# I.C. ENGINES AND COMBUSTION

Papers presented at the XII National Conference on I.C. Engines and Combustion, Indian Institute of Petroleum

Dehra Dun, India
September 15-18, 1992

Editor SUDHIR SINGHAL



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

#### Organised by



Petroleum Products Application Division Indian Institute of Petroleum, Dehra Dun, India

©1992, Tata McGraw-Hill Publishing Company Limited

No part of this publication can be reproduced in any form or by any means without the prior written permission of the publishers

Due care has been taken to ensure that the information provided in this book is correct. However, the publisher and the editor bear no responsibility for any inadvertent omission or inaccuracy in the book

This edition can be exported from India only by the publishers, Tata McGraw-Hill Publishing Company Limited

Published by Tata McGraw-Hill Publishing Company Limited, 4/12 Asaf Ali Road, New Delhi 110 002 and printed at Raikamal Electric Press. B 35/9 G T Karnal Road, Delhi 110 033

# XII NATIONAL CONFERENCE ON INTERNAL COMBUSTION ENGINES AND COMBUSTION

15-18 September, 1992

#### CONFERENCE COORDINATION COMMITTEE

Dr. T.S.R. Prasada Rao, Director, Indian Institute of Petroleum

Chairman

Mr. Sudhir Singhal

Dr. G.C. Joshi

Dr. K.S. Jauhri Mr. P.N. Bhambi

Dr. B.P. Pundir

Dr. Mukesh Saxena,

Secretary

#### TECHNICAL COMMITTEE

Mr. Sudhir Singhal

Mr. K.K. Gandhi

Dr. B.P. Pundir

Dr. Mathew Abraham

Mr. H.K. Madan

Dr. Mukesh Saxena

Dr. S.K. Singal

Chairman Convener

#### ORGANISING COMMITTEE

Dr. B.P. Pundir

Dr. Mukesh Saxena

Mr. P.V. Dogra

Mr. D.L. Kapoor

Dr. Himmat Singh

Mr. Dinesh Kumar

Dr. P.C. Nautiyal

Dr. S.K. Goyal

Mr. S.K. Bansal

Mr. Sudhir Singhal

Mr. R.K. Sharma

Dr. Mahendra Pal

Mr. K.K. Gandhi

Mr. J. Sharma

Dr. K.S. Jauhri Dr. Mathew Abraham

Mr. R.L. Mendiratta

Chairman Convener

### SESSION ORGANISERS

#### I.C. ENGINES

1.0.	ENGINES	
1.	Alternative Fuels	Mr. Sudhir Singhal Indian Institute of Petroleum
		Dehra Dun
2.	Combustion Phenomena in Engines	Prof. V. Ganesan
	Companion 1 nonomena in 2 ngmes	Indian Institute of Technology
		Madras
3.	Diagnostic and Instrumentation	Dr. P.A. Lakshminarayanan
	Techniques	Kirloskar Oil Engines Ltd.
		Pune
4.	Emissions	Dr. B.P. Pundir
		Indian Institute of Petroleum
		Dehra Dun
5.	Engine Design and Development	Mr. R.P. Sharma
		Ashok Leyland Ltd.
,		Hosur
6.	Engine Lubrication and Lubricants	Mr. R.A. Rao Indian Additives Ltd.
		Madras
7.	Fuel Quality and Conservation	Mr. N.R. Raje
1.	ruei Quanty and Conscivation	Indian Oil Corporation
		Faridabad
	•	
CO	MBUSTION	
1.	Fundamental Studies of	Prof. S.P. Sharma
	Combustion Phenomena	Indian Institute of Technology
		Bombay
2.	Heterogeneous Combustion	Prof. R. Natarajan
		Indian Institute of Technology
		Madras
3.	Industrial Combustion	Mr. V. Raghuraman
		National Productivity Council
	D	New Delhi
4.	Reaction Kinetics in Combustion	Prof. K.A. Bhaskaran
		Indian Institute of Technology Madras
5.	Turbulent Reacting Flows	Prof. H.S. Mukunda
5.	Turbulent Reacting Flows	Indian Institute of Science
		Bangalore
		~041.010

