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PLASMA WASTE TREATMENT: PROCESS DESIGN AND ENERGY OPTIMIZATION

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EXTENDED ABSTRACT

Plasma treatment is a technologically advanced and environmentally friendly process of disposing waste materials and converting them to commercially usable by-products. Plasma treatment, technically known as gasification / vitrification, is a non-incineration thermal process that uses extremely high temperatures in an oxygen starved environment to completely decompose input waste material into very simple molecules. The by-products of the process are a combustible gas and an inert slag. Furthermore, it consistently exhibits much lower environmental levels for both air emissions and slag leachate toxicity than competing technologies, e.g. incineration.

A typical plasma treatment system consists of a feed preparation subsystem, a plasma furnace and a gas cleaning system. It is mentioned here that the amount of off-gas produced by the plasma furnace, is less than a half of the amount produced by a comparable capacity incinerator. Furthermore and most importantly, due to the high operating temperatures in plasma furnace and to the following rapid quenching with water, the formation of complex molecules, such as dioxins, is prevented.

The product gas of the process is actually a clean synthesis gas, composed primarily of hydrogen, carbon monoxide and nitrogen with smaller amounts of methane, acetylene and ethylene. Starting from this point, a proposal for an integrated process design of the plasma treatment is presented in this work. The main goal of the proposed process design is to optimize the overall efficiency of the system by recovering the maximum amount of energy, which is expected to be sufficient not only to satisfy the electricity requirements of the plant but also to be available for sale.

To this purpose, we present a preliminary energy / exergy analysis of the plasma waste treatment process along with the proposed energy recovery system. The importance of a cogeneration subsystem that will recover the energy of the produced synthesis gas, which results in steam and electricity production, is demonstrated. Preliminary results for the case of an organic waste indicate the production of 0.8 MW electricity (net value) and 0.9 MW of steam.

Key words: plasma, waste treatment, process design, energy recovery, exergy analysis.