Under Water Blast Analysis

A B. Tech Project Report Submitted in Partial Fulfillment of the Requirements for the Degree of

Bachelor of Technology

by

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CERTIFICATE

*This is to certify that the work contained in this thesis entitled " **Underwater blastanalysis**" is a bonafide work of **Nitin Kumar, Rajeev Sutrakar** (**Roll No.210103079, 210103088)** carried out in the Department of Mechanical Engineering, Indian Institute of Technology Guwahati under my supervision and that it has not been submitted elsewhere for a degree.*

Supervisor: **Dr. Niranjan Sahoo**

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Department of Mechanical Engineering,

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Nov, 2023

Guwahati.
Assam.

DECRARATION

I certify that the writing I've submitted reflects my views in my own words, and when I've borrowed someone else's thoughts or words, I've properly acknowledged and referenced those sources. In addition, I affirm that I have followed all rules governing academic honesty and integrity and that I have not created or manipulated any idea, data, fact, or source in my work. I am aware that any violation of the aforementioned rules will result in Institute disciplinary action and may also result inpenalties from the sources who were not properly cited or from whom proper permission was not obtained when required.

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Acknowledgements

I would like to thank my supervisor, Dr. Niranjan Sahoo for assigning me this project. His friendly nature and supportive attitude was a great motivator for me. From him, I got a lot to learn and would specially thank him for constantly motivating me to work harder.I dedicate the work to Dr. Niranjan Sahoo and the Department of Mechanical Engineering, IIT Guwahati. I would also like to thank Mr. Aditya sharma a research scholar to guide us in our btech project.

ABSTRACT

Under water explosion is key concept for various of multipurpose uses such as torpedo development and silt removal from sea ports etc. to learn more about underwater blast we take help of various simulating software's such as Ansys here in this project we have just began the basics of underwater explosion by learning the shock wave and its characteristics in shock tube. Further we will deep dive into the concepts of underwater explosion with the help of this knowledge.

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LIST OF SYMBOLS AND ABBREVIATIONS

Symbol Description

γ	Specific heat ratio
α	Speed of sound
T	Temperature
R	Gas constant
M	Mach number
P	pressure

INTRODUCTION

1.1 Understanding shock wave

Shock wave is a propagating disturbance that travels at a greater speed of sound (at the local temperature and pressure) i.e. Mach no greater than 1

1.2 knowing shock tube

Shock tube is an instrument which is capable of producing shock wave. The intensity of shock wave can be varied by changing the material used in diaphragm of shock tube here in our experiment we are using aluminum sheet as our diaphragm.

1.3 What's Ahead

We will see different properties of shock wave in a shock tube by simulating it in Ansys software.

By simulating we will get to know the pressure variation, density variation and velocity of gas in shock tube which will play a crucial role in understanding the dynamics of shock wave inside a shock tube and calculating Mack number of our shock wave

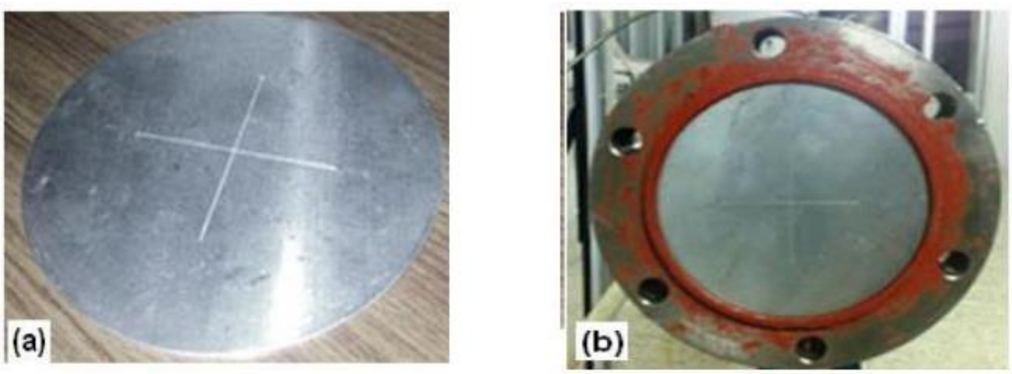

Figure 1.1

Figure 1.2

CHAPTER 2

Simulating shock tube

2.1 Details of shock tube

Shock tube is divided into two sections one having a high pressure called driver and one low pressure region called driven section separated by a diagram.

