Engineering Research Express

PAPER

Computational study of shock diffraction over convex edges

Debiprasad Banerjee[1,2] **and Pabitra Halder**[1]

[1] Department of Aerospace Engineering and Applied Mechanics, IIEST, Shibpur, Howrah-711103, West Bengal, India
[2] Mechanical Engineering Department, Heritage Institute of Technology, Kolkata-700107, West Bengal, India

E-mail: banerjeedebiprasad@gmail.com **and** debiprasad.banerjee@heritageit.edu

Keywords: shock diffraction, slipstream angles, pressure load, specific heat flux, separation point, reattachment region

RECEIVED
3 July 2023

REVISED
18 October 2023

ACCEPTED FOR PUBLICATION
22 November 2023

PUBLISHED
13 February 2024

Abstract

Numerical analysis of normal shock diffraction over various step corners is presented using an implicit second-order upwind least squares cell-based method. Slipstream angle calculation for various corner angles and Mach numbers, variation of pressure load and specific heat flux with incident shock Mach numbers and different step corners along the step wall, separation point movement, and reattachment of the streamlines are some of the key features of the present study. Detailed studies have been conducted about the perturbed region enclosed within the diffracted shock wave and the last running expansion wave with the increase in the incident shock Mach numbers. The finite Volume Method is used to solve the governing equations numerically for the simulation of the moving shock. Various flow characteristics such as secondary shock, contact surface, expansion wave, slipstream, vortex, etc are well captured. Apart from isopycnics; Mach contours, isobars, and isotherms are plotted as well. The reattachment region formed after the flow separation near the step edge is mentioned and corresponding lengths over various steps are presented. Separation point movement along the step wall is highlighted and a relevant increase in reattachment length is reported. The slipstream angles get increased with incident shock Mach numbers and with corner angles. However, the rate of increment of slipstream angle decreases gradually. The core of the vortices generated and the reattachment of the separated streamlines are indicated by the two downfalls in the heat flux values.

Nomenclature

a	acoustic velocity
c_p	specific heat at constant pressure
h	specific enthalpy
M	Mach number
M_s	incident shock Mach number
p	pressure of the gas
s	specific entropy
t	time
T	temperature
u	x-directional velocity of the gas
u_p	induced gas velocity
v	y-directional velocity of the gas
W	shock wave velocity
Subscripts & Symbols	
0	total quantities
1	quantities ahead of the incident shock