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A new general form of characteristics method applied on minimum length nozzles design

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In this work, we present a new form of characteristics method, which is a technique for solving partial differential equations. Typically, it applies to first-order equations; the aim of this method is to reduce a partial differential equation to a family of ordinary differential equations along which the solution can be integrated from some initial data. This latter developed under the real gas theory, because when the thermal and the caloric imperfections of a gas increases, the specific heat and their ratio do not remain constant anymore and start to vary with the gas parameters. The gas doesn't stay perfect. Its state equation change and it becomes for a real gas. The presented equations of the characteristics remain valid whatever area or field of study. Here we need to have inserted the developed Prandtl-Meyer function in the mathematical system to find a new model when the effect of stagnation pressure is taken into account. In this case, the effects of molecular size and intermolecular attraction forces intervene to correct the state equation, the thermodynamic parameters and the value of Prandtl-Meyer function. However, with the assumptions that Berthelot's state equation accounts for the molecular size and intermolecular force effects, expressions are developed for analyzing the supersonic flow for thermally and calorically imperfect gas. The supersonic parameters depend directly on the stagnation parameters of the combustion chamber. The resolution has been made by the finite differences method using the corrector predictor algorithm. As results, the developed mathematical model used to design 2D minimum length nozzles under the effect of the stagnation parameters of fluid flow. A comparison for air with the perfect gas PG and high-temperature models on the one hand and our results by the real gas theory on the other of nozzles shapes and characteristics are made.

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