Today, we will:

- Continue our discussion about emission factors (EFs) and do some example problems
- Discuss how to *calculate*, *estimate*, and *measure* EFs

Example: EFs and APCS (Air Pollution Control System)

Given: A steel plant produces 820 Mg of steel per day using a basic oxygen furnace (BOF). Fumes are cleaned with an electrostatic precipitator before going up the stack. Measurements of the stack exhaust show that 32 kg of particulate matter are emitted per day.

To do: Calculate the overall efficiency of the APCS as a percentage (to 3 digits).

Solution: First we look up the EF of particle emissions in a BOF: EF = 14.25 kg/Mg.

Estimating EFs from Basic Chemistry

Example: EFs from combustion of natural gas

Given: Natural gas is burned in a power plant. There is no APCS. Exhaust gases go up the stack at $T = 500$ K and $P = 100$ kPa.

(a) To do: Estimate the mol fraction, mass fraction, mass concentration, and molar concentration of CO_2 going up the stack. Give all answers to 3 significant digits.

(b) To do: Estimate (from first principles and chemistry) the EF of CO_2 emitted by burning methane, and compare with EPA's published EFs for burning natural gas (NG).

Solution: Assumptions and Approximations:

- Assume NG is mostly methane CH_4. For simplicity, let's assume it is 100% methane.
- Assume ideal or stoichiometric combustion, meaning that *all* the carbon in the fuel gets converted to carbon dioxide in the combustion gases (exhaust gases).
- Assume **simple air** (also called **simple dry air**): 21% O_2, 79% N_2 by volume or by mol.

(**a**) Chemical equation:

$$CH_4 + a(O_2 + 3.76\ N_2) \rightarrow bCO_2 + cH_2O + dN_2$$

Solve for the molar coefficients:

Example: EFs and APCSs (Air Pollution Control Systems) in parallel

Given: On an average day, a chemical plant generates 40.0 Mg of a product, and in the process emits an air pollutant. The uncontrolled emission factor for the air pollutant is EF = 5.3 kg/Mg. The plant has in place an APCS with a removal efficiency E = 89.%.

(a) To do: Calculate the amount of the air pollutant actually emitted into the atmosphere on in one typical day. Give your answer in kg to two significant digits.

Solution:

(b) To do: The government regulation gets more strict, and the plant is allowed to emit only 10 kg of the air pollutant per day. Calculate the minimum efficiency of a second APCS that is to be put in series with the existing one in order to meet the new regulation.

Solution: