PROBLEM 7.1.4

$$C_2H_5OH + aO_2 + bNH_3 \rightarrow cCH_{1.704}N_{0.149}O_{0.408} + dCO_2 + eH_2O$$

a) WRITE 5 CONSTRAINTS:

$$RQ = \frac{\text{mol } CO_2 \text{ gen}}{\text{mol } O_2 \text{ cons}} = \frac{d}{a} = 0.66 \quad \#1$$

O ATOM BALANCE: $1 + 2a = 0.408c + 2d + e$ #2

H ATOM BALANCE: $6 + 3b = 1.704c + 2e$ #3

C ATOM BALANCE: $2 = c + d$ #4

N ATOM BALANCE: $b = 0.149c$ #5

THESE 5 EQNS CAN BE SOLVED SIMULTANEOUSLY TO FIND VALUES OF a, b, c, d, e:

FROM EQN 4: $d = 2 - c$

FROM EQN 1: $d = 0.669$ OR $a = 1.5152d = a = 1.5151(2-c)$

FROM EQN 5: $6 = 0.149c$

NOW REWRITE EQNS 2 & 3:

$$1 + 2[1.5152(2-c)] = 0.408c + 2[2-c] + e$$

$$6 + 3[0.149c] = 1.704c + 2e$$

OR

$$3.0608 = 1.4384c + e$$

$$6 = 1.257c + 2e$$

$c = 0.075$

$e = 2.953$

$d = 1.925$

$b = 0.012$

$a = 2.917$

MW C_2H_5OH = $2(12) + 6 + 16 = 46\ g/mol$

MW $CH_{1.704}N_{0.149}O_{0.408}$ = $12 + 1.704 + 0.149(14) + 0.408(16) = 22.32\ g/mol$

b) $Y_{X/S} = \frac{22.32\ g\ CELLS}{mol\ CELLS} \times \frac{0.075\ mol\ cells}{mol\ S} \times \frac{mol\ S}{46\ g\ S} = 0.036\ g/g$

$Y_{X/O} = \frac{22.32\ g\ CELLS}{mol\ CELLS} \times \frac{0.075\ mol\ cells}{2.917\ mol\ O_2} \times \frac{mol\ O_2}{32\ g\ O_2} = 0.018\ g/g$