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PLASMA REACTOR FOR MATERIAL SYNTHESIS AND WASTE RECYCLING*

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In the modern world, a huge amount of waste of various origins is accumulated: municipal solid waste, industrial waste and organic waste [1]. Separate types of waste can be processed in various ways, such as thermochemical method (combustion, gasification, pyrolysis) and biochemical (anaerobic digestion) [2]. There is a group of plasma methods for waste disposal, the advantages of which can be considered: the possibility of achieving high temperatures and heating rates [3]. The main disadvantage is the relative complexity of the design of plasma reactors, their cost and the high energy intensity of the waste recycling process [4]. In this regard, the issue of simplifying the design of plasma reactors and increasing their energy and resource efficiency is topical. One of the approaches for improving such reactors is the use of air as the initial working gaseous atmosphere [5]. This approach makes it possible to reduce the weight and dimensions of arc reactors; allows to abandon the vacuum circuit as part of the installation, which further reduces the energy intensity of the waste processing process.

In the course of the research, an atmospheric arc plasma reactor was created [6], its automation system was developed, and software was written for it [7]. The reactor contains a power source with a working direct current up to 200 A, electrodes - an anode and a cathode in the form of rods; a working non-sealed graphite chamber in the form of a glass, in the walls of which holes are made, into which the electrodes of the discharge circuit are inserted. The system for recording electrical parameters includes a two-channel digital oscilloscope, a Hall sensor and a potentiometer-type voltage divider.

The created arc reactor was tested in the processes of recycling various wastes: plastics, rubber tires, broken glass, ash and slag waste.

The peculiarity of the created reactor is the use of atmospheric air as a working gaseous atmosphere. At the same time, the synthesis products are gaseous products (namely, methane, hydrogen, CO and CO_2 gases), which shield the reaction zone from atmospheric oxygen, preventing oxidative processes; this also enables to synthesis of various materials, in particular, carbon nanostructures in the process of waste disposal. Preliminary calculation and experimental data show the possibility of reducing the energy intensity of the waste processing process by eliminating the vacuum circuit and the vacuum pump by about 10 times compared to direct analogues. At present, the created reactor and the methodology for working on it are implemented on a laboratory level. Further research will focus on recycling other types of waste and scaling up.

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