

INTERNAL COMBUSTION ENGINES AND COMBUSTION

*Proceedings of the
XIII National Conference on I.C. Engines and Combustion
Indian Institute of Science, Bangalore
January 18-20, 1994*

**EDITOR
B.N. RAGHUNANDAN**



**TATA MCGRAW-HILL PUBLISHING COMPANY LIMITED
New Delhi**

McGraw-Hill Offices

New Delhi New York St Louis San Francisco Auckland Bogotá Guatemala
Hamburg Lisbon London Madrid Mexico Milan Montreal Panama
Paris San Juan São Paulo Singapore Sydney Tokyo Toronto

CONTENTS

Preface

v

SECTION I: INTERNAL COMBUSTION ENGINES

Session: Emissions/Fuel Conservation

1. Fuel Injection Concepts for HD Diesel Engines to meet Stringent Emission Regulations
G. Lemperle 1
2. Effect of Methanol Blends on Performance and Emission Characteristics of a Three Cylinder Passenger Car Engine
D.S. Khatri, A. Ramesh and M.K. Gajendra Babu 8
3. Control of NO_x and Smoke in a Direct Injection Diesel Engine using Methanol-Diesel Emulsion as a Fuel
N. Nedunchezian, K. Balagurunathan, P.S. Rao and V. Ganesan 14
4. Effect of Ignition Energy on the Performance, Combustion and Emission Characteristics of a Lean Burn Spark Ignition Engine
S. Dhandapani, B. Nagalingam and K.V. Gopalakrishnan 24
5. A Comparative Study of the Exhaust Emission Characteristics of Diesel and Vegetable Oil Operation in a Single Cylinder Low Heat Rejection Research Engine
S. Jabez Dhinagar, B.N. Nagalingam and K.V. Gopalakrishnan 30
6. Regulating Basic Operating Parameters—An Approach towards Diesel Conservation
B.N. Jajoo, B.P. Tale and K.M. Watt 36
7. Swirl Improvement in Direct Injection Diesel Engines for Control of NO_x Emissions
S. Sivakumar, V. Manivannan, G. Balamurugan and K. Balagurunathan

Session: Alternative Fuels

8. Performance of a Natural Gas Dual Fuel Operation of a Stationary DI Engine
P.K. Banerjee, P.P. Kamat, G.S. Khairnar, H.V. Vinod and P.P. Parikh 48
9. Plant oil as Diesel Engine Fuel
K.C. Sinhai and A. Rehman 55
10. Cyclic Variations and Irregular Combustion in Methanol Operated Two-Stroke S.I. Engine
Mathew Abraham and M.L. Sharma 63

vii

11. Knock Suppression in Hydrogen-Diesel Dual-fuel Engines
G.P. Prabhu Kumar 70
12. Experimental Studies on Hydrogen Fueled Multicylinder SI Engine
T. Arumai Salin Milton and A.N. Rao 78
13. Studies on Diesel and Gasoline Vehicles Converted to Run on CNG as Supplementary Fuel
J. Sharma, A.K. Aigal and K.K. Gandhi 82
14. CNG Operation of an Existing Automotive SI Engine—Performance Evaluation
G.C. Khairnar, P.P. Kamat, P.K. Banerjee, H.V. Vinod and P.P. Parikh 89
15. Fumigation of Methanol in a Single Cylinder Direct Injection Diesel Engine
N. Nedunchezian, R. Subramanian, R. Venkatachalam and A. Balasubramanian 97
16. Natural Gas Powered Automotive CI and SI Engines—A Review
R.V. Seeniraj, G. Siva Kumar, C. Subramanian and G. Nagarajan 104
17. Alternative Fuels for Semi Adiabatic Engine
S. Jayaraj and Subramaniam 111

Session: Engine Components/Design

18. A Dual Intake System for Two Wheeler Application for Reduction in Fuel Consumption and Emissions
Mukesh Saxena 120
19. Turbocharging a Diesel Engine with Ejector System at Exhaust
S.K. Dalai, C.L. Dhamejani, M.V. Subba Rao and R.K. Joshi 127
20. Petroleum Based Lubricating Oil for Methanol Fumigated Diesel Engines—A Study
R.K. Sharma 136
21. Investigation of Fuel Injection Hydraulics for Conventional and Alternate Fuels
K.K. Ramalingam, K. Vijayan, P. Tamilporai and S. Malyadri 143
22. Performance Improvement of Two-Stroke Engine with a Modified Scavenging System
M. Makendhiran, E. Raja Sekar, S. Subramaniam, P. Tamilporai and K.K. Ramalingam 151

