Emission index problem

Thursday, December 7, 2017 11:56 AM

A spark ignition engine is running on a dynamometer test stand and the following measurements of the exhaust products are made:

CO_2 = 12.47%
CO = 0.12%
O_2 = 2.3%
C_6H_{14}(equivalent) = 367 ppm
NO = 76 ppm

All concentrations are by volume on a dry basis. The engine is fueled by iso-octane (C_8H_{18}, MW = 114.2 kg/kmol). Determine the emission index of the unburned hydrocarbons expressed as equivalent hexane. MW_{C6H14} = 86.2 kg/kmol.

$$EI_{C_6H_{14}} = \left(\frac{X_{C_6H_{14}}}{X_{CO} + X_{CO_2}}\right)\left(\frac{x\ MW_{C_6H_{14}}}{MW_{C_8H_{18}}}\right)$$

$$= \left(\frac{367 \times 10^{-6}}{0.0012 + 0.1247}\right)\left(\frac{8\ (86.2)}{114.2}\right)$$

$$= 0.0176\ kg/kg \quad or \quad 17.6\ g/kg$$

$$EI_{C_6H_{14}} = \left(\frac{X_{C_6H_{14}}}{X_{CO} + X_{CO_2} + 6X_{C_6H_{14}}}\right)\left(\frac{8\ (86.2)}{114.2}\right)$$

$$= \left(\frac{367 \times 10^{-6}}{0.0012 + 0.1247 + 6(367 \times 10^{-6})}\right)\left(\frac{8\ (86.2)}{114.2}\right)$$

$$= 0.0173\ kg/kg \quad 17.3\ g/kg$$

Corrected Concentration Problem

Thursday, December 7, 2017 12:03 PM

A spark ignition engine is running on a dynamometer test stand and the following measurements of the exhaust products are made:

CO_2 = 12.47%
CO = 0.12%
O_2 = 2.3%
C_6H_{14}(equivalent) = 367 ppm
NO = 76 ppm

All concentrations are by volume on a dry basis. The engine is fueled by iso-octane (C_8H_{18}, MW = 114.2 kg/kmol).

A) Convert the given NO concentration to a wet basis, and
B) What is the NO concentration corrected to 5% O2?

A) $X_{NO,wet} = X_{NO,dry} \frac{N_{mix\ dry}}{N_{mix\ wet}}$

$N_{mix\ wet}$, 4

$\frac{N_{mix,dry}}{} = 1 + \frac{}{2(4.76a - y/4)} = 1.146$

$a = \frac{X + (1 - X_{O2,dry})\, y/4}{1 - 4.76\, X_{O2\,dry}}$

$= \frac{8 + (1 - 0.023)\, 18/4}{1 - 4.76(0.023)} = 13.92$

$X_{NO\,wet} = X_{NO\,dry} \frac{N_{mix\,dry}}{N_{mix\,wet}} = 76\ ppm / 1.146$

$= 66.3\ ppm$

B) $N_{mix\ @\ ?O_2} = 4.76\left[\frac{X + (1 - X_{O2})\, y/4}{1 - 4.76\, X_{O2}}\right] - y/4$

$N_{mix\ @\ 2.3\%O_2} = 4.76\left[\frac{8 + (1 - 0.023)\frac{18}{4}}{1 - 4.76(0.023)}\right] - \frac{18}{4}$

$\simeq 61.76$

$N_{mix\ @\ 5\%\,O_2} = 4.76\left[\frac{8 + (1 - 0.05)\frac{18}{4}}{1 - 4.76(0.05)}\right] - \frac{18}{4}$

$= 72.18$

$X_{NO\ @\ 5\%\,O_2} = X_{NO\ @\ 2.3\%O_2} \frac{N_{mix\ @\ 2.3O_2}}{N_{mix\ @\ 5\%\,O_2}}$

$= 76 \text{ ppm} \left(\frac{61.76}{72.18} \right)$

$= 65 \text{ ppm}$