EXPLOSIONS AND SAFETY

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PRE-REQUISITES : Basic Mechanics and Thermodynamics

INTENDED AUDIENCE : Engineering students and practicing engineers

INDUSTRIES APPLICABLE TO : Industries handling Chemicals and Explosives, Army, Navy, Air Force, DRDO, ISRO, HAL, Space and Defense and Process-related Industries

COURSE OUTLINE :

The physical principles governing the various kinds of explosions are dealt with. Starting with simple modeling of blast waves derived from energy release in explosions, predictions for the damage caused by explosions and methods of ensuring safety are considered. The mechanisms of energy release in gaseous, liquid, dust and solid explosives are examined. Physical explosions and explosions of pressure vessels are also considered. The interaction of blast waves from explosions with objects is dealt with and the damages that occur are quantified.

ABOUT INSTRUCTOR :

Prof. K. Ramamurthi worked in ISRO and thereafter in the Department of Mechanical Engineering at IIT Madras. He is presently Chairman of the Combustion and Shock Wave Panel (CDSW) of ARMREB in DRDO and Chairman of Extramural Research in Combustion of SERB. His research interests are in detonation, blast waves, combustion instability and thermodynamics.

Prof. Prasad Patnaik B.S.V is currently Professor in the Department of Applied Mechanics at IIT Madras. His research interests are in the field of Computational Fluid Dynamics (CFD) applied to Fluid Structure Interaction (FSI). He has worked on the development of CFD tools applied to FSI, Nuclear Thermal Systems, Bio-Fluid Mechanics etc.

COURSE PLAN :

Week 1: Chap 1: Introduction

Lec 1: Loud Bang and Disruption (1)

Lec 2: Blast Wave in an Explosion; Prediction from Dimensional Considerations (2)

Lec 3: Typical Examples of Explosions and Classification (3)

Week 2: Chap 2: Theory of Blast Waves

Lec 4: Shock Hugoniot and Rayleigh Line (4)

Lec 5: Properties behind Constant Velocity Shock (5)

Lec. 6. Blast waves; Concentration of Mass at Front, Snow Plow Approximation (6)

Week 3: Chap 3: Characteristics of Blast Waves

Lec 7: Decay of a Blast Wave, Sach's Scaling (7)

Lec 8: Overpressure and Impulse in the near and Far Field (8)

Lec 9: Missiles, Fragments and Shrapnel, Craters (9)

Week 4:Chap 4: Interaction of Blast with Objects and Structures

Lec 10: Reflection and Transmission of Blast Waves, Impedance (10)

Lec 11: Amplification of Reflected Blast waves, Spall, Damage to Organs, Mushroom Cloud (11)

Lec 12: Damage from Blast waves, Iso-damage Curve (12)

Week 5: Chap 5: Energy Release in an Explosion

Lec 13: Energy Release in a Chemical Reaction, Standard Heats of Formation (13)

Lec 14: Stoichiometry, Equivalence Ratio and Heat Release in Fuel-rich and Oxidizer-rich Compounds (14)

Lec 15: Energy release calculations, Higher and Lower Calorific Values, Internal Energy of Formation (15)

Week 6:Chap 6: Rate of Energy Release

Lec 16: Concentration, Activation Energy, Energy Release Profile (16)

Lec 17: Thermal Theory of Explosions (17)

Lec 18: Application of Thermal Theory and Inferences (18)

Week 7: Chap 7: Modeling of Rate of Energy Release

Lec 19: Role of Chain carriers in an explosion (19)

Lec 20: Fire and Combustion (20)

Lec 21: Combustion and Explosions (21)

Week 8: Lec 22: Case Histories of explosions involving Volatile Liquids (22)

Chap 8: Detonations

Lec. 23: Introduction to Detonations (23)

Lec 24: Structure of Detonation (24)

Week 9: Lec 25: Realizable States in a Detonation (25)

Lec 26: One Dimensional Model of a Detonation (26)

Lec 27: Case Histories of explosions Involving Detonation or Quasi-Detonation (27)

Week 10:Chap 9: Different Types of Explosions

Lec 28: Explosions in Confined and Unconfined Geometries (28)

Lec 29: Dust Explosion I (29)

Lec 30: Dust Explosion II (30)

Week 11: Lec 31: Physical Explosions (31)

Lec 32: Rupture of Cryogenic Storage Vessels and Pressure Vessels (32)

Chap 10: Condensed Phase Explosions

Lec 33 Condensed Phase Explosives based on Hydrocarbons (33)

Week 12:Lec 34: Condensed Phase explosives and their Properties (34)

Lec 35: TNT Equivalence and Yield of an Explosion (35)

Lec 36: Quantification of damages in an Explosion (39 and 40)