Here we are simulating a shock tube having following dimensions

Internal diameter = 45mm

Length of driver = 2000mm

Length of driven = 5000mm

Diver pressure = 5.5 bar

Driven pressure =1 bar

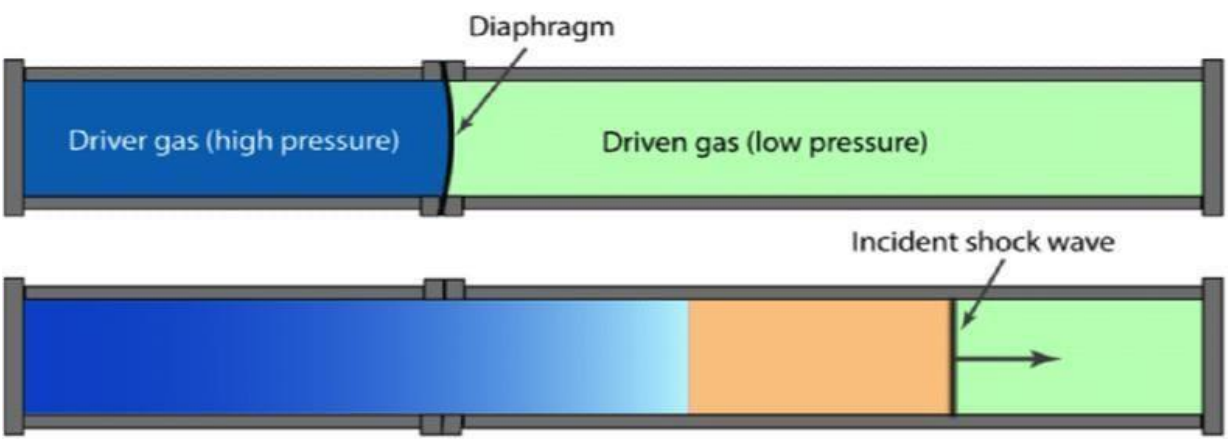

Figure 2.1

2.2 simulations results

2.2.1 Pressure

We get the following graph of static pressure inside the shock tube

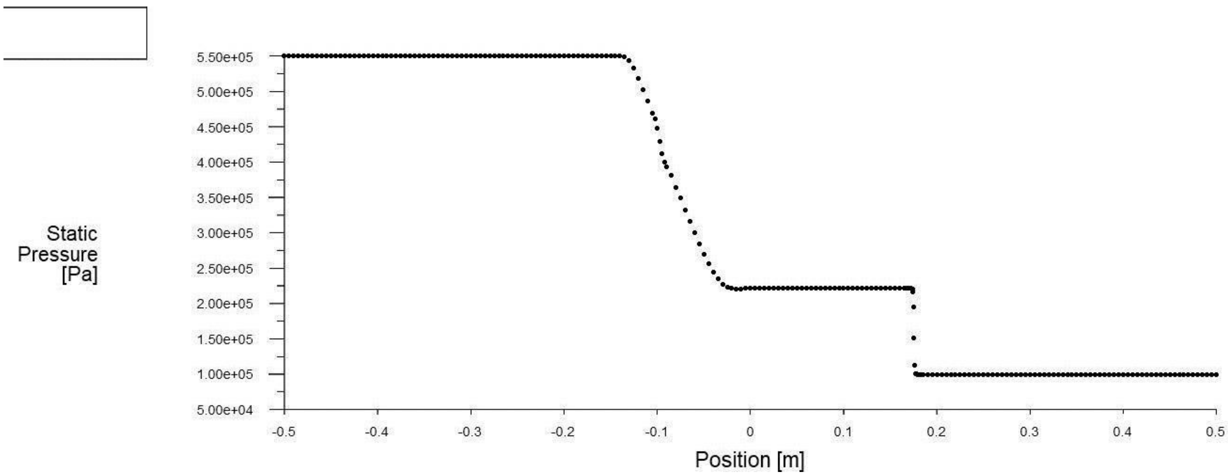

Figure 2.2

2.2.2 Velocity

We get the following graph of static pressure inside the shock tube

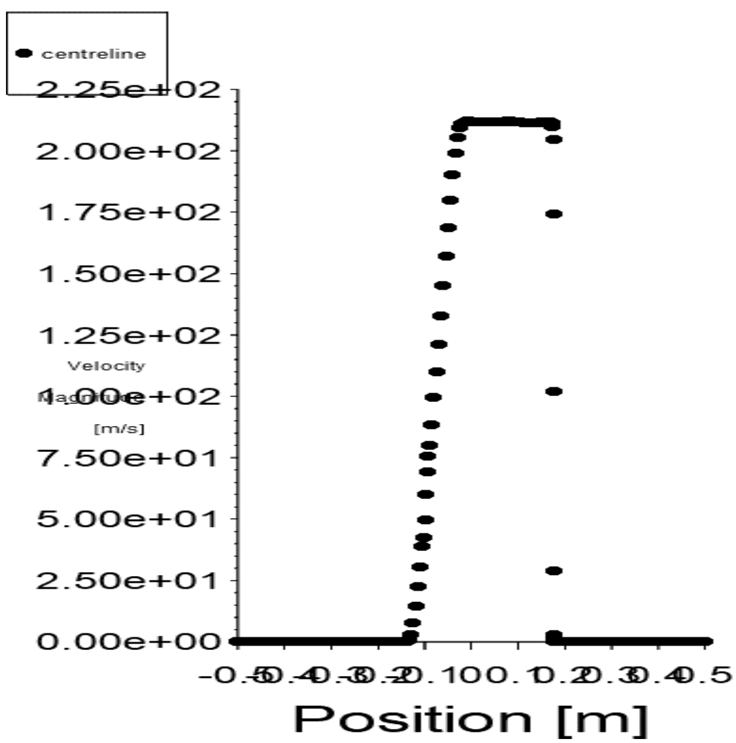

Figure 2.3

CHAPTER 3

Calculations

3.1 Theoretical value of Mach Number

By using the relation between driver pressure p4 and driven pressure p1

And normal shock pressure p2 and driven p1

$$\frac{p_2}{p_1} = 1 + \frac{2\gamma_1}{\gamma_1 + 1}\left(M_s^2 - 1\right); \frac{T_2}{T_1} = \frac{1 + \left(\frac{\gamma_1 - 1}{\gamma_1 + 1}\right)\frac{p_2}{p_1}}{1 + \left(\frac{\gamma_1 - 1}{\gamma_1 + 1}\right)\frac{p_1}{p_2}}$$

