

COMPARATIVE LIFE CYCLE ASSESSMENT OF VOLATILE ORGANIC COMPOUNDS PURIFICATION METHODS: NON-THERMAL PLASMA VS OZONATION

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Abstract

Volatile organic compounds (VOC) are significant source of pollution in industrial processes related to production of paint, varnish coating and other chemicals. There are several methods for VOCs cleaning from the industrial gas streams. The treatment methods based on active generation of oxidizing particles for ventilation exhaust cleaning are gaining popularity and can compete with traditional methods.

The aim of the study – to make a comparative life cycle analysis of two methods for purification of volatile organic compounds: non-thermal plasma (NTP) based on corona discharge and ozone generation based on dielectric-barrier discharge (DBD) principles.

SimaPro 8.1 software using IMPACT 2002+ method and Ecoinvent 3 database was applied for the life cycle analysis. The general LCA procedures were performed according to the ISO 14040 standard. Two VOC cleaning technologies have been modeled for ventilation exhaust gases. The capacity of the ventilation exhaust cleaning functional unit was set 1000 Nm³ of flue gases. The performance data for calculations (process inputs and outputs) have been normalized to this capacity, thus allowing to make comparison. The initial concentration of pollutants in the exhaust gas was chosen equal in both processes.

In this study, system boundaries were set to the processes of the flue gas treatment technologies. The resources needed for the transportation of process material and the elimination of byproduct, as well as the materials used for the manufacturing the flue gas treatment devices were not evaluated. The main attention was paid to the technological process with respect to the material and energy consumption and emissions to the atmosphere.

The modeling results revealed that in the categories ‘global warming potential’ and ‘ozone layer depletion’, NTP process indicated twice lower impact values compared to ozone generation by DBD method. Assessment of damage by categories: human health, ecosystem quality, climate change and resources, also indicated merit of NTP process. As a result, comparative LCA of flue gas purification from volatile organic compounds revealed that non-thermal plasma method (NTP) has advantage against ozone generation based on dielectric-barrier discharge (DBD) method.

Keywords: VOCs, non-thermal plasma, dielectric-barrier discharge, life cycle assessment.