Article # 17

Five Steps to "Tons of CO_2 Mitigated"

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It has become fashionable to calculate tons of CO_2 mitigated by complicated software where the software knows what to do, but the user does not. This is called the black box syndrome. Firms operating machinery which burn carbonaceous fuels (boilers, furnaces) within their premises and are considering either compensating for their CO_2 emissions or reducing their CO_2 emission to claim CO_2 credits can follow a very precise and simple calculation procedure to establish their own CO_2 emissions without having to rely on some mysterious black box calculation and wondering how accurate their results are.

Step 1: Get the Carbon content of one kg of fuel. In case of coal, other solid fuels or natural gas it is best to let a laboratory do this. For commercially traded furnace and boiler oils, suppliers know this number. For LPG the carbon content depends on the weight fraction of propane and butane in LPG.

Step 2: Calculate the CO_2 generated if complete combustion takes place, i.e. all the Carbon of the fuel is burned to CO_2.

Example: Consider a high ash coal with 39.85 % C, and 36.15% ash.
One ton of this coal emits at most 0.3985 x 3.667 **=1.4613 tons of CO_2.**
The factor 3.6667 is derived from the stochiometric equation that 1 kgmol of Carbon weighs 12 kg and generates 1 kgmol of CO_2 weighing 44 kg (i.e., 44 kg of CO_2 produced per every 12 kg of C burned).

Step 3: Not all Carbon is burned to CO_2. Some remains in the residue or is incompletely burned to CO or is stored as liquid and gaseous C_nH_m. However, only the Carbon left in the residues is of any significance and should be calculated. Generation of CO and higher hydrocarbons (C_nH_m) is insignificant. Accounting for them is not improving the accuracy of the calculation since high levels of CO or soot are a sure sign of badly adjusted combustion and should not be considered a business as usual practice.

Step 4: Establish the Carbon remaining in the residues by the loss of ignition test (LOI). This test is standard and often performed on a daily basis in all combustion systems where coal is fired and of course unnecessary for gaseous or liquid fuels. It is in particular a necessity if excess air is adjusted since reducing excess air will usually increase LOI.

Example: Assume the LOI test revealed 8% Carbon in the residue of the coal. The total mass of residues (including ash and Carbon) can be calculated from the coal's reported ash content and the LOI test results: 0.3615/ (1- 0.08) = 0.39293. In other words firing of 1 ton of coal has generated 392.93 kg of residues. This residue contains however 8 % Carbon or 0.08 x 392.93 = 31.4 kg. Consequently 31.4 x 3.667/1000 = 0.1151 tons of CO_2 need to be subtracted because they were not formed.

The final result is 1.4613 – 0.1151 = **1.3462 tons of CO_2 are emitted.**

Step 5: The last step is to multiply this figure by the firm's annual consumption to arrive at the total tons of CO_2 emitted per annum by burning this coal. The uncertainty is changing coal qualities. The LOI changes as well depending on how combustion is controlled. However Step 4 is redundant if oil or gas is burned.