Energy efficient utilization of sorting «tailings» of solid municipal waste to obtain solid and gaseous fuel

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Annotation

Currently one of the most important areas of development in the world is the introduction of efficient technologies for the deep processing of renewable raw materials and waste. Municipal solid waste (MSW) has a high proportion of combustible components containing various hydrocarbons, so they can be used to produce energy. RDF (refuse derived fuel) is a ready-made fuel with high heat of combustion, which can be used as a main or additional source of thermal energy. In my study the MSW residues are used as raw material for RDF, after sorting at the waste sorting station in Lipetsk.

In the work I examined industrial furnaces for the construction and metallurgy industries as possible consumers of such fuel. Since reserves of natural raw materials are gradually being depleted, the use of various wastes to replace mineral fuel in such furnaces is very relevant. Therefore, in the dissertation work I proposed to use RDF pyrolysis gas to replace part of natural gas, which allows stabilizing the composition and heat of gas combustion, reducing the cost of traditional fuel and eliminating the formation of ash and impurities that degrade the marketable product rate.

Thus, the possibility of qualified energy utilization of MSW, reduction of landfill, resource saving when replacing part of RDF mineral fuel makes the topic of dissertation research relevant. In my dissertation work I solved the following strategic problems: 1 - obtaining RDF with a combustion heat comparable to solid mineral fuel; 2 - reducing of the environmental load when handling MSW using the example of a municipality with a population of 500 thousand people; 3 - reducing of cost price of energy-intensive industries products due to replacement of part of energy resources with pyrolysis gas, emphasizing product quality-assurance requirements on the example of cement clinker firing furnaces.

The main goal of the present work is the scientific justification and development of the technology for the production of RDF from the MSW residues after sorting at a waste sorting station with the possibility of obtaining of high-calorie pyrolysis gas to replace part of the traditional fuel in energy-intensive industries. The problem of the environmental load reduction of large municipalities due to a significant reduction of MSW landfill volume was solved.

The main tasks were:

- to determine the morphological composition and characterize the qualitatively combustible components of the MSW residues at the waste sorting station of Lipetsk;

- to assess the energy potential of fuel fractions of the MSW residues and compare the indicators with traditional solid energy resources;

- to substantiate the technology of the MSW residues processing to realize the energy potential and develop a procedure for producing of solid fuel from fuel fractions of MSW (RDF), as well as to study the physical and chemical properties of fuel briquettes obtained according to the proposed technology;

- to investigate the composition of gases of polymers pyrolysis, as well as of RDF pyrolysis and experimentally determine the material balance of the RDF pyrolysis process;

- to experimentally confirm the efficiency of using an available aluminosilicate catalyst to increase the combustion heat of pyrolysis gas, to determine the recommended dosage of the catalyst when preparing RDF

- to substantiate environmental safety measures for the use of solid fuel based on MSW as an alternative energy source for heating of cement clinker kilns;

- to develop a computer model of the RDF pyrolysis process to optimize the process mode.

Scientific novelty. 1. A scientific and technological substantiation of the effective production and use of RDF fuel from MSW residues after industrial sorting and a technology for the production and use of RDF pyrolysis products to replace part of natural gas when heating industrial furnaces-reactors were developed. 2. The typical morphological composition and technical characteristics of MSW residues after industrial sorting were determined using the example of the industrial city of the Central Federal District with a population of 500 gys. people, the efficiency of obtaining fuel from MSW residues was proven. 3. Thermal behavior during pyrolysis of the main polymeric materials that make up the basis of MSW residues after sorting (LPPE, LDPE, PP, and PET) with varying temperature and heating rate was studied, the composition of the pyrolysis gas of polymer wastes was experimentally determined, and its combustion heat was calculated. The possibility of using montmorillonite in fuel to increase the gas yield due to reduction of liquid pyrolysis products yield was investigated. 4 The analysis of combustion conditions of RDF and pyrolysis gas was carried out,

solutions that ensure environmental safety of the use of these energy resources in industrial furnaces using the example of a cement clinker firing unit were proposed. 5. For the first time, a computer model of the RDF pyrolysis process was developed in the ChemCad software package, which makes it possible to predict the amount and average composition of pyrolysis products, select the optimal operating mode of the reactor depending on the morphological composition of the reference fuel.

The theoretical and practical significance of the work. Morphological analysis of MSW residues after sorting at a waste processing enterprise in Lipetsk was carried out, the possibility of using them as raw materials for the production of alternative fuel for industrial furnaces, which will reduce the volume of waste sent for disposal, was shown. A technology of RDF production from combustible fractions of MSW residues of the city of Lipetsk was developed. Optimal conditions of pyrolysis, which provide the maximum yield and high heat of the pyrolysis gas combustion, were determined. The dosage of a catalytic aluminosilicate additive of montmorillonite in RDF, which provides an increase in the combustion heat by 16% and an increase in the volume of pyrolysis gas by 1.2 times was determined. Measures to ensure the environmental safety of RDF combustion in cement kilns are proposed and substantiated. The expected economic effect from the introduction of the technology was calculated. A computer model of RDF pyrolysis was developed based on the literature and experimental data on the kinetics of thermal decomposition of fuel in the ChemCad software package.

Key points for the thesis presentation:

1. The results of determining the morphological composition, ash content, the yield of volatile substances, moisture content of MSW residues after sorting at the waste sorting station in Lipetsk, substantiation of feasibility of its use as a secondary energy resource.2. Technology for obtaining of RDF from MSW residues. 3. Experimentally determined compositions of products of polymers and MSW pyrolysis, technological conditions of pyrolysis.4. Results of using an aluminosilicate additive in RDF to increase the yield of pyrolysis gas and its combustion heat. 5. Substantiation of environmental safety conditions for use of energy resources from MSW for cement furnace heating. 6. Economic substantiation of application of the proposed MSW processing technology. 7. Computer model of RDF pyrolysis based on experimental and literary data of the process.