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Municipal Solid Waste Incineration: Recovery or Disposal. Case Study of City Timisoara, Romania

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Abstract

MSW incineration is found to be the most advanced level of the waste disposal/treatment hierarchy. It might be classified as either a recovery operation or a disposal operation. Municipal solid waste and bio-coal is converted into electricity and district heating by incineration. The considered waste incineration plant will be located in Timisoara, Romania. Moreover, the energy efficiency (R1) and primary energy savings (PES) were calculated. The obtained results, for three scenarios, exceed the limits imposed and qualify incineration as a recovery operation into a high efficiency cogeneration process.

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Keywords: case study; energy efficiency; municipal waste incineration; primary energy; recovery.

1. Introduction

Although the technology is widespread in Europe, in Romania so far have not been put into operation any incineration plants for municipal waste, the elimination thereof being carried out exclusively by depositing on the ground.

A Municipal Solid Waste Incinerator (MSWI) could be classified as either a recovery operation (R1 - Use principally as a fuel or other means to generate energy) or a disposal operation (D10 - Incineration on land) [1]. The same document makes clear, by introducing the energy efficiency formula (R1), when the incineration of municipal

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solid waste is energy-efficient and may be considered as a recovery operation. The R1 formula expresses the ratio between the energy recovery efficiency of an incinerator and that of a traditional power plant.

In [2] it was presented a correlation between R1 and exergetic efficiency and highlighted the limits of the R1 formula, which penalizes small facilities and those in hot climates. Besides, production of electricity from waste can give larger increases in exergy recovery and exergy efficiency than increasing the delivery of district or process heat although the latter is necessary to reach exergy efficiencies of 20% or more.

In [3] it was calculated, for a plant located in Bergen (Norway) both first-law and second-law-efficiency of a combined heat and power (CHP) plant. Focusing on the production of electricity from waste can give larger increases in exergy recovery and exergy efficiency than increasing the delivery of district or process heat although the latter is necessary to reach exergy efficiencies of 20% or more. Waste heat recovery from slag and especially exhaust gases also has the potential to contribute to an increase in exergy recovery.

[4] has analyzed the influence of plant-side and demand-side characteristics on primary energy savings. The plant-side and demand-side power to heat ratio of the energy system have been identified as crucial parameters of primary energy savings. The highest potential of primary energy savings is related to the electrical efficiency of the CHP plant. With increasing electrical efficiency (and therefore increasing plant-side power to heat ratio), the theoretical potential on primary energy saving also increases. In some countries, very large waste-to-energy plants are common, while in other countries smaller plants are more common. Germany and France have the largest capacities for MSW incineration. Although Germany has a higher capacity than France, France has the largest number of plants (125). Most of the countries have an incineration capacity of less than a quarter of their generated MSW. This can be an indication of either high recycling rates or large parts of waste going to landfills [5].

The aim of this study is to investigate whether for the case study, the incineration of municipal solid waste in a cogeneration plant is a recovery operation, by calculating both energy efficiency and primary energy savings (PES) from the design data of the plant.

2. Case studies

2.1. About the new CHP waste incineration plant in Timisoara, Romania

Waste incineration plant to be built and analyzed will be located in Timisoara, Romania. Timisoara is located at the following coordinates: 45° 47'N, 21° 17'E and has a total area of 130,5 square kilometers and about 304.000 inhabitants.

Alternative energy recovery from municipal solid waste was chosen also because in Timisoara there are:

- a waste sorting station serving as a recycling center which recovers approximately 45% of the municipal waste. The station consists of a hall inside which are mounted two processing lines, one for the manual selection of recyclable waste and the second for automatic sorting of waste reusable for energy purposes;
- a centralized system for heat supply, allowing the capitalization along with electric power and heat resulting from the incineration of the municipal solid waste;
- the possibility of implementation and use of green technologies for the storage of waste from waste treatment;

The fuel, whose type, annual quantity and net calorific value (NCV) [6] is presented in Table 1, whose energy will be used in a high efficiency cogeneration plant. It is composed of a boiler incinerator, which will produce about 40t /h steam at a pressure of 42 bar (a) and a temperature of 430° C, and a condensing turbo generator of approx. 7 MW, with two controlled steam extractions at 3,5 bar (a) and 0,8 bar (a) respectively.

The temperature inside the boiler exceeds 850° C, and optionally, for starting and maintaining a temperature higher than 850° C, the boiler is equipped with two gas burners. The burners with natural gas have both a power of 12 MW operated by programmable automatic system. Two heat exchangers transfer the heat of the steam extracted from the turbine to district heating network having a temperature of 115° C in winter and 85° C in the summer.

Water temperature in the district heating return pipe has about 60°C. The maximum heat output that will be delivered in the district heating network is 22 MW. Currently the district heating system has two power sources (CHP Timisoara South and district heating plant Timisoara Center). The waste incineration plant will be located in the vicinity of Timisoara South CHP and the waste sorting station.