

**Energy,
Combustion
and the
Environment**

Volume 2

Clean Combustion Technologies

Part A

Edited by

Maria da Graça Carvalho

Woodrow A. Fiveland

F. C. Lockwood

Christos Papadopoulos



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Clean Combustion Technologies

Selected Papers from the Proceedings of the Second International Conference
Lisbon, Portugal, July 19–22, 1993

Part A

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Gordon and Breach Science Publishers

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Amsteldijk 166
1st Floor
1079 LH Amsterdam
The Netherlands

Some of the articles appearing in this book were originally published in *Combustion Science and Technology*, volume 108, numbers 4–6.

British Library Cataloguing in Publication Data

Clean combustion technologies : proceedings of the Second
International Conference

Part B - (Energy, combustion and the environment ; v. 2
– ISSN 1073-7804)

1. Combustion engineering - Environmental aspects -
Congresses

I. Carvalho, Maria da Graça
628.5'32

ISBN 90-5699-608-8 (part A)
90-5699-621-5 (part B)
90-5699-622-3 (two-part set)

Clean Combustion Technologies

Energy, Combustion and the Environment

A series edited by Scott Samuelsen
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The subject of this series is the production of energy and the relationship of this production to environmental impact. The scope focuses on: (1) fossil fuels, since these are projected to serve as the principal energy sources for more than 100 years; (2) three levels of environmental air quality impact, including urban air quality, tropospheric global warming and acid rain, and stratospheric ozone degradation; and (3) both stationary and aeroengine sources of energy production.

Volume 1

Combustion Technologies for a Clean Environment

Edited by Maria da Graça Carvalho, Woodrow A. Fiveland, F. C. Lockwood,
and Christos Papadopoulos

Volume 2

Clean Combustion Technologies — Parts A and B

Edited by Maria da Graça Carvalho, Woodrow A. Fiveland, F. C. Lockwood,
and Christos Papadopoulos

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INTRODUCTION TO THE SERIES

The world is in transition toward acknowledging, and accepting, that a basic conflict exists between the provision of energy to support the world's economies and standard of living, and the protection of the air resource that sustains the world's life. The *Energy, Combustion and the Environment* book series is designed to place this conflict into perspective, and to provide readers—students, consulting engineers, regulators, legislative staff, and environmental action groups—with the information and tools required to understand the challenges and conduct analyses to address these challenges.

PREFACE

The conference sequence on Combustion Technologies for a Clean Environment, popularly known as the "Clean Air" conferences, was initiated by its organizers because they felt that, despite the many events dealing with environmental issues, this particular topic had rather surprisingly been largely missed. The popularity and overall success of the first conference bore testament to the validity of their perception. The second conference proved even more successful; contained in this volume are 75 of the reviewed, refereed papers presented at the second Clean Air conference. Topics covered range from chemical kinetics fundamentals to applied research in power stations. New subject areas include: pollutant dispersion, hybrid fueled combustors, new power generation cycles and concepts, and catalytic combustion.

The mix of academic and industry contributions that drew praise during the first Clean Air conference has been retained and, we hope, enhanced. Contributions from invited lecturers, who again comprise geographically dispersed and internationally reputed experts, are included. At this second conference, because it is a European-initiated conference series, two of the invited speakers lectured on themes relevant to the European Union.

It is probably useful at a scientific conference to have some comment from government sources since one thing is certain; pollution abatement measures, like aircraft safety, generally cost money; and in a world that is now almost completely based on market economy concepts, disasters are—in the absence of legislation—inevitable. Most of the atmospheric pollution we experience is due to combustion processes, as much from motor vehicles as from industry. Worldwide, this is accelerating rather than diminishing and the same is true even in some developed countries. To an extent, it may be argued that pollution abatement technology has failed to keep pace with market and, therefore, combustion growth. But the failure is also attributable to inability of government to effect more stringent regulations in a world where public material expectations seem invariably to exceed green aspirations, since the latter undoubtedly imply a degree of economic restraint.

It is the hope of the organizers that the Clean Air conferences can continue to provide a forum for combustion technologies that will assist in suppressing the current dichotomy of economic prosperity and environmental protection.

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- IST–Instituto Superior Técnico
- ITEC–Instituto Tecnológico para a Europa Comunitária
- JNICT–Junta Nacional de Investigação Científica e Tecnológica
- Palácio de Queluz
- SECIL–Companhia Geral de Cal e Cimento, SA
- SHELL
- THERMIE

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Clean Coal Technology for the 21st Century: Research and Technological Development Strategy of the European Community

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FOREWORD

The Maastricht Treaty provides a new political and institutional context to the European integration process. All European Community (EC) policies and activities are given a new impetus with the aim of setting up the basis for an economic, monetary and eventually a political union. Research and Technological Development (RTD) policy is not an exception.

As a result, the European Community's RTD activity in the field of energy has to be defined according to the objectives of the Maastricht Treaty in general as well as more specifically to those of the Community's RTD policy and the Community's Energy Policy. Thus, it is of particular importance to:

- secure a stable energy supply at acceptable costs;
- use energy sources in an optimal way protecting the environment and contributing to the objective of stabilisation of CO₂;
- maintain the competitiveness of the Community's industry and the high technology standards of its energy industry;
- allow full use of the internal market for all producers and users of energy RTD;
- contribute to optimal utilisation of regional energy sources and strengthening the economic and social cohesion;
- pave the way for technology cooperation with third countries, in particular in Central and Eastern Europe.

As far as funding is concerned, the substantial increase for research and technology which occurred in the last few years is not likely to continue. Moreover, the fourth Framework Programme foresees the allocation of some of the resources to the demonstration activities. Accordingly, a careful reassessment of the size and modalities of funding is needed, taking into account the opportunities offered by the entire EU intervention framework, in particular those of the internal policies, of the Structural Funds and of the loans of the EU financial instruments such as EIB, NIC, EURATOM and ECSC.

This evolution and related requirements will have significant consequences on energy RTD. It is now time to start a new way of thinking in order to define an actual