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## An Assessment of Pollution with Volatile Organic Compounds in the Electric Arc Furnaces

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### Abstract

The steelmaking in the electric arc furnace is in the category of the industrial processes with high degree of pollution because in the air environmental factor are transferred the following pollutant substances: volatile organic compounds (VOCs), particulate matter, carbon oxides, sulphur oxides, nitrogen oxides, dioxins and furans. The aim of this paper is to assess the volatile organic compounds (VOCs) emissions from steelmaking in the electric arc furnaces, in order to improve the industrial gaseous emissions management. The experimental researches were carried out on two electric arc furnaces with alkaline lining. The measurement of volatile organic compounds emissions was performed using a Mini Rae Plus Classic device. After evaluating the level of emissions, during the melting stage of charge, it results that the VOCs concentrations from electric arc furnaces depend on the degree of contamination of the charge with organic matter, paints and plastics. The reduction of volatile organic compounds emissions to the steelmaking in the electric arc furnaces may be accomplished by charge component selection and by the use of raw materials with a degree of contamination as low as possible.

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## 1. Introduction

Volatile organic compounds (VOCs) incorporate a wide range of carbon-containing compounds that are emitted into the atmosphere from a variety of industrial processes. One of the industrial sources of volatile organic compounds emissions from the ferrous metals industry includes electric arc furnaces [1,2,3,4,5,6,7].

Volatile organic compounds, as defined in EU Directive 2010/75 [8,9], are organic compounds having at 293.15 K a vapour pressure of 0.01 kPa or more, or having a corresponding volatility under the particular conditions of use. Due to their characteristics, the use of VOC solvents in certain installations generates emissions of organic compounds that contribute directly to air pollution and climate change and are also ozone precursors i.e. they react chemically with nitrogen oxides in the presence of sunlight to form ozone. While ozone is beneficial in the upper atmosphere, where it shields the earth from dangerous UV rays, it can be harmful when present in high concentrations at ground level. According to EC Directive 1999/13/EC [10], an organic compound is defined as any compound containing at least the element carbon and one or more of hydrogen, halogens (e.g., chlorine, fluorine or bromine), oxygen, sulphur, phosphorus, silicon, or nitrogen, with the exception of carbon oxides and inorganic carbonates and bicarbonates. An even wider definition is used in the EU National Emissions Ceilings Directive 2001/81/EC [11], where a VOC is any organic compound of anthropogenic nature, other than methane, that is capable of producing photochemical oxidants by reaction with nitrogen oxides in the presence of sunlight.

Volatile organic compounds (VOCs) are of serious environmental concern because of the harmful properties that they exhibit in varying degrees. These include [1,3]:

- direct toxicity to human health;
- contribution to photochemical ozone generation at ground level, with consequent harmful effects;
- destruction of stratospheric ozone;
- contribution to global climate change.

The side effects of the volatile organic compounds on human health can consist of: respiratory system diseases, cardiovascular and gastrointestinal diseases, eyesight problems and skin diseases. Volatile organic compounds are hepatotoxic, nephrotoxic, neurotoxic and carcinogen.

The harmfulness of volatile organic compounds (VOCs) varies greatly, not only because the individual and combined significance of these properties exhibits wide variation between substances, but also it depends on the presence of other substances in the environment. This is related to mass release rate, subsequent dispersion and to its environmental persistence. According to their harmfulness, the volatile organic compounds (VOCs) are divided in the following categories [12,13]:

- extremely hazardous to health (substances such as benzene, vinyl chloride and 1,2 - dichloroethane);
- Class A compounds - those organic compounds that may cause significant harm to the environment (may contribute substantially to photochemical ozone creation or stratospheric ozone destruction or global warming);
- Class B compounds - organic compounds of lower environmental impact than Class A compounds (the remaining majority of VOCs are of lower harmfulness, but whose release must be prevented or minimized).

The potential sources that generate the volatile organic compounds in the steelmaking are: organic matters, paints and plastics from the charge [2]. Sources of volatile organic compounds (VOCs) from electric arc furnaces include [12]:

- scrap preparation with solvent degreasers;
- combusting auxiliary fuel;
- hydrocarbons contained in the oils, wire casing, foam and plastics found in the steel scrap feedstock can vaporize when melting takes place;
- decarburization of scrap;
- charging of the furnace;
- tapping of the molten metal and slag.

The aim of this paper is to assess the volatile organic compounds emissions from steelmaking in the electric arc furnaces, in order to improve the industrial emissions management, by identifying the sources that generates these air pollutants.

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