ABOUT THE UNSTEADY STARTING PROCESS AND THE SUBSEQUENT STEADY FLOW THROUGH NOZZLES WITH RIGID AND WITH MOVING WALLS

Georg A. Heilig
Fraunhofer Institut für Kurzzeitdynamik Ernst-Mach-Institut Eckerstraße 4
D-79104 Fi-eiburg i. Br. , Germany

The reflection of a plane incident shock wave at a cylinder, as it can be visualised in a conventionally driven shock tube with the aid of a 24 sparc camera, is a basic process in the field of fluid dynamics. Several publications dealing with this objective can be found in the literature. Up to now the main interest was put mostly on the short lasting diffraction phase of the incoming shock hitting the obstacle. The figures la and lb show the flow field around a 5 cm cylinder at two time instants of the diffraction phase. In figure lb the diffraction phase is nearly terminated, the Mach stem just reaches the right stagnation point. No part of the cylinder surface is exerted to ambient conditions from now on. The first part of this study shows, that because of the closed top of the test section the flow which will establish around the cylinder in the next milliseconds can be regarded as a steady nozzle flow.

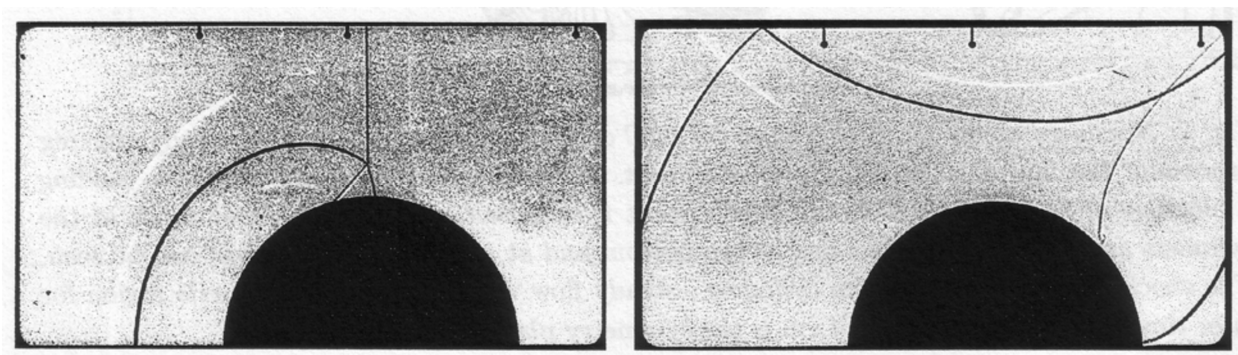

Fig. 1a & 1b: Shadow pictures of the unsteady fiow field around a cylinder with radius 5 cm at time 104 µs (left) and at time 284 µs (right) after the impact of the incident shock (M_0 = 1.38, p_0 = 0.985 bar) at the left stagnation point. In the right figure the diffraction phase is nearly terminated. The reflected shock and the Mach stem travel away from the cylinder and leave the test section.

In the second part of the study the rigid 5 cm cylinder is replaced by a thin flexible Aluminium shell (thickness 1 mm) of radius 5 cm. Due to the pressure loading which results from the diffraction of an incident shock the shell will deform elasto-plastically to a certain amount and then remains in a final deformed shape although the pressure loading continuously persits. This deformed shape is obtained from experiments and from numerical simulation. It is setup as rigid boundary condition at time t = 0 for a further numerical analysis.