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BIOGAS PRODUCTION FROM SEPARATED SLURRY AS A SLURRY MANAGEMENT STRATEGY: A CONSEQUENTIAL LIFE CYCLE ASSESSMENT

LORIE HAMELIN[1], MARIANNE WESNÆS[2], HENRIK WENZEL[3], BJØRN M. PETERSEN[4]

[1] Institute of Chemical Engineering, Biotechnology and Environmental Technology, University of Southern Denmark, Campusvej 55, 5230 Odense M. <loha@kbm.sdu.dk>
[2] Institute of Chemical Engineering, Biotechnology and Environmental Technology, University of Southern Denmark, Campusvej 55, 5230 Odense M.
[3] Institute of Chemical Engineering, Biotechnology and Environmental Technology, University of Southern Denmark, Campusvej 55, 5230 Odense M.
[4] University of Aahrus, Faculty of Agricultural Sciences, Research Centre Foulum, Blichers Allé 20, 8830 Tjele.

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ABSTRACT In high animal density countries, anaerobic digestion of slurry represents an environmental opportunity for both slurry management and renewable energy production. This study assesses the environmental consequences of four biogas production alternatives where slurry is the only input in the process (i.e. without supplementary addition of easily degradable carbon). This is achieved by concentrating the slurry through the use of different separation technologies. The biomass mixture input for biogas production thus includes solid fraction from slurry separation as well as raw slurry, proportioned in order to achieve economical methane yield. The separation processes considered are: mechanical separation (pig slurry), mechanical separation combined with the addition of flocculants ("mechanical-chemical" separation: for both pig and cow slurry) and mechanical separation combined with a thermal treatment (pelletisation: pig slurry). These four biogas alternatives were compared to a reference slurry management scenario, i.e. using the slurry as a fertiliser without prior treatment. The modelling is based on Danish conditions and uses the consequential life cycle assessment methodology. The produced biogas is used for production of heat and power and the degassed slurry is used as an organic fertiliser. The emissions inventoried are expressed per 1000 kg freshly excreted slurry and the inventory includes all emissions occurring after slurry excretion until application to land. The whole flow of biogenic carbon was considered in the study, including carbon sequestration as well as the emissions flows caused by changes in the soil carbon pool. Increased crop yield related to the use of digested slurry as a fertiliser was also considered. Inventoried emissions were related to eight environmental impact categories. Results showed that biogas from separated slurry does allow significant environmental benefits compared to the reference slurry management, though these benefits are very dependent upon the separation efficiency, especially for volatile solids. For all impacts categories assessed, two major hot spots were highlighted: in-house slurry storage (mostly through ammonia and methane) as well as field processes. The importance to account for biogenic carbon dioxide emissions resulting from changes in the soil carbon pool was also highlighted; for all scenarios, biogenic carbon dioxide represented more than 60 % of the positive contributions to the impact category “global warming”.

Keywords: Life cycle assessment, biogas, slurry, separation, anaerobic digestion, manure management.