DOI: 10.34854/ICPAF.52.2025.1.1.173

MATHEMATICAL MODELING OF THE PLASMA CONVERTER *)

[1,2]Petrenko P.I., [1]Chemodanov N.S., [1]Artemov A.B., [1]Pereslavtsev A.V., [1]Voshchinin S.A.

[1]National Research Center "Kurchatov Institute", Moscow, Russia, petrenko_pi@nrcki.ru.
[2]National Research Nuclear University "MEPhI", Moscow, Russia.

The purpose of this work is to develop a mathematical model of the plasma converter (plasma furnace) of equal temperatures as the main unit of the plasma waste processing complex. A distinctive feature of the furnace of equal temperatures is that the shaft of such a furnace is free and not filled with waste. In this case there is no temperature gradient along the height of the plasma converter.

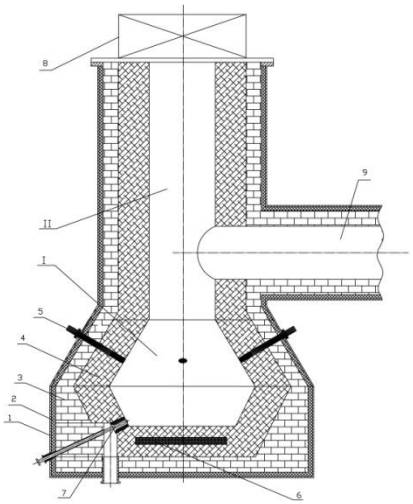

Figure 1. Plasma converter with waste capacity of 830 kg/hour

The advantage of this design is that in such a furnace plasma-chemical reactions take place practically in the entire volume of the furnace, which makes it possible to regulate the physicochemical processes, stoichiometry and composition of the gases produced.

Based on previous studies, [1] a mathematical model of the physical and chemical processes in a plasma converter has been developed.

Energy supply into the converter is carried out by four EDP-600 plasmatrons with nominal electric power of 600 kW each, placed in the vault of the pyrolysis and melting chamber. The working gas of plasmatrons is carbon dioxide (CO2), consumption per 1 plasmatron is 185 kg/h.

The converter has a tuyere for oxygen supply placed in the vault of the pyrolysis and melting chamber. Oxygen supply is up to 240 kg/h.

At this stage of modeling, the following model composition of primary pyrolysis waste was used after decomposition of the waste material in the chamber: a mixture of toluene 33% (361 kg/h), water (H2O from the waste composition 54%, 592 kg/h, H_2O <l> 13%, 149 kg/h).

The source of the liquid product mixture is placed on the assumed surface of the slag melt at a level of 100 mm from the converter hearth.

To model the flow dynamics in the combustion area, was used the system of equations for the k-ε turbulence model with the Non Premixed Combustion model.

Based on this model, the distributions of temperature, velocity and gas current lines were calculated. We plan to develop a plasma-arc ejector for experimental work on the «Prometheus» bench.

References

[1]. Pereslavtsev A.V. Plasma waste processing: a monograph / A.V. Pereslavtsev, S.A. Voshchinin, A.V. Artemov. - Vologda: Infra-Engineering, 2023. - 436 c.

*) abstracts of this report in Russian