Geophysical Research Abstracts,
Vol. 11, EGU2009-8666, 2009
EGU General Assembly 2009

Carbon-14 based biomass fraction detection in power plant flue gas CO2: validation and results

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Replacing non-renewable fossil fuels by renewable fuels like biomass-based ones is one of the tools to combat increasing atmospheric CO2 concentrations. In order to promote biofuel-based electricity generation, a tool must be available to reliably quantify the bio-based CO2 fraction in the flue gas of a power plant. For traditional power plants, such as coal-fired ones to which wood is added, the calculation can be performed -albeit with considerable uncertainty- based on the weight and substance of the fuels. For e.g. waste incineration plants, however, such an approach is virtually impossible.
The carbon-14 method (also called radiocarbon or 14C) is the most direct, and therefore most powerful method to discriminate fossil from bio-mass CO2, as fossil fuel CO2 is virtually 14C-free, while biomass CO2 contains the present-day "natural" amount of 14C. Therefore, the carbon-14 we measure in a CO2 sample can be directly related to the fraction of biomass carbon in the specific sample. The carbon-14 method is such is well established, and routinely applied in an appreciable number of laboratories world-wide.
The project we conducted, in co-operation with the electricity generation company Essent, had two goals: (1) To demonstrate the applicability of the carbon-14 method, and to validate its result for the biomass fraction against fuel-based data and (2)To use the method for a waste incineration plant.
All 14C-determinations have been performed in our laboratory, using our Accelerator Mass Spectrometer (AMS) facility.

At the coal- and wood-fired “Amercentrale” we measured biomass CO2 rates to be just above 10% on the first sampling day and 5% on the second sampling day. The results for both days compared very well to those based on fuel input data. The 14C-based data, however, are potentially more accurate.
Subsequently, we determined the biomass fraction of the waste incineration plant “Moerdijk” to be on average $50.3 \pm 1.5\%$ during the sampling period (in total 10 hours, during two different days).

In conclusion, the Carbon-14 method applied on flue gas CO2 is a very reliable method to determine the biomass carbon fraction of combusted materials at a power plant or a waste incineration plant. For a waste incineration plant it is so far the most reliable method, as the diversity of the combusted waste materials in time, does not allow a proper calculation based on fuel data yet. Furthermore, the method is easy to implement in practice.