmol/mol
x_{THCcor} = 150.3—1.1
x_{THCcor} = 149.2 µmol/mol

(2) For the NMHC determination described in paragraph (b) of this section, correct $x_{THC[THC-FID]}$ for initial THC contamination using Equation 1065.660–1. You may correct $x_{THC[NMC-FID]}$ for initial contamination of the CH_4 sample train using Equation 1065.660–1, substituting in CH_4 concentrations for THC.

(3) For the CH_4 determination described in paragraph (c) of this section, you may correct $x_{THC[NMC-FID]}$ for initial THC contamination of the CH_4 sample train using Equation 1065.660–1, substituting in CH_4 concentrations for THC.

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

(1) If you do not measure CH_4, 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_{NMHC} using the nonmethane cutter's penetration fraction (PF) of CH_4 and the response factor penetration fraction ($RFPF$) of C_2H_6 from §1065.365, the response factor (RF) of the THC FID to CH_4 from §1065.360, the initial THC contamination and dry-to-wet corrected THC concentration $x_{THC[THC–FID]cor}$ as determined in paragraph (a) of this section, and the dry-to-wet corrected CH_4 concentration $x_{THC[NMC–FID]cor}$ 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):

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

Eq. 1065.660-2

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.

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

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

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

Example:

$x_{THC[THC–FID]cor}$ = 150.3 µmol/mol
$x_{THC[NMC–FID]cor}$ = 20.5 µmol/mol
$RFPF_{C2H6[NMC–FID]}$ = 0.019
$RF_{CH4[THC–FID]}$ = 1.05

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

x_{NMHC} = 131.4 µmol/mol

(ii) For penetration fractions determined using an NMC configuration as outlined in section §1065.365(e), use the following equation:

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

Eq. 1065.660-3

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(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 µmol/mol
$PF_{CH4[NMC–FID]}$ = 0.990
$x_{THC[NMC–FID]cor}$ = 20.5 µmol/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 µmol/mol

(iii) For penetration fractions determined using an NMC configuration as outlined in section §1065.365(f), use the following equation:

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

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 µmol/mol
$PF_{CH4[NMC–FID]}$ = 0.990
$x_{THC[NMC–FID]cor}$ = 20.5 µmol/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 µmol/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:

$$x_{NMHC} = x_{THC[THC\text{-}FID]cor} - RF_{CH4[THC\text{-}FID]} \cdot x_{CH4}$$

Eq. 1065.660-5

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.

x_{CH4}= concentration of CH_4, dry-to-wet corrected, as measured by the GC–FID.

$RF_{CH4[THC–FID]}$ = response factor of THC–FID to CH_4.

Example:

$x_{THC[THC–FID[cor}$ = 145.6 μmol/mol
$RF_{CH4[THC–FID]}$ = 0.970
x_{CH4} = 18.9 μmol/mol
x_{NMHC} = 145.6 − 0.970 · 18.9
x_{NMHC} = 127.3 μmol/mol

(c) *CH_4 determination*. Use one of the following methods to determine CH_4 concentration, x_{CH4}:

(1) For nonmethane cutters, calculate x_{CH4} using the nonmethane cutter's penetration fraction (*PF*) of CH_4 and the response factor penetration fraction (*RFPF*) of C_2H_6 from §1065.365, the response factor (*RF*) of the THC FID to CH_4 from §1065.360, the initial THC contamination and dry-to-wet corrected THC concentration $x_{THC[THC–FID]cor}$ as determined in paragraph (a) of this section, and the dry-to-wet corrected CH_4 concentration $x_{THC[NMC–FID]cor}$ 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):

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

Eq. 1065.660-6

Where:

x_{CH4} = concentration of CH_4.

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

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

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

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

Example:

$x_{THC[NMC–FID]cor}$ = 10.4 μmol/mol
$x_{THC[THC–FID]cor}$ = 150.3 μmol/mol
$RFPF_{C2H6[NMC–FID]}$ = 0.019
$RF_{CH4[THC–FID]}$ = 1.05

$$x_{CH4} = \frac{10.4 - 150.3 \cdot 0.019}{1 - 0.019 \cdot 1.05}$$

x_{CH4} = 7.69 μmol/mol

(ii) For penetration fractions determined using an NMC configuration as outlined in §1065.365(e), use the following equation:

$$x_{CH4} = \frac{x_{THC[NMC\text{-}FID]cor} - x_{THC[THC\text{-}FID]cor} \cdot PF_{C2H6[NMC\text{-}FID]}}{RF_{CH4[THC\text{-}FID]} \cdot \left(PF_{CH4[NMC\text{-}FID]} - PF_{C2H6[NMC\text{-}FID]} \right)}$$

Eq. 1065.660-7

Where:

x_{CH4} = concentration of CH_4.

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

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

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

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

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

Example:

$x_{THC[NMC–FID]cor}$ = 10.4 μmol/mol
$x_{THC[THC–FID]cor}$ = 150.3 μmol/mol
$PF_{C2H6[NMC–FID]}$ = 0.020
$RF_{CH4[THC–FID]}$ = 1.05
$PF_{CH4[NMC–FID]}$ = 0.990

$$x_{CH4} = \frac{10.4 - 150.3 \cdot 0.020}{1.05 \cdot \left(0.990 - 0.020 \right)}$$

x_{CH4} = 7.25 μmol/mol

(iii) For penetration fractions determined using an NMC configuration as outlined in §1065.365(f), use the following equation:

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

Eq. 1065.660-8

Where:

x_{CH4} = concentration of CH_4.

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

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

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

$PF_{CH4[NMC–FID]}$ = nonmethane cutter CH_4 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:

$x_{THC[NMC–FID]cor}$ = 10.4 μmol/mol
$x_{THC[THC–FID]cor}$ = 150.3 μmol/mol
$RFPF_{C2H6[NMC–FID]}$ = 0.019
$PF_{CH4[NMC–FID]}$ = 0.990
$RF_{CH4[THC–FID]}$ = 1.05

$$x_{CH4} = \frac{10.4 - 150.3 \cdot 0.019}{0.990 - 0.019 \cdot 1.05}$$

x_{CH4} = 7.78 μmol/mol

(2) For a GC–FID, x_{CH4} 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 diluted exhaust), and convert this into a C_1-equivalent molar concentration. Add these C_1-equivalent molar concentrations to the molar concentration of NOTHC. The result is the molar concentration of THCE. Calculate THCE concentration using the following equations, noting that equation 1065.665–3 is only required if you need to convert your OHC concentration from mass to moles:

$$x_{THCE} = x_{NOTHC} + \sum_{i=1}^{N} \left(x_{OHCi} - x_{OHCi\text{-init}} \right) \qquad \text{Eq. 1065.665-1}$$

$$x_{NOTHC} = x_{THC[THC\text{-}FID]cor} - \sum_{i=1}^{N} \left(x_{OHCi} \cdot RF_{OHCi[THC\text{-}FID]} \right) \qquad \text{Eq. 1065.665-2}$$

$$x_{OHCi} = \frac{\frac{m_{dexhOHCi}}{M_{OHCi}}}{\frac{m_{dexh}}{M_{dexh}}} = \frac{n_{dexhOHCi}}{n_{dexh}} \qquad \text{Eq. 1065.665-3}$$

Where:

x_{THCE} = The C_1-equivalent sum of the concentration of carbon mass contributions of non-oxygenated hydrocarbons, alcohols, and aldehydes.

x_{NOTHC} = The C_1-equivalent sum of the concentration of nonoxygenated THC.

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

$x_{OHCi\text{-init}}$ = The C_1-equivalent concentration of the initial system contamination (optional) of oxygenated species i, dry-to-wet corrected.

$x_{THC[THC\text{-}FID]cor}$ = The C_1-equivalent response to NOTHC and all OHC in diluted exhaust, HC contamination and dry-to-wet corrected, as measured by the THC-FID.

$RF_{OHCi[THC\text{-}FID]}$ = The response factor of the FID to species i relative to propane on a C_1-equivalent basis.

$C^{\#}$ = The mean number of carbon atoms in the particular compound.

M_{dexh} = The molar mass of diluted exhaust as determined in § 1065.340.

$m_{dexhOHCi}$ = The mass of oxygenated species i in dilute exhaust.

M_{OHCi} = The C_1-equivalent molecular weight of oxygenated species i.

m_{dexh} = The mass of diluted exhaust.

$n_{dexhOHCi}$ = The number of moles of oxygenated species i in total diluted exhaust flow.