Plasma torches are widely used in manufacturing processes of plasma heating (particularly in supersonic and hypersonic aerodynamical testing), alloys and metal processing (melting, cutting, coating etc.), and also for industrial waste disposal. Current issues of plasma torch modeling are the adequate consideration of MHD-effects in arc currents, intense turbulence generation due to a sharp heat emission (a fluent electric arc zone with the heat density of $2 \cdot 10^{11}$ W/m$^3$). High temperatures often require both correct transport coefficients and radiation transport calculation in view of non-equilibrium plasma. Combustion and non-transferred electrical arc heating is often used to expand the available temperature and Mach number ranges of the facilities aimed for aerodynamic testing of supersonic and hypersonic cruise vehicles (HCV) whereas chemical reaction of equilibrium dissociation and ionization take place producing of different multiplicity. These processes are often considered as phase transitions stretched in the temperature scale and resulting in a sharp and non-monotonic variation of the transport coefficients of gas mixtures. In this paper the calculations of certain thermophysical parameters of in the temperature range $260 \ldots 100000$ K basing on the equations of equilibrium dissociation and ionization and in a view of the effects of real gases (4th order virial corrections) and plasma (Debye correction), as well as the comparison of the obtained results with other researchers are presented. The authors also propose a modified technique of one-dimensional nozzle profiling including variable adiabatic index that utilizes the dependence of the gas enthalpy on temperature. According to the results of profiling we developed a supersonic nozzle and to verify the acceleration characteristics of supersonic nozzle, as well as to determine the gas velocity, a series of measurements of stagnation pressure was conducted. As a source of high-enthalpy plasma flow we used a 50 kW plasma torch with a swirl stabilization and expanding channel providing high flow rates, efficient heating of the working medium and small thermal losses in the water-cooled anode surface. Relay on findings, one can conclude that at the vicinity of nozzle exit a transonic flow mode exists that can be preserved at large distances from the nozzle.