Assessment of Nitrogen Emissions from the Various Installation of Waste Treatment Plants to Support Waste Management in Mitigating Climate Change

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INTRODUCTION

The global N cycle is more severely altered by human activity than the global carbon (C) cycle, which has serious implications for human health, biodiversity, air and water quality (Suddick E.C., Whitney P. et al. 2013). The increased release of reactive nitrogen (Nr) into the environment is directly related to rapid population growth, urbanization, and socio-economic development in developing countries, which is directly related to the increase in the production of waste, which is one of the emissions sources of Nr. Reactive nitrogen easily moves in the atmosphere, from air to water and soil, and back to plants in its numerous chemical forms and affects atmospheric concentrations of the three most important anthropogenic greenhouse gases: carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) (Pinder R.W., Davidson E.A. et al.2012). The waste sector contributes <5% of global GHG Emissions. The waste fraction with the highest emissions from anthropogenic sources includes organic waste. In the urban area, organic waste is directly produced in households mainly as kitchen and green waste and in sewage treatment plants as sewage sludge. Organic waste is treated based on biological and thermal processes. In European countries, the biological treatment of waste is divided into (Jędrczak A. 2008): a. aerobic (composting) and anaerobic (methane fermentation) biological processes intended essentially for the treatment of clean, separately collected biodegradable waste, municipal and industrial origin, b. mechanical-biological treatment (MBT) processes intended mainly to treat mixed municipal waste before final storage. NH_3 emissions are mainly observed in the composting and storage process, while N_2O is formed at every stage of waste management. About 98% of N emissions from waste are NH_3 and 2% are N_2O. Waste combustion mainly produces NO_x emissions. Both NO_x and NH_3 emissions from waste indirectly cause N_2O emissions (Beck-Friis B., Smårs S. et al., 2001). The article presents the calculation of nitrogen emissions from various biological waste treatment installations. The aim of this article is to support decision-makers in making decisions in the field of organic waste management, taking into account the impact of various processing techniques on nitrogen emissions and climate change.

MATERIALS AND METHODS

The article presents nitrogen emissions from 6 biological treatment installations of various waste streams: 1. Composting green waste, 2. Composting bio-waste, 3. Composting sewage, 4. MBT - Biostabilization, 5. MBT - Biodrying , 6. MBT - Fermentation. The calculations were made for each stage of biological waste treatment, taking into account changes in quantitative and qualitative characteristics of waste.

RESULTS AND DISCUSSION

Figure 1 shows the mass flow and nitrogen emissions to air and in leachate from MBT in the process of aerobic biostabilization of waste.

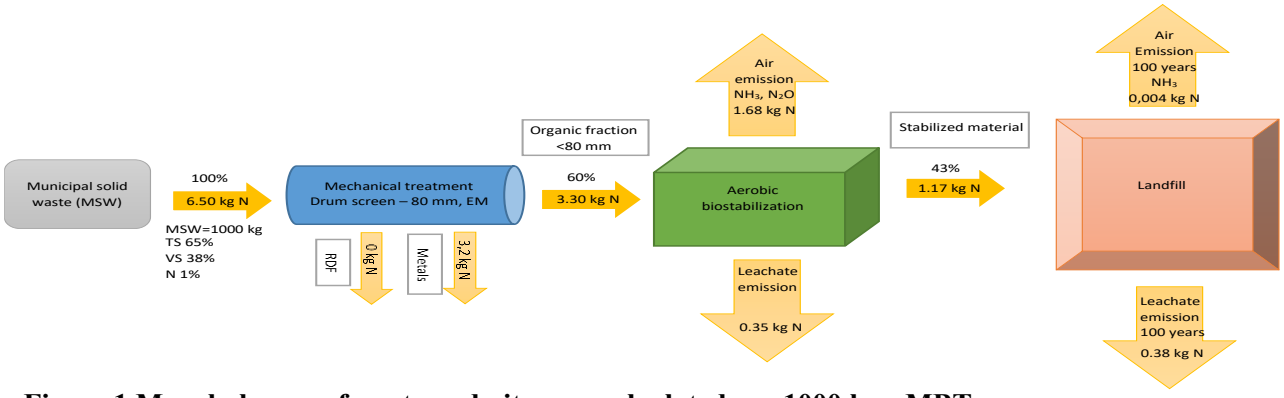

Figure 1 Mass balances of waste and nitrogen calculated per 1000 kg - MBT

The article shows that among the methods of biological waste treatment, the lowest nitrogen emissions come from the fermentation of waste and the highest from the aerobic biostabilization of the MSW. In this article, the emission assessment Nr was made based on the typical composition of the waste. The actual emissions depend on the composition of the waste, the operational conditions of the process, and the number of emissions avoided. The selection of the appropriate waste treatment technology can significantly reduce the Nr emissions.

CONCLUSION

Nitrogen emissions from waste treatment plants have a very big impact on the reduction of Nr and the control of direct emission to air, soil and water. In the literature information on the emission Nr from waste is still very limited and often random. The increase in knowledge in this area may have a very positive impact on waste management aimed at reducing emissions Nr.

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REFERENCES

Suddick, E.C., Whitney, P. et al., The role of nitrogen in climate change and the impacts of nitrogen–climate interactions in the United States: foreword to thematic issue, Biogeochemistry,114:1–10, 2013

Pinder, R.W., Davidson E.A. et al., Climate change impacts of US reactive nitrogen, PNAS 109 (20):7671–7675, 2012

Jędrczak, A., Biological Waste Treatment; Polish Scientific Publishers PWN Warsaw, Poland, 2008

Beck-Friis, B., Smårs S., Jönsson, H., Kirchmann, H. (2001). Gaseous Emissions of Carbon Dioxide, Ammonia and Nitrous Oxide from Organic Household Waste in a Compost Reactor under Different Temperature Regimes. Journal of Agricultural Engineering Research 78: 423-430.