

Abstract

The environmental impact of electricity generation is significant because on one hand modern society uses large amounts of electrical power and on the other hand combustion processes based electricity generation poses serious environmental concerns. On the other hand, the idea of circular economy is becoming more and more popular, allowing the transformation of the household and industrial waste into the useful products.

Electricity generation via the gasification of disposed wooden railway sleepers and combustion of the syngas for electricity production in cogeneration is discussed in this thesis. During the production process of railway sleepers they are immersed in creosote oil to ensure their biocidal properties, therefore making them environmentally harmful. Consequently, the proper selection the utilization technique of disposed railway sleepers in order to maximally minimize the environmental burdens becomes very important issue. As the supplies of disposed railway sleepers are limited and geographically scattered (mostly along the railroads), as the reasonable method of their utilization with the recovery of their chemical energy, is electricity generation via gasification process and syngas combustion in internal combustion (IC) engines. Environmental aspects of such a complex technology have not been evaluated before, as the main use of disposed, wooden railway sleepers the incineration technology is outlined most often.

The substantial part of the thesis is devoted to the evaluation of the life-cycle environmental effects of the use of disposed wooden railway sleepers as a fuel for gasification process aimed at electricity production. To achieve this, the novel concept of the technology for this fuel gasification was elaborated. This concept was verified in the pilot scale by making experimental test runs. Apart from the pilot scale verification, experimental tests allowed to gather the data necessary for the stage of the life-cycle-inventory of LCA analysis. LCA analysis was carried out with the use of SimaPro software and as a methodology of environmental impact assessment, the ReCiPe method was selected. This in turn allowed to make a complex evaluation of the environmental impact of the regarded gasification technology in eighteen impact categories, three impact categories and finally one aggregated value expressed in ecopoints. The analysis was supplemented with the sensitivity analysis and the uncertainty analysis was also calculated.

Special attention was given to the comparison of the environmental impact of disposed railway sleepers to the alternative way of their utilization – incineration focusing on the giving a precise answer which of two compared methods is more environmentally friendly. The results

obtained proved that, the electricity generation via gasification of disposed railway sleepers is more environmentally friendly in terms of life cycle than their incineration, as it is the most common practise nowadays. Therefore, when regarding electricity production basing on disposed railway sleepers, the gasification process is more favourable instead of combustion for the disposed railway sleepers in the aspect of minimisation of environmental loads.

Apart from gaining the new knowledge in the area of environmental effects of this kind of solid waste – based fuel application for electricity generation combined with the production of heat in terms of life cycle assessment, the obtained results are very important from the practical point of view. The create a set of technological guidelines, necessary for the design and construction of real – scale gasification units which will be using disposed railway sleepers for distributed electricity generation.