Session: Mathematical Simulation

23. Modelling of Intake Port Swirl
Pramod S. Mehta and Abhay Chaturvedi 157
24. Swirl Ratio Influence on the Flow Field in a Compression Ignition Engine—A Numerical Study and Experimental Comparison
D. Mohan Krishna and V. Ganesan 164
25. Dual Injector Direct Injection Diesel Engine—A Thermodynamic Simulation Model
Md. Rafiqul Islam, J.P. Subrahmanyam and M.K. Gajendra Babu 169

viii

26. A Computational Study on Heat Release Rates with Single and Dual Spark Plug
S.R. Deshpande and Harish Chandra 177
27. A Flow Based Convective Heat Transfer Model for a Direct Injection Diesel Engine
N. Marouf Wani, M.K. Gajendra Babu 181
28. Modeling of Transient Spray Mixing Process in Diesel Engine Combustion Chamber
G. Lionel Christopher, M.C. Ramaswamy and Pramod S. Mehta 188

Session: Engine Combustion and Performance

29. Performance of a Two-Stroke SI Engine with High Engine Ignition System
P. Ramesh Babu, B. Nagalingam and K.V. Gopalakrishnan 198
30. Air Flow Visualization in the Cylinder of Two Stroke Engines
Dinesh Kumar, B.P. Pundir and P.S. Mehta 207
31. Scavenging Flow and Its Effect on Cyclic Variations and Irregular Combustion in Two Stroke SI Engines
Mathew Abraham, M.I. Sharma and Satya Prakash 214
32. Performance Analysis of a Two-Stroke Spark Ignition Engine with In-Cylinder Petrol Injection
G.E. Yathishchandran, Anil Kumar, V. Tumbal, Ranapratap Reddy and B.S. Samaga 222
33. Experimental Investigation on Lean Burning in SI Engine (using Fireball Combustion Chamber)
S. Chandrasekaran, K.K. Ramalingam and V. Senthilmurugan 228
34. Diesel Fuel Cetane Number Effects on Engine Performance and Emissions
S.K. Singhal, Laxminarayan and B.P. Pundir 235
35. Performance of Diesel Engine with Compound Cooling
F.G. Kadoli and Krishna Murthy 241

SECTION II: COMBUSTION AND PROPULSION

Session: Flames and Flame Propagation

36. Measurement of Burning Velocity Near the Limits of Inflammability by Zero-Gravity Method
S. Okajima 247
37. Computational Studies on the Flame Propagation in Producer Gas Air Mixture and Experimental Comparisons
D.P. Mishra, P.J. Paul and H.S. Mukunda 256
38. Direct Simulation of Mixing and Reaction in Circular Jets
Joseph Mathew and Amit J. Basu 263
39. Effect of Initial Pressure and Temperature on the Laminar Burning Velocity of Methane—Air Mixture
P.K. Bose, S. Mitra and S.P. Sharma 270

ix

40. Computational Studies of the Ambient Parameters on Stretched H₂-Air Premixed Flames with Detailed Kinetics
D.P. Mishra, P.J. Paul and H.S. Mukunda 277
41. Flame Propagation in Benzene, Nitro Oxide and Nitrogen System
U.C. Durgapal, D. Thomas and V. Ramanujachari 284
42. Unified Correlations for Prediction of Turbulent Burning Velocity Data
G. Ramachandran and U.S.P. Shet 288

