

**Energy,  
Combustion  
and the  
Environment**

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Volume 2

# **Clean Combustion Technologies**

## ***Part B***

Edited by

**Maria da Graça Carvalho**

**Woodrow A. Fiveland**

**F. C. Lockwood**

**Christos Papadopoulos**



# Clean Combustion Technologies

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

## Part B

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# **Clean Combustion Technologies**

## **Energy, Combustion and the Environment**

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A series edited by Scott Samuelsen