

Comparative life-cycle assessment of sewage sludge treatment: pyrolysis, incineration and gasification

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Abstract. With the acceleration of urbanization processes, production of sewage sludge is growing rapidly. Treatment and conversion of sewage sludge into energy is a key objective of sustainable sludge management strategies. However, there is no optimal treatment technology for sewage sludge, as any method has also certain advantages and disadvantages regarding costs, environmental impact, energy production etc. This work is aimed at investigating the selection of a feasible and optimal thermochemical technology for the treatment of sewage sludge using a life cycle assessment (LCA) considering all categories of exposure. The study particularly analyzed three methods of treatment: 1) slow pyrolysis with different holding times to produce activated carbon and fast pyrolysis to produce biogas; 2) incineration of sewage sludge; and 3) gasification. A comparative assessment showed that the pyrolysis method led to the least environmental impact in most categories, including aquatic and terrestrial ecotoxicity, acidification of land and aquatic environments, etc., and has the most efficient energy balance and material recovery potential. Along with the comparative assessment, an analysis of residual solid materials from thermochemical processes, such as bio-coal and ash, was carried out to determine the possibility of mitigating their environmental impact. The conclusions of this work are an important tool in the decision-making process for the development of a safe and sustainable policy for the disposal of sewage sludge.