## CONTENTS

	SECTION I: IC ENGINES	1
SESS	ION: ALTERNATIVE FUELS	
1.	Conversion of KCL Make KTA-3067-G Diesel Engines to Dual Fuel Engines, Used on AC SCR Rig A.N. Ganla, A.E. Bhosale	3
2.	Techno-Economics of Retro-Fitting of Existing Thermal Power Plant by Topping with Gas-Turbines	
3.	A.N. Rao, K.S. Bhaskar A Small Scale Wood Gas Production System for I.C. Engines	11
4.	B.T. Nijaguna, F.G. Kadoli, G.B. Varadaraju Performance of Scooter Engine on LPG Using Conventional Carburettors	17
5.	B.T. Nijaguna, F.G. Kadoli, T. Vijay Kumar Studies on Hydrogen Usage in an SI engine as an Automotive Fuel in the Indian Context	25
6.	M. Ravi, A.N. Rao, M.C. Ramaswamy, T.R. Jagadeesan Alternative Engines and Fuels in Traffic—A Solution also for India?	32
7.	Herbert. H Heitland Methanol as Automotive Fuel-GNFC Experience	38
8.	P.H. Shah  A Combustion Model for Ethanol-Diesel Dual Fuel Indirect Injection Diesel Engine	44
9.	H.B. Mathur, M.K. Gajendra Babu, K.C. Singhai  Effect of Methanol and its Blends with Gasoline on a Catalytically Activated Combustion of a Lean Burn S.I. Engine	53
10.	S. Dhandapani, B. Nagalingam, K.V. Gopalakrishnan Drive by Tests of Vehicles Fitted with Retrofitted C.N.G. Conversion Kits in Non-Laboratory Situations	61
11.	B.E. Gopal Saikia The Use of Jatropha Oil and its Blends with Diesel Engine in Low Heat Rejection Diesel Engine	67
12.	T. Bhaskar, B. Nagalingam, K.V. Gopalakrishnan Feasibility Study of Solar Coal Gasification	73
13.	A.N. Rao, S. Balasubramanian  Experimental Investigations on Dual Fuel Operation of Hydrogen	80
15.	in a C.I. Engine  M. Ravi, A.N. Rao, M.C. Ramaswamy, T.R. Jagadeesan	86
14.	An Assessment of Dual-Fuel Alcohol-Diesel Bus Operation— The Indian Experience	
	K.K. Gandhi, S. Singhal	92

15.	Producer-Gas Operated SI Engine-Development and Analysis Shashikantha, P.K. Banerjee, P.P. Parikh	100
16.	Strategy for use of Natural Gas as a Transportation Fuel in India S. Singhal, J. Sharma, K.K. Gandhi	109
SESS	ION: COMBUSTION PHENOMENA IN ENGINES	
17.	Experimental Investigation of the Effect of Fumigated Fuel on the Performance of a Diesel Engine	
	A. Balasubramanian, P. Selvakumar	115
18.	Charge Stratified Engine	
	S. Jayaraj, M.V. Appalaraju	125
19.	A Computer Model for Fuel-Air Mixing Calculations in Direct Injection	
	Diesel Engines	
	J. K. Sharma, Ravinder Singh	133
20.	Numerical and Experimental Investigations into the Performance of a Four Stroke DI Diesel Engine	
	P. Ram Reddy, D. Mohan Krishna, K.R. Govinda Mallan, V. Ganesan	139
21.	Three-Dimensional Analysis of Air Motion in an Engine Cylinder—	
	Effect of Piston Configuration	
	D. Mohan Krishna, K. Rajagopal, V. Ganesan	146
22.	Heat Transfer and Performance Analysis of Automotive Diesel	
	Engine through Multizone Modelling	
	N. Baluswamy, P. Tamilporai	153
23.	Analysis of Fuel Droplet Heat and Mass Transfer in Lean Burn	
	SI Engine	
	R.V. Seeniraj, Md. Shamim Akhter	160
24.	Diesel Engine Combustion—A Comprehensive Computer Simulation	
	N. Baluswamy, G. Devaradjane, H.G. Prakash Rao	167
25.	Process of Lean Burning in an SI Engine	
	N. Baluswamy, G. Devaradjane	174
26.	Simulation of a Turbocharged Spark Ignition Engine	
	P. Mohanan, M.K. Gajendra Babu	181
27.	A Thermodynamic Computer Simulation Model for a Low Heat	
	Rejection Direct Injection Diesel Engine	
	Md. Rafiqul Islam, J.P. Subrahmanyam, M.K. Gajendra Babu	187
28.	Experimental Investigations on a Dual Ignition Gasoline Engine	
	G. Jain, S. Kabra, J.P. Subrahmanyam, M.K. Gajendra Babu	193
29.	Studies of Some Combustion Parameters in a Two Stroke Engine	
	with Selective Exhaust Gas Recirculation	
	Mukesh Saxena	197
30.	Effect of Charge Flow on SI Engine Performance	
	S. Chandrasekaran, P. Tamilporai, K.K. Ramalingam	206
31.	A model for Simulating Small DI Diesel Engines	
	S.K. Singal, B.P. Pundir, P.S. Mehta	213

