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Opracowanie modelu matematycznego zjawiska emisji metali ciężkich do powietrza, wody i ziemi w wyniku spalania paliw stałych w obiektach energetycznych

Rozprawa doktorska

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Development of a mathematical model of the phenomenon of heavy metals emission to air, water and soil as a result of combustion of solid fuels in power unit

Abstract

The conducted research confirmed the possibility of reducing mercury emissions from flue gas by using a polymer material and a hybrid solution including the analyzed material and other sorbents. The results of laboratory tests were used to develop a mathematical model to model the mercury reduction process. The doctoral dissertation also included an analysis of the possibility of using other sorbents to reduce mercury emissions. Based on the collected object data, a dedicated numerical model was developed as part of the work, allowing modeling of the mercury adsorption process on the activated carbon surface.

The conducted research indicated that in the case of a hybrid solution, polymer modules should be used as the primary method of reducing mercury emissions, while activated carbon should be used to obtain the output mercury concentration in exhaust gases required by regulations. This is especially important when the mercury concentration at the inlet varies greatly due to changes in mercury content in the fuel. The use of a polymer module installation together with activated carbon gives a chance to achieve the mercury concentration to the desired level, because a solution based only on modules does not allow for quick adaptation to changing flow conditions and, as mentioned earlier, to the variable mercury content in coal. Using only a polymer solution is associated with less flexibility and higher investment costs, which can also lead to overinvestment and operation of the installation at incomplete capacity.

Considering the above, the work also attempts to estimate the OPEX and CAPEX costs of the solutions analyzed in the work. Various combinations of technologies have been presented, showing solutions that seem to be the most advantageous from the economic point of view for the selected reference object. The research carried out as part of the doctoral dissertation is an important contribution to the existing knowledge on the use of hybrid solutions dedicated to reducing the emission of harmful mercury into the atmosphere. The developed numerical models will allow in the future to select the appropriate configuration and technology for a given facility, along with the possibility of reducing the CAPEX investment cost and lowering the OPEX operating cost.