$$\frac{p_4}{p_1} = \left(\frac{p_2}{p_1}\right)\left[1 - \frac{(\gamma_4 - 1)(a_1/a_4)\left(\frac{p_2}{p_1} - 1\right)}{\left(\sqrt{2\gamma_1}\right)\left(\sqrt{\left(2\gamma_1 + (\gamma_1 + 1)\left(\frac{p_2}{p_1}\right) - 1\right)}\right)}\right]^{\frac{-2\gamma_4}{(\gamma_4 - 1)}}$$

$$a_1 = \sqrt{\gamma_1 R_1 T_1}; \ a_4 = \sqrt{\gamma_4 R_4 T_4}$$

We obtain Mach number = 1.48

3.2 Simulation value of Mach Number

By using simulation value of normal shock pressure p2 as 2.25 bar and further using relation between p2 and p1 with Mach number

$$\frac{p_2}{p_1} = 1 + \frac{2\gamma_1}{\gamma_1 + 1}\left(M_s^2 - 1\right); \frac{T_2}{T_1} = \frac{1 + \left(\frac{\gamma_1 - 1}{\gamma_1 + 1}\right)\frac{p_2}{p_1}}{1 + \left(\frac{\gamma_1 - 1}{\gamma_1 + 1}\right)\frac{p_1}{p_2}}$$

$$\frac{p_4}{p_1} = \left(\frac{p_2}{p_1}\right)\left[1 - \frac{(\gamma_4 - 1)(a_1/a_4)\left(\frac{p_2}{p_1} - 1\right)}{\left(\sqrt{2\gamma_1}\right)\left(\sqrt{\left(2\gamma_1 + (\gamma_1 + 1)\left(\frac{p_2}{p_1}\right) - 1\right)}\right)}\right]^{\frac{-2\gamma_4}{(\gamma_4 - 1)}}$$

