UNIVERSITY OF
NOTRE DAME

Introduction to Chemical Engineering (CBE 20255)

Prof. William F. Schneider

NAME (PRINT):_____

AS A MEMBER OF THE NOTRE DAME COMMUNITY, I WILL NOT PARTICIPATE IN OR TOLERATE ACADEMIC DISHONESTY

SIGNED: _____

PLEASE SHOW YOUR WORK. CLEARLY DEMONSTRATE YOUR SOLUTION PROCEDURE AND STATE ANY ASSUMPTIONS YOU MAKE. WRITE YOUR SOLUTIONS IN THE SPACE PROVIDED. BLANK PAGES ARE INCLUDED TO PROVIDE MORE ROOM FOR YOUR WORK. ASK THE PROCTOR IF YOU NEED ADDITIONAL SCRATCH PAPER.

1 Clean combustion

Catalytic combustion in O_2 is a potentially clean way of getting the energy out of methane (CH_4):

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$$

but the catalytic process can be contaminated by the undesirable formation of formaldehyde (HCHO):

$$CH_4 + O_2 \longrightarrow HCHO + H_2O$$

CH_4 and O_2 are fed to a catalytic reactor in equimolar proportions at an assumed basis of $100\,\mathrm{mol\,s^{-1}}$ and allowed to come to steady state.

1.1 (4 pts) Draw a process diagram and label all the unknown variables.

1.2 (4 pts) Write down all possible atomic species balances.

1.3 (2 pts) Compare the number of unknowns to the number of balances.

1.4 (4 pts) The yield of formaldehyde (amount produced relative to the maximum possible produced) is 0.20. What is the formaldehyde flow rate exiting the reactor?

1.5 (6 pts) The methane conversion is 0.90. What is the selectivity to CO_2 over HCHO?

2 Full of gas, part 2

A 10.0 L bottle contains 0.500 mol of a gas at 298 °C.

2.1 (4 pts) Not knowing anything about the gas, what would you estimate the pressure inside the bottle to be? (Recall $R = 0.0821$ l atm/mol K.)

2.2 (4 pts) A friend tells you, "Oh, no, at these conditions the compressibility of that gas is 0.90." What is the pressure inside the bottle?

