Experimental and numerical studies are needed when designing the high-speed engines integrated with the aircraft. Flight experiments are complicated, expensive enough and should be carried out at the final stage of development only. Therefore a large number of studies carried out on the ground facilities. It is necessary to generate the high-enthalpy hypersonic flows, simulating flight conditions. Such flows are characterized by high total temperature and pressure. One of the tasks that need to be solved in the organization of ground research on the facility is the choice of method of heating the working medium. The different heating methods are considered: using the cowper stove or recuperative heat exchanger, adiabatic heating, heating by electric arc or fire heating. Each of these methods has its own advantages and disadvantages. For the experiment it is needed the choice of simulated parameters that depends on the specific tasks formulations. So, for example, it is necessary to simulate the full flow enthalpy and the dynamic pressure to determine the integral engine characteristics. For simulation of processes of ignition and kinetics of chemical reactions necessary to reproduce the static and total temperatures, but this leads to higher enthalpy values. You must also take into account the fact that in ground-based experiments, especially when using fire heater, the working gas composition is different from the pure air that affects the processes of ignition and combustion in the combustion chamber. The fire type heating only allows currently testing of large scale models of aircraft duration of the order of hundreds of seconds with simulated flight conditions with large Mach numbers. The analysis of different combinations of simultaneously reproduced characteristic parameters is carried out. The numerical flow simulation is important at the design stage. In connection with the increasing power of computer engineering in recent years there was possible the solution of complex simulation tasks on large enough computational grids, containing hundreds millions cells, using modern turbulence models, non-equilibrium chemical kinetics. Before experimental research the preliminary numerical simulation of the flows around aircraft and in the engine duct in the ground facilities conditions in high enthalpy hypersonic flow is performed. The calculated characteristics are determined for following validation. The obtained data allow to predict the expected flight characteristics on the results of ground-based experiments.