$$a_1 = \sqrt{\gamma_1 R_1 T_1}; \ a_4 = \sqrt{\gamma_4 R_4 T_4}$$

We get Mack number = 1.44

3.3 Experimental value

By using following data obtained by experiments done in laboratory

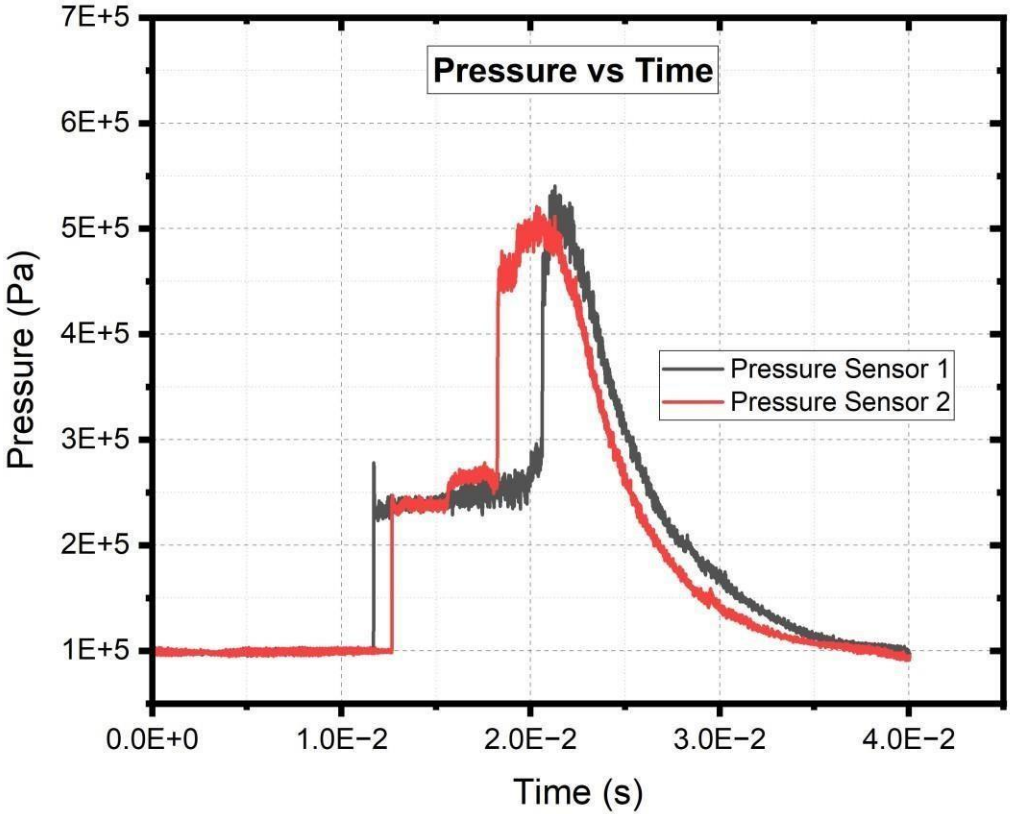

Figure 3.1

We get Mach number = 1.52 ± 0.028 (± 1.9%)

CHAPTER 4

4.1 RESULTS

SOURCE OF INFORMATION	MACH NUMBER
Experimental value	1.52 ±0.028(±1.9%)
Theoretical value	1.48
Simulated value	1.44

4.2 ERROR ANALYSIS

4.2.1 Error in theoretical value

Calculated percentage error = 2.63%

4.2.2 Error in simulated value

Calculated percentage error = 5.26%

CHAPTER 5

Conclusion and Future work

• in this semester we have simulated shock tube and successfully obtained pressure and velocity distribution inside shock tube also we have obtained Mach number of shock wave which is nearly equal to experimental and theoretical value of Mach number of respective shock wave.

• In future we will explicitly work on simulating under water splash which will help us to do a comprehensive study of underwater explosion

REFERENCES

An experimental investigation towards calibration of a shock tube and stagnation heat flux determination – Sumit Agarwal and Niranjan sahoo

Website The engineering Toolbox
https://www.engineeringtoolbox.com/amp/individual-universal-gas-constant-d_588.html

to solve the higher order eqution we used the following websites
https://www.wolframalpha.com/.

Images of shock tube taken from the below reference

https://www.researchgate.net/figure/Schematic-of-the-shock-tube-apparatus-Top-panel-the-driver-and-driven-sections_fig1_328214660.

To learn ansys software we follow the videos

shttps://youtu.be/3FHk1_vCpkk?si=tZ1y4NOLtPROLxcI.
https://youtu.be/t4J0RXuq9xk?si=FJqRPCyVjvcFzz5x.