Fundamentals of Combustion

Location : ISAE-ENSMA

Objectives : To provide fundamental knowledge of thermodynamics applied to reactive systems in order to better understand related phenomena: flames. To provide fundamental knowledge of combustion, and the methods and means of calculating effects on the surroundings.

Prerequisites : Basic fluid mechanics and thermodynamics, shocks, waves of small amplitude

Contents :

Courses :
Generalities on combustion of solids, principles, regimes, process stabilization, types of flame, solid fuel and solid propellants, conduction, gasification, radiation, heat transfer, ignition, burning velocity calculation, heterogeneous combustion, …
Generalities on thermodynamics, gasdynamic discontinuities, application to supersonic and hypersonic propulsion.
Application to rocket propulsion and fire safety analysis. Development of a theoretical model for gas-solid and liquid-gas combustion.

Project : Numerical calculation of the governing thermodynamic parameters of the Rocket propulsion
The main objective of this project is the calculation of the performance of rocket engines Vulcain (Ariane) and SSME (Space Shuttle Main Engine) by studying the thermodynamic cycle corresponding to the operating conditions of these engines. This study is performed using a numerical code of chemical equilibrium. The predictions of these calculations will be compared to the manufacturer data.

Lab works: Experimental study of the flame propagation in an open space
The main objectives of this laboratory work are the determination of the velocity propagation of a flame in an open space and the evaluation of the acoustic effects on the ambient atmosphere.

Duration : 18 sessions of 60’ each

Professors : Zakaria BOUALI, Djamel KARMED , Vincent ROBIN

Bibliography :

Pope, S.B., *Turbulent flows*, Cambridge University Press, 2000.

Turns, S.R., *An introduction to combustion: concepts and applications*, Mac Graw Hill International Editors, Mechanical Engineering Series, 1996.

"Compressibility Effects of Unreacted Propellant on Thermally Choked Ram Accelerator Performance" (P. BAUER and C. KNOWLEN), Eur. Phys. J. Appl. Phys., 21, (2003), pp.233 – 238

D. Honoré, B. Lecordier, A. Susset, D. Jaffre, M. Perrin, J-M Most, M. Trinité, « Time resolved particle image velocimetry in confined bluff body burner flames », Experiment in Fluids (supp), pp S248-254, 2000

Evaluation : Written exam (quiz)