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THE INFLUENCE OF SHOCK WAVE ON ABLATION THERMAL ENVIRONMENT OF RE-ENTRY VEHICLE PROTUBERANCE

Abstract

Arc heated wind tunnel (AHWT) is one kind of ground test facility to evaluate thermal protection system (TPS). The simulation parameters include total enthalpy, heat flux, flow pressure and so on. AHWT can make a high temperature supersonic flow field in test chamber. The flow filed Mach number of most free jet test in AHWT is nearly 2.0 to 5.0.

In supersonic test flow field, different kinds of shock wave appear in different test conditions. In picture A, the test chamber static pressure and the total pressure can not match the requirement of supersonic flow field, so there is a rhombus area formed by the reflection of oblique shock wave. In picture B, a taper sample makes an oblique shock wave. In picture C, a bow shock wave appears in front of a cylinder sample. In picture D, the interaction of bow shock wave and oblique shock wave is made by a complex shape sample.

The temperature and pressure will change sharply after shock wave, so that the heat flux distribution of sample surface is changed directly. Consequently the test result of TPS evaluation will be influenced by some uncontrolled shock wave. Even sometimes there are some unexpected shock waves appear in flow field because of the variety of facility parameters and sample installation, and these shock waves will cause the thermal environment much more harder and make the test unsuccessful at last. So it is very important for TPS evaluation test to do the research of shock wave influence on thermal environment parameters in AHWT.

In re-entry vehicle protuberance such as cable cover evaluation test, firstly there is a interaction between bow shock wave and oblique shock wave on the surface of cable cover, because the sample shape is a combination of flat and bevel. Secondly the holder has a curving head, so the bow shock wave also appears in front of sample. The shock waves make a huge difference of thermal environment parameters in different areas of sample surface, and this influence can be proved by heat flux measurement and sample ablation character.

The test result shows that heat flux will make a great rise after shock wave, so that the local thermal environment will be harder. The unnecessary shock wave should be avoided in test.