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Effect of the stagnation temperature on the normal shock wave

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Abstract

When the stagnation temperature increases, the specific heat does not remain constant and starts to vary. The gas is perfect, its state equation always remains valid, except when it was called by gas calorifiquement imperfect or gas at high temperatures. The purpose of this work is to develop a mathematical model for a normal shock wave at high temperatures; when the stagnation temperature is taken into account, less than the dissociation of the molecules as a generalisation model of perfect with constant heat-specific. A study on the error given by the perfect gas model compared to our model is presented in order to establish a limit of application of the perfect gas model. The application is for air.

Key words:*Supersonic flow, Subsonic flow, High temperature, Supersonic nozzle, Thermodynamics ratios, Normal choc wave, Entropy, Relative error, Interpolation*

1. Introduction

The study of an ideal gas flow (PG) can be made under the basis of a few known cases (Anderson, 1988; Zucker and Bilbarz, 2002; Oosthuisen and Carscallen, 1997; Anderson, 1982; Comolet, 1979 ; Powell, 1978). Among these assumptions, the gas must be calorifiquement perfect. The specific heats are constant and do not depend on temperature, which is not really the case when the temperature increases.

The purpose of this work is to develop a mathematical model by adding the effect of change of CP with temperature, lower than the dissociation threshold of molecules, where the gas becomes calorifiquement imperfect and thermally perfect. The development of a mathematical flow through the shock is based on the use of equations, conservation of the mass, quantity of movement and energy, adding the state equation of gas perfect. The shock is characterized by the conservation of stagnation temperature (Zucker and Bilbarz, 2002; Comolet, 1979). In reference (Hill and Peterson, 1965), we find, for air, a table containing some values CP and γ depending on the temperature in the interval 55 K and 3550 K. An interpolation polynomial is made to the values of the table (McLain, 1974; Powell, 1978) to find an analytical function CP (T) (Zebbich and Youbi, 2007; Zebbiche and Youbi, 2005; Zebbiche and Youbi, 2006; Zebbiche, 2008).

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