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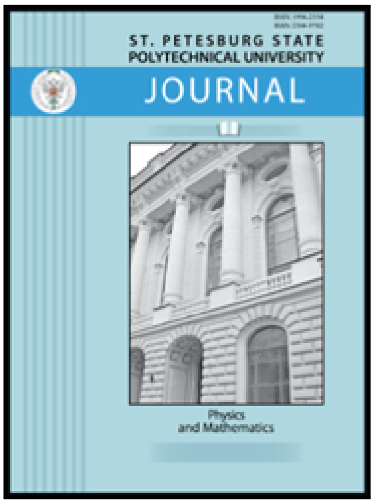

The EOS choice effect on the simulated results obtained for an underwater electrical explosion of conductors

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The EOS choice effect on the simulated results obtained for an underwater electrical explosion of conductors

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In the paper, the effect of the choice of equations of state (EOSs) depicting the states of metal plasma and water on the simulated results obtained for an underwater electrical explosion of conductors has been analyzed. In order to compare various EOSs, a one-dimensional, cylindrically symmetrical, magnetohydrodynamic model of an underwater wire explosion was employed. The simulated results were compared with the experimental data on both micro- and nanosecond explosions of aluminum and copper wires. The right choice of EOSs and the model of transportation coefficients allowed us to improve the agreement between the experimental and simulated data and to replicate the thermodynamic evolution of the system more closely. The comparison revealed the most appropriate EOSs for application to simulation of an electrical explosion.

Key words: magnetohydrodynamics; electrical explosion of conductors; metal plasma; equation of state

Introduction

Electrical explosion of conductors (EEC) is the process of sudden expansion of matter in the course of intense Joule heating of the volume of a metal by an electric current pulse. This phenomenon is interesting both from a practical and from a theoretical standpoint. The practical interest in the EEC is due to a wide range of its applications, including methods for creating soft radiation sources, generating shock waves and synthesizing energy-saturated nanoparticles. The theoretical interest is directed towards studying a complex multiphase phenomenon associated with the behavior of matter under extreme thermodynamic conditions [1]; this phenomenon pertains to the field of physics of high energy densities. The electric explosion in water considered in this study is an instrument for creating shock waves used in stamping, and an object for analyzing chemical reactions at the interface between molten metal and water.

Mathematical modeling plays a key role in the study of electric explosions. The currently existing models can provide a qualitatively complete picture of the discharge in the exploding conductor and the subsequent evolution of the system. Quantitatively accurate estimates of the distributions of thermodynamic