Applied Mechanics and Materials
ISSN: 1662-7482, Vols. 592-594, pp 1738-1745
doi:10.4028/www.scientific.net/AMM.592-594.1738

Submitted: 2014-04-22
Revised: 2014-05-20
Accepted: 2014-05-20
Online: 2014-07-15

Prediction of HCCI engine performance with Three Zone Extended Coherent Flame Combustion model

T.Karthikeya Sharma[1 a] , G.Amba Prasad Rao[2 b], K.Madhu Murthy[3 c],

[1] Research Scholar, Department of Mechanical Engineering, NIT Warangal- (A.P)-India

[2]Professor in MED, Department of Mechanical Engineering, NIT Warangal- (A.P)-India

[3]Professor in MED, Department of Mechanical Engineering, NIT Warangal- (A.P)-India

[a] karthikeya.sharma3@gmail.com, [b] gap@nitw.ac.in, [c] madhu@nitw.ac.in

Key Words: HCCI, ECFM-3Z, Phi-T charts, Piston Work, Turbulent Kinetic energy.

Abstract: Soot, NO_x paradox in compression ignition engines is an extremely challenging issue. Low temperature combustion followed by Homogeneous charge compression ignition (HCCI) type of combustion is capable of reducing nitrogen oxides and soot simultaneously. Homogeneous charge compression ignition (HCCI) has a potential for high fuel conversion efficiency and extremely low emissions of particulate matter and oxides of nitrogen (NO_x). However, feasibility of HCCI is also posing certain issues .In this paper, three zone extended coherent flame combustion model of STAR-CD package has been used to study the CI engine in both conventional and HCCI mode. A comparison of important parameters like in-cylinder pressure, temperatures, CO, NO_x emissions, in conventional and HCCI mode are predicted. Relatively Low in-cylinder pressures and temperatures are realized in HCCI mode when compared to conventional mode of combustion. Uniform mixing of fuel-air, turbulent kinetic energy and velocity contours are obtained in HCCI mode.

Introduction:

IC Engines have become indispensible prime movers over the past one and half century. Though the performance of conventional SI and CI engines is satisfactory, SI engine suffers with poor part load efficiency and high CO emissions. The CI engine yields high particulate and NOx emissions. These effects may be attributed to their conventional combustion process. Of late, a hybrid combustion process called Homogeneous charge compression ignition (HCCI) equipped with advanced low-temperature combustion technology is gaining attention by the researchers. In principle, HCCI involves the volumetric auto combustion of a premixed fuel, air, and diluents at low to moderate temperatures and at high compression ratios. The other associated advantages with HCCI mode of combustion have been well documented and presented it a potentially promising combustion mode for internal combustion engines [1,2].

The different combustion models which are well developed for predicting engine processes are Transient Interactive Flamelets (TIF) model, Digital Analysis of Reaction System –Transient Interactive Flamelets model (DARS-TIF), G –equation model, Extended Coherent Flame Combustion Model -3 Zones [3, 4] and the Equilibrium-Limited ECFM (ECFM-CLEH) [5,6]. Each model has its own limitations and is suitable for a specific set of problems. Generally speaking; ECFM-3Z and ECFM-CLEH can be used for all types of combustion regime whereas ECFM-3Z is mostly suitable for homogeneous turbulent premixed combustion with spark ignition and Compression Ignition.

Methodology:

A single cylinder direct injection, Mexican hat piston bowl, CI engine with specifications given in Table.1 has been taken for the analysis. A CFD package STAR-CD is used for the analysis to study the in-cylinder flame distribution, heat release rates, in-cylinder pressures and temperatures, CO and NO emissions were studied in CI engine in conventional and in HCCI Mode. The engine specifications considered for the analysis are shown in Table 1.