Numerical Study of an Under-expanded Jet

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The use of a numerical method to examine the flow in the nozzle and plume of a low density under-expanded jet is described. Under-expanded jets are found in a number of applications, for example rocket exhausts at high altitude, vehicle manoeuvring thrusters, propulsion simulation devices and fuel injectors. The flow is charasterised by a complex flow-field with a sudden expansion of the free jet from the nozzle, compression reflection at the jet boundary and shock wave reflection at the plume axis, resulting in a repeated barrel shock pattern. Confidence in the numerical results is established by comparison with experimental data measured at DERA Farnborough in the low density tunnel there. The high resolution of the numerical results has contributed to the understanding of several flow features: shock reflection hysteresis; Mach disc curvature; flow stagnation and recirculation behind the Mach disc; the presence of a small diameter Mach disc in the apparent regular reflection. A second round of wind tunnel testing was carried out to confirm some of these findings. The final paper will stress this aspect of the work.