EENV 444 Air Pollution Control II: Test # 2, Take Home Test: Fall 2024.

No group or consulting allowed.

Due on Dec 3, 2024, Tuesday in class 9:30 am or earlier.

Make appropriate assumptions when needed and justify

1.0 A 1000 MWe coal fired powerplant burns 12,500 Btu/lb. coal containing 2.5% sulfur and 150 ppb of mercury. You are asked to determine the efficiency of control system required to meet the NSPS (Based on energy output) for SO2 and Mercury. Also suggest the type of control systems you would recommend in order to meet the emission standards of SO2 and Hg. The thermal efficiency of the powerplant is 38%. If the coal contains 60% carbon, what will be the amount of CO2 emitted per day (tons) from this powerplant.

Following steps are used for grading your answers:

a) Identify the Emission Standards for SO2 and Hg (based on energy output) (3)
b) Determine the efficiency required to meet the above standards. Please show all your calculations (5)
c) Justify the type of control system you have chosen to meet the standards. (2)
d) Determine the amount of CO2 emissions and a brief note on its effect on climate change (2)

2.0 The company decided to use limestone FGD process to control the SO2 emissions from the above power plant with 95% removal of sulfur dioxide. You are a new engineer and you are asked to determine the amount of solid sludge created by the limestone process. The limestone available is at 95% purity (5% inert) and the process needs 15% excess limestone. Also determine the amount of energy required to run the main fan and for pumping the sludge, given the following information: Every pound of coal burned produces 16 pounds of exhaust with a MW of 29 and the L/G ratio is 70 gallons per 1000 scf. The sludge has to be pumped with a 100 feet head loss to store it in the pond. The sludge has a specific gravity of 1.15. Fan efficiency is 0.7 and the fan pressure drop is 12 inches of H2O. The pump efficiency is 0.7.

Steps used to grade your answer are:

a) identify equation to estimate the amount of limestone needed, theoretical and actual (4)
b) identify the amount of waste stream , solids and liquids (4)
c) Total Hp required for the fan, pump and heating the flue gas (4)

3.0 A 2 feet diameter packed tower packed with 1-inch ceramic Raschig rings, with a gas to liquid mass flow ratio of 1, is treating a gas stream containing 1.5 % ammonia (volume basis). The outlet ammonia concentration shall not exceed 0.1 % by volume to meet the EPA requirements at the exit gas stream of the tower. The tower is working at 100 F and 1

atmosphere and the gas stream is at 100F and 1 atm. The height of transfer unit based on overall gas film coefficients is 1.85. The slope of the equilibrium line is 1.3

Steps used to grade your answer are:

a) Determine the gas flow rate the packed tower could treat, to meet the emission requirements. (5)

b) Determine the height of the packed tower. Show all calculations including the graph (5)

4.0 A power plant is planning to use Wellman-Lord SO2 control process. Determine the amount of makeup soda ash required per day for the coal fired power plant given the following information: 600 MWe plant, 38% thermal efficiency, 12,000 btu/lb. coal with 1.5 % sulfur, 95 % sulfur removal is required. Steps used to grade your answer are:

a) determine the amount of SO2 to be removed (3)

b) determine the makeup soda ash required per day (3)

5.0 a) Estimate the NOx emissions in ppm and kg/hr. from a coal containing 1.8% organic nitrogen combusted at an air fuel ratio of 1.5 of stoichiometric. One thousand kg of coal is combusted per hour and producing 22,000 kg/hr. of flue gas (MW=28). Ignore the thermal NOx for this problem. (5)

5 b) Calculate the stoichiometric amount of air required for complete combustion in kg of air/kg of fuel, of fuel oil represented by the formula $C_{11}H_{20}N$. Assume no Thermal or Fuel NOx is formed. Complete combustion products are CO_2, H_2O and NO

Solve problem 16.9 from our text book (3)

6.0 Review "Code of Ethics" from two professional Societies and compare and contrast. The two professional societies (you may consider any two of these): American Academy of Environmental Engineers, American Society of Civil Engineers, Air and Waste Management Association, American Chemical Society and others. (2)