Session: Propulsion

43. Flow Computations in a Practical Gas Turbine Combustor
T.R. Shembharkar and B.R. Pai 295
44. Numerical Study of Gas Turbine Combustor Flows
R. Gopinath and V. Ganesan 303
45. Modelling and Simulation of Diesel Engine—Controllable Pitch Propeller Propulsion System for Performance Evaluation
M. Raghunandan and D.S. Ranganath 312
46. Sensitivity Analysis of Two-phase Turbulent Round Jet Flows
V. Ramanujachari and R. Natarajan 321
47. Impact of Aircraft Engine Emissions on Stratospheric Ozone: A Computational Investigation
S. Parthiban, R. Sumathi and B.N. Raghunandan 330
48. Combustion Studies on Metallized Composite and Composite Modified Double Base Propellants
B.K. Athavale, S.N. Asthana, P.G. Shrotri and Haridwar Singh 338
49. Flame Spread Over a Propellant Surface with a Backward Step
J. Jaganathan and B.N. Raghunandan 346
50. Static Pressure and Mean Velocity Distributions Inside a Two-dimensional Model of the Secondary Combustor of an Integrated Rocket Ramjet
S. Sankaran, R. Natarajan and B.H.L. Gowda 352
51. Experimental Investigation of the Influence of the Operating Conditions on the Combustion Efficiency of Space-Craft Liquid Apogee Motor
M. Jayaraman, U.P. Kamath, K.L. Valliappan and A.E. Muthunayagam 359
52. Development of Dump Diffuser System for Gas Turbine Combustor
P.K. Pandey, M.N. Bhat and P.S. Ramanujam 368

Session: Fuel Spray/Droplets

53. Numerical Study of Interference Effects in Binary Sphere Systems under Forced Convection Conditions
M.S. Balaraju, K.N. Seetharamu and R. Natarajan 377
54. Droplet Ignition and Combustion including Liquid Phase Heating
N. Shaygan and S. Prakash 388

x

55. Experimental Investigation of Drop-Size Distribution for Air Motion Deflected Diesel Spray
A.K. Aigal, S.K. Singal and B.P. Pundir 400
56. Atomization of Sheets and Jets Formed in Liquid Propellant Rocket Injectors
K. Ramamurthi 407
57. Experimental Investigation of Interference Effects during Combustion in Binary Sphere Systems Arranged in Side-by-Side Configuration
S. Thamilarasan, B.H.L. Gowda and R. Natarajan 416

Session: Industrial and Domestic Combustion Systems

58. Some Important Considerations in the Combustion of Indian Fuel Oils
K.S. Kambo, T.N. Singh and P.N. Bhambi 425
59. Combustion of Liquid Petroleum Gas and Coal in a Circulating Fluidized Bed
P.K. Nag and B.V. Reddy 434
60. Performance Study of IIP Film Burner with Preheated Air—A Case Study
H.K. Madan, Dhani Ram, A.L. Arora and P.N. Bhambi 440
61. Better Economy through Energy Saving in Billet Reheating Furnaces
T.N. Singh, K.M. Agarwal and S.K. Khanna 447

SECTION III: PAPERS PRESENTED IN THE SPECIAL SESSION IN HONOUR OF Prof. M.V. NARASIMHAN

62. Silencing of Internal Combustion Engine—An Overview
M.L. Munjal 453
63. Multidimensional Modeling of Uniflow Scavenging in Two-Stroke Engines
M.R. Ravi and A.G. Marathe 462
64. Towards CAD of Crankshaft
U. Shrinivasa, D.N. Venkatesh and V. Prakash 471
65. Modeling Reciprocating Parts and Connecting Rod for Crankshaft Coupled Vibration Analysis
S. Rajendran 478
66. Influence of Reciprocating Parts and Connecting Rod on Coupled Free Vibration of Crankshaft
S. Rajendran 488
67. Effect of Bends on Gas Flow through Manifolds
Caleb David, A.S. Subramanian and M.V. Narasimhan 503
68. Effects of Bends in Diesel Engine Manifolds
Caleb David, A.S. Subramanian and M.V. Narasimhan 511
69. An Experimental Investigation on Mixture Preparation in the Induction System of S.I. Engines: Two Throttling Methods
Hakim A. Abbas and N. Raman 518

xi

70. A New Throttling Method for Improvement of Engine Performance and Fuel Economy
Hakim A. Abbas and N. Raman 528
71. Comparative Evaluation of Numerical Schemes used for Solutions of the Characteristic Equations: A Case Study
M.N. Kumar and V.H. Gupta 537
72. Influence of Some Fuel Injection Parameters on Gaseous Emissions of DI Diesel Engines
Caleb David, S. Bhattacharya and V.V. Zambare 543
73. Utilisation of Cotton Seed Oil in a Diesel Engine
K.R. Babu, P. Ramesh Babu and K.V. Reddy 552

Author Index

559