32.	Effect of Mesh Size on the In-Cylinder Flow Field Computations in Three Dimensional Calculations	
	K. Rajagopal, D. Mohan Krishna, V. Ganesan	225
33.	Correlation of Combustion parameters and Engine Roughness  M.S. Pandit, V.S. Walawalkar, V.Y. Deo	231
SESS	ION: DIAGNOSTIC AND INSTRUMENTATION TECHNIQUES	
34.	Gravimetric Measurement of Particulates with Part Flow Dilution	
	Tunnel Systems	220
35.	Wolfgang Singer Optimizing Diesel Engine Parameters to Improve Engine Performance	239
33.	Using Orthogonal Array Technique (L27)	
	S.S. Dharmadhikari, S.K. Seam, R. Jagannatham	245
36.	On Measurement of Blow by Quantity-Design and Testing of a	
	Simple Set-Up	
	P.P. Parikh, G.S. Khairnar, Narayan Shankar	258
37.	Analysis of Heat Transfer through the Cylinder Head of an I.C. Engine Using Finite Element Technique	
	N. Baluswamy, M. Mani	264
SESS	SION: EMISSIONS	
38.	Analysis of Blow-By from Combustion Engines	
	P. Hampaiah, M. Udaya Ravi, B.S. Samaga	272
39.	Some Studies of NOx Emissions from Stationary Diesel Engine Using Blended Fuels	
	H.M. Dange, V.R. Marathe	278
40.	A Two Zone Model for the Prediction of Exhaust Emissions from Diesel Engines	
	N. Baluswamy, G. Devardjane, R. Thangavel	282
41.		
	K.C. Vora, V.G. Pirangute, B. Ghosh	288
42.	Studies on Exhaust Throttling in Two Stroke Engines for Reduction in Hydrocarbon Emissions	
	Mukesh Saxena	298
43.	Catalytic Converter—A Feasibility Study for an Indian Two Wheelers	
	Dinesh Kumar, Laxminarayan, B.P. Pundir	304
SESS	SION: ENGINE DESIGN AND DEVELOPMENTS	
44.	Solution to Rigid Body Vibrations of a 3 Cylinder Diesel Engine	
	P.A. Lakshminarayanan, A.D. Dani	.310
45.	Effect of Inlet Flow Inclination on the Flow Field and Scavenging in	
	an Axisymmetric Uniflow Scavenged Engine M.R. Ravi, A.G. Marathe	323
46.	Computer Simulation of an I.C. Engine during Startup	343
40.	Atul R Patil Nitin C Panada	330

47.	Static Analysis of Connecting Rod Small End by Analytical and Finite	
	Element Methods: A Comparative Study	TRIT TOTAL
	S. Bhattacharya, N.V. Marathe, S.B. Savkar	342
48.	Structural Attenuation Characteristics of a Small Single Cylinder DI	
	Diesel Engine	2.34
	B. Ghobadian, Madhav Bhattacharya, N. Singh, S.C. Jain, P.S. Mehta	350
49.	Turbocharger Matching Calculations—A Case Study	
	M. Makkar, J.K. Sharma	358
50.	Analysis of Heat Transfer in the Piston of a Semi-Adiabatic Engine	mar
1000	N.K. Samaria, D.K. Chandrakar, R. Prasad	364
51.	Analytical Studies on Dual-Charging of Two Stroke Engine for	
	Reduction of Scavenged-Through Fuel Losses	
	Mukesh Saxena, H.B. Mathur	370
52.	Experimental Investigations to Study the Effect of Different Spark	
	Plugs on the Performance of a Lean Burn 4-Stroke S.I. Engine	
	S. Parathasarthy, B. Nagalingam, K.V. Gopalakrishnan	379
53.	Role of Some Design Parameters on Cyclic Variations and Part Load	
	Fuel Economy in a Two-Stroke Cycle SI Engine	
	Mathew Abraham, J. Sharma, M.L. Sharma	385
SESS	ION: ENGINE LUBRICATION AND LUBRICANTS	
54.	Studies on Rail-Road Diesel Engine Oils in Laboratory Bench Tests	
	S.T. Nahe, I.N. Parekh, V.S. Rao	393
55.	A Software Package for Computation of Wear Profiles and its	
	Application in Two Stroke Engine Cylinder Liners	
	A.K. Gondal, P.G. Khanwalkar, S. Singhal	400
56.	Jojoba Oil Application in an Automotive Diesel Engine	
	M.N. Bandooni, Mahipal, S. Singhal	406
57.	Effect of Base Stock Composition on Lubricant Performance in Engines	
-	Himmat Singh, Sudhir Singhal	412
58.	Performance of Multigrade Oils under Stop and Go Service	DET TE
	M.N. Bandooni, Mahipal	418
	ica os Estanti I multing in Two Stroke Brights in Estantia	100
SESS	ION: FUEL QUALITY AND CONSERVATION	
59.	Evaluation of Additives and Devices for Fuel Economy	
200	K.S. Jain, R.C. Sethi, R.K. Joshi	424
60.	Additives for Diesel Fuels of the 1990s	103
00.	Kim B. Peyton	432
61.	Performance of Reed-Valve Mounted Two Stroke Crankcase	432
01.	Scavenged SI Engine	
	K.K. Ramalingam, Naga Rejendra Gowd, B., G.C. Garg	436
62.	Improvement of Gasoline Quality—Use of Multifunctional Additives	430
02.	for Engine Intake System Cleanliness	
	Ved Singh, G.K. Acharva, R.K. Malhotra, G.K. Sharma, S.C. Mehta	443
	vea sinyn. G.K. Acharva, K.K. Mathotra, G.K. Sharma, S.C. Menta	443

