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Quantification of methane and nitrous oxide emissions from various waste treatment facilities by tracer dilution method

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Urban activities generate solid and liquid waste, and the handling and aftercare of the waste results in the emission of various compounds into the surrounding environment. Some of these compounds are emitted as gasses into the atmosphere, including methane and nitrous oxide. Methane and nitrous oxide are strong greenhouse gases and are considered to have 25 and 298 times the greenhouse gas potential of carbon dioxide on a hundred years term (Solomon et al. 2007). Global observations of both gasses have shown increasing concentrations that significantly contribute to the greenhouse gas effect. Methane and nitrous oxide are emitted from both natural and anthropogenic sources and inventories of source specific fugitive emissions from the anthropogenic sources of methane and nitrous oxide of are often estimated on the basis of modeling and mass balance. Though these methods are well-developed, actual measurements for quantification of the emissions is a very useful tool for verifying the modeling and mass balance as well as for validation initiatives done for lowering the emissions of methane and nitrous oxide. One approach to performing such measurements is the tracer dilution method (Galle et al. 2001, Scheutz et al. 2011), where the exact location of the source is located and a tracer gas is released at this source location at a known flow. The ratio of downwind concentrations of the tracer gas and the methane and nitrous oxide gives the emissions rates of the greenhouse gases. This tracer dilution method can be performed using both stationary and mobile measurements and in both cases, real-time measurements of both tracer and quantified gas are required, placing high demands on the analytical detection method. To perform the methane and nitrous oxide measurements, two robust instruments capable of real-time measurements were used, based on cavity ring-down spectroscopy and operating in the near-infrared spectral region. One instrument measured the methane and tracer gas concentrations while another measured the nitrous oxide concentration. We present the performance of these instruments at different waste treatment facilities (waste water treatment plants, composting facilities, sludge mineralization beds, anaerobic digesters and landfills) in Denmark, and discuss the strengths and limitations of the method of the method for quantifying methane and nitrous oxide emissions from the different sources. Furthermore, we have measured the methane emissions from 10 landfills with emission rates ranging from 5 to 135 kg/h depending on the age, state, content and aftercare of the landfill. In addition, we have studied 3 waste water treatment plants, and found nitrous oxide emission of 200 to 700 g/h from the aeration tanks and a total methane emission ranging from 2 to 15 kg/h, with the primary emission coming from the sludge treatment.

References

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