Solve the following problems and show how you were able to arrive at the solutions. Describe and justify the assumptions that were made to solve the problems, if all of the information is not provided in the problem statement. You are welcome to work in groups but your final solutions and interpretation of the results are to be prepared individually. Provide a brief interpretation of your results for problem no. 2 (5 pt. per problem).

1) (40 pt) A Midwestern utility burns coal to produce 700 MW<sub>e</sub> (megawatt electrical power). The combustion air enters at 350 K and 101 kPa and coal enters at 300 K and 101 kPa. The thermal to electrical energy conversion efficiency is 35% when using the higher heating value (HHV) of the coal to determine the thermal to electrical conversion efficiency. The combustion chamber operates at an equivalence ratio (\(\phi\)) of 0.85. Assume (1) complete (no CO formation) and adiabatic combustion, (2) all nitrogen in the fuel and air forms N<sub>2</sub> (no NOx formation), (3) all Cl forms HCl (no Cl<sub>2</sub> formation), (4) all S forms SO<sub>2</sub> (no SO<sub>3</sub> formation), and (5) all ash becomes flyash. Standard temperature and pressure are 0°C and 1 atm, respectively. The coal contains 68.8% C, 4.5% H, 1.5% N, 7.7% O, 1.1% S, 0.4% Cl, 8.4% moisture, and 7.6% ash by mass, as received. The HHV of the coal is 25 MJ/kg, as received. The specific heats for the coal and ash are 1.5 J/g-K and 1.8 J/g-K, respectively.

1a) (15 pt) Determine the actual concentrations of CO<sub>2</sub>, H<sub>2</sub>O, N<sub>2</sub>, O<sub>2</sub>, HCl, and SO<sub>2</sub> units of actual percent by volume, and particulate matter in the flue gas stream using actual g/m<sup>3</sup>.

1b) (10 pt) Determine the concentrations of HCl, and SO<sub>2</sub> in the flue gas stream at 101 kPa, 0°C, dry and 12% dry CO<sub>2</sub> using units of percent by volume.

1c) (10 pt) Determine the mass emission rates of each of the gases species and the particulate matter in unit metric tonne/yr.

2) (20 pt) Locate a manuscript relevant to CEE546 that you would like to review and discuss in class. Indicate why the manuscript is important and why it is relevant to CEE546 in a brief paragraph of 5-10 sentences. Submit that manuscript and your paragraph with your solutions to this assignment.