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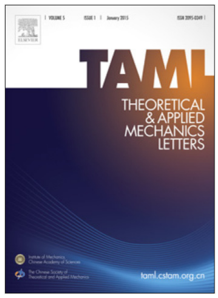


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# A Study on Characteristics of Shock Train inside a Shock Tube

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**Key words: :** Shock Tube, Reflected Shock Wave, Boundary Layer Separation, Contact Surface, Shock Train

**Abstract:** Shock tubes are devices which are used in the investigation of high speed and high temperature flow of compressible gas. Inside a shock tube, the interaction between the reflected shock wave and boundary layer leads to a complex flow phenomenon. Initially a normal shock wave is formed in the shock tube which migrates towards the closed end of the tube and that in turn leads to the reflection of shock. Due to the boundary layer interaction with the reflected shock, the bifurcation of shock wave takes place. The bifurcated shock wave then approaches the contact surface and shock train is generated. Till date only a few studies have been conducted to investigate this shock train phenomenon inside the shock tube. For the present study a CFD analysis has been performed on a two dimensional axi-symmetric model of a shock tube using unsteady, compressible Navier-Stokes equations. In order to investigate the detailed characteristics of shock train, parametric studies have been performed by varying different parameters such as the shock tube length, diameter, pressure ratio used inside the shock tube.

## I. Introduction

The interaction between normal shock wave and boundary layer along the wall surface in internal compressible flows causes significantly complicated flows. When shock wave strength is strong enough to separate the boundary layer, the normal shock wave is bifurcated and one or more shock waves appear downstream of the bifurcated shock. A series of shocks are generated, which are called shock train (ST)[1].

Currently many studies have been carried out on flow fields such as supersonic wind tunnel and duct[2-6]. The generation and flow characteristics of ST have become relatively well known. However, when the phenomenon on shock train was investigated experimentally using supersonic wind tunnel, which makes it difficult to carry out the experimental tests in terms of time and cost.

From several previous studies[7-10], researchers have reported that ST phenomenon occurred in a simple shock tube. The shock wave generated by the diaphragm burst, shock wave propagates along the low-pressure section as shown in Fig. 1 The boundary layer near tube wall is induced by the shock wave at a position where the shock wave interacts with the solid wall[11-13]. When the shock wave arrives at the end of shock tube, shock wave is reflected from end of shock tube and then propagates toward the high pressure section. In this case, the shock wave propagates toward upstream and interacts with the boundary layer developing along the wall in low pressure section. ST occurs when reflected shock wave interacts with the contact region (backward contact surface). However, subsequent studies have not been carried out systematically and so ST is not well known to date. The shock tube can be easily tested because it is very simple structure and can generate shock wave more easily. In addition, the reproducibility of the flow field is very high, and it has been used in various fields such as gas dynamics and high-speed fluid engineering. Therefore, it is expected that the studies of complex phenomena of compressible flows are performed in a simple shock tube in engineering applications.

In the present studies, the generation mechanism of ST was investigated and flow field characteristics were obtained by varying shock tube length, diameter and diaphragm pressure ratios. The generation of shock train was clearly observed in details. The numerical results on wave diagram of present studies are shown in Fig. 1.

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