63.	Low Temperature Operability of Diesel Vehicles with MDFI Doped Summer Grade Diesel Fuel	
64.	R.K. Malhotra, G.K. Acharya, N.R. Raje	453
	R.L. Mendiratta, B.P. Pundir	463
	SECTION II: COMBUSTION	469
SESS	SION: FUNDAMENTAL STUDIES OF COMBUSTION PHENOMENA	
1.	Computational Studies of Premixed CH4-Air Stretched Flames Including Detailed Kinetics	
2.		471
3.	S.P. Sharma, C.J. Joseph, P.K. Bose  The Pressure and Temperature Dependence of Laminar Burning  Velocity for Methanol-Air Mixtures	481
4.	P.K. Bose, S.P. Sharma, C.N. Chablani Measurement of Infra-Red Radiation from Flames	488
5.		497
6.	Nitrogen System  U.C. Durgapal, S. Goel, V. Ramanujachari, V. Mahajan  An Experimental Study on Laminar Burning Velocity of Methane—	502
7.	Air Mixtures in the Presence of Diluent  S.P. Sharma, P.K. Bose, K. Iyer, C.J. Joseph  A Theoretical Analysis of Transient Droplet Combustion and Emission	507
	Characteristics of Hydrocarbon Fuels  Anwar Mehdi, Shah Shahood Alam, Ahtisham A. Nizami	516
8.	Modelling Coal Combustion in Air Entrained Flow Reactor S. Sundar Narayanan	523
SESS	SION: HETEROGENEOUS COMBUSTION	
9.	An Optical Study of the Fuel-Air Interaction in a Twin-Fluid Acoustic Atomiser	
10.	N.R. Ramesh, R. Natarajan Combustion over Vertical Fuel Surfaces with Baffles	529
11.	B.N. Raghunandan, S.N. Sridhara, S. Amrithaganesh  A Trajectory Simulation Model for Particle Motion in Decaying  Turbulent flow	535
12.	T. Sudhakar Rao, V. Ramanujachari, R. Natarajan Theoretical Investigations of a Combusting Gas Jet	541
12.	V. Ramanujachari. R. Natarajan	547

#### SESSION: INDUSTRIAL COMBUSTION Partial Combustion of Diesel in Low Pressure Oil Burner G.N. Banerjee, H.K. Tripathy, J.N. Mohanty, A.K. Jouhari, D.N. Dev 553 Substitution of Fuel Oil by Low Sulphur-Heavy Stock in Furnaces 14. T.N. Singh, A.L. Arora, P.N. Bhambi 559 15. Design and Development of Bubble Incinerator K.S. Kambo, U.K. Jaiswal, P.N. Bhambi 565 16. Two Stage Atomising Burner H.K. Madan, T.N. Singh, P.N. Bhambi 572 Submerged Combustion Burner 17. S.K. Khanna, H.K. Madan, P.N. Bhambi, A.K. Shaha 579 SESSION: REACTION KINETICS IN COMBUSTION 18. Soot Formation Kinetics of Toluene V. Ramabhadran Nair, K. Thyagarajan 585 Theoretical Investigation of Base Flows and Supersonic External 19. Combustion A.R. Srikrishnan, V. Sriramulu, K.A. Damodaran 591 SESSION: TURBULENT REACTING FLOWS 20. A Note on Laminar Flames V.K. Rao and M.F. Bardon 597 Some Studies on Heat Transfer and Combustion in a Circulating 21. Fluidized Bed Furnace P.K. Nag, B.V. Reddy 610

Diagnostics for Research in Atomization and Turbulent Two-Phase Flows

616

625

W.D. Bachalo, S. Sankar, C.A. Schuler

A.K. Gupta, Surendra Kumar

Plume Dynamics above a Circular Fire Source

22.

23.