

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.

$$m_{\text{fuel}} = 0.0004$$

$$m_{\text{air}} = 0.0056$$

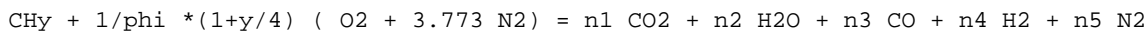
$$AF = \frac{m_{\text{air}}}{m_{\text{fuel}}}$$

$$y = 1.87$$

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

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

The stoichiometric equation looks like



Balance

$$1 = n_1 + n_3$$

$$y = 2 \cdot n_2 + 2 \cdot n_4$$

$$\frac{1}{\phi_2} \cdot \left[1 + \frac{y}{4} \right] \cdot 2 = 2 \cdot n_1 + n_2 + n_3$$

$$\frac{1}{\phi_2} \cdot \left[1 + \frac{y}{4} \right] \cdot 2 \cdot 3.773 = 2 \cdot n_5$$

$$N_{\text{mdry}} = n_1 + n_3 + n_4 + n_5$$

$$0.13 = \frac{n_1}{N_{\text{mdry}}}$$

$$0.028 = \frac{n_3}{N_{\text{mdry}}}$$

Note that the two phi's compare well

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

AF = 14	AFs = 14.6	$m_{\text{air}} = 0.0056$	$m_{\text{fuel}} = 0.0004$	$n_1 = 0.8228$	$n_2 = 1.078$
$n_3 = 0.1772$	$n_4 = -0.1428$	$n_5 = 5.472$	$N_{\text{mdry}} = 6.329$	$\phi_1 = 1.043$	$\phi_2 = 1.012$

$$y = 1.87$$