THC calculation

EXAMPLE
Data
Ambient conditions:
ambient temperature: 23 °C = 297.2 K,
barometric pressure: PB = 101.33 kPa,
relative humidity: Ra = 60 per cent,
saturation vapour pressure: Pd = 2.81 kPa of H2O at 23 °C.

Volume measured and reduced to standard conditions (para. 1.)
V = 51.961 m3

Analyser readings:

	Diluted exhaust sample *(Ce)*	**Dilution-air sample** *(Cd)*
HC (1)	92 ppm	3.0 ppm
CO	470 ppm	0 ppm
NOx	70 ppm	0 ppm
CO2	1.6 per cent by volume	0.03 per cent by volume

(1) in ppm carbon equivalent

THC calculation

Given that:

DF = $\frac{13.4}{C_{C02} + (C_{HC} + C_{CO}) \cdot 10^{-4}}$ for petrol and diesel

DF = $\frac{11.9}{C_{C02} + (C_{HC} + C_{CO}) \cdot 10^{-4}}$ for LPG

DF = $\frac{9.5}{C_{C02} + (C_{HC} + C_{CO}) \cdot 10^{-4}}$ for NG

DF's differs in percentage terms by the following:

ΔDF% (LPG – Petrol) = -11.2%

ΔDF% (CNG – Petrol) = -29.1%

Calculating for all fuels the corrected concentration of HC in the sampling bag:

$Ci = Ce - Cd \left(1 - \frac{1}{DF}\right)$

Ci = 89.371 for petrol
Ci = 89.418 for LPG
Ci = 89.558 for CNG

so, in percentage terms, the differences, in relation to petrol, are:

ΔCi **% (LPG-petrol) = +0.053%**

ΔCi **% (CNG-petrol) = +0.209%**

They are positive but negligible

THC calculation

Given that:

$\mathbf{M_{HC} = C_i * V_{mix} * Q_{HC}}$

Differences in DF's do not weigh significantly in final calculation.

Q_{HC}'s are, instead, influential:

QHC = 0.619 for petrol
QHC = 0.649 for LPG
QHC = 0.714 for NG

In conclusion, considering **the cycle fully driven on gas**, the mass emissions per km will be higher with respect to **the real case** (~30%petrol, ~70%gas):

ΔM_{HC}%(LPG-real)= + 1.56%
ΔM_{HC}%(LPG-real)= + 4.16%

Consumption calculation

Given:

$FC = (0.118 / 0.750) \cdot [(0.866 \cdot HC) + (0.429 \cdot CO) + (0.273 \cdot CO2)]$ for petrol

$FCnorm = (0.1212 / 0.538) \cdot [(0.825 \cdot HC) + (0.429 \cdot CO) + (0.273 \cdot CO2)]$ for LPG

$Fcnorm = (0.1336 / 0.654) \cdot [(0.749 \cdot HC) + (0.429 \cdot CO) + (0.273 \cdot CO2)]$ for CNG

Disregarding the minor factors, HC and CO, which are anyway higher in case of gas:

$FC \approx (0.118 / 0.750)*0.273*CO2 = 0.157*0.273*CO2$ for petrol

$FCnorm \approx (0.1212 / 0.538)*0.273*CO2 = 0.225*0.273*CO2$ for LPG

$Fcnorm \approx (0.1336 / 0.654)*0.273*CO2 = 0.204*0.273*CO2$ for CNG

In conclusion, **considering the cycle fully driven on gas**, FC's result higher in comparison with the real case (~30%petrol, ~70%gas).

$\Delta FC\%$ (LPG-real) ≈ + 10%

$\Delta FC\%$ (CNG-real) ≈ + 7.5%