Heywood Problem 3-5

The measured engine fuel flow rate is 0.4 g/s, air flow rate is 5.6 g/s, and the exhaust gas composition (measured dry) is CO2=13.0%, CO=2.8%, with O2 essentially zero. Unburned hydrocarbon emissions can be neglected. Compare the equivalence ratio calculated from the fuel and air flow with the equivalence ratio calculated from the exhaust gas composition. The fuel is gasoline with a H/C ratio of 1.87. Assume H2 concentration equal to one third the CO concentration.

$$m_{fuel} = 0.0004$$

$$m_{air} = 0.0056$$

$$AF = \frac{m_{air}}{m_{fuel}}$$

$$y = 1.87$$

$$AFs = 34.56 \cdot \left[\frac{4 + y}{12.01 + 1.008 \cdot y}\right]$$

$$\phi_1 = \frac{AFs}{AF}$$

The stoichiometric equation looks like

CHy + 1/phi *(1+y/4) (O2 + 3.773 N2) = n1 CO2 + n2 H2O + n3 CO + n4 H2 + n5 N2

Balance

$$1 = n1 + n3$$

$$y = 2 \cdot n2 + 2 \cdot n4$$

$$\frac{1}{\phi_2} \cdot \left[1 + \frac{y}{4}\right] \cdot 2 = 2 \cdot n1 + n2 + n3$$

$$\frac{1}{\phi_2} \cdot \left[1 + \frac{y}{4}\right] \cdot 2 \cdot 3.773 = 2 \cdot n5$$

$$Nmdry = n1 + n3 + n4 + n5$$

$$0.13 = \frac{n1}{Nmdry}$$

$$0.028 = \frac{n3}{Nmdry}$$

Note that the two phi's compare well

Unit Settings: [kJ]/[K]/[kPa]/[kg]/[radians]

AF = 14	AFs = 14.6	m_{air} = 0.0056	m_{fuel} = 0.0004	n1 = 0.8228	n2 = 1.078
n3 = 0.1772	n4 = -0.1428	n5 = 5.472	Nmdry = 6.329	ϕ_1 = 1.043	ϕ_2 = 1.012

$y = 1.87$