Numerical Assessment of the Rates of Solid Fuel Combustion Reactions and Their Impact on the Working Process of a Solid-Fuel Piston Engine

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Abstract

The use of coal as a motor fuel for internal combustion engines (ICE) is a topic that periodically arouses interest among specialists due to the relatively low cost and significantly greater proven reserves of these fuels on Earth. The use of coals with a high degree of conversion of the chemical energy contained in them into mechanical work can be especially relevant for marine energy, which is based on ICE. The transition to cheaper solid fuels in the future will strengthen the leading position of the merchant fleet in the global transportation market. At the end of the new century, under the auspices of the United States (U.S.) Department of Energy, a research program for this problem was implemented, during which not only experimental studies were performed but also the theoretical foundations for modeling solid fuel combustion processes in the working space of a piston engine were developed. Based on this experience, the authors proposed their own solution to the problem of using solid fuels in reciprocating engines based on the forced purging of a layer of solid fuel in an external reactor having a common heat and mass transfer with the working cylinder of the engine. The main limiting factor determining the feasibility and nature of the course of the proposed thermodynamic cycle are the rates of solid fuel burnup reactions in the engine reactor. To study the nature of the course of the main reactions, the authors implemented a mathematical model based on techniques previously tested for solving problems associated with the burning out of solid fuel particles entering the engine's working space as part of water-coal suspensions. The analysis of the results of modeling the process of burning solid fuel in the reactor of a high-speed solid-fuel piston engine (SFPE) with forced purging of the layer is devoted to this article.

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Topic

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- Engines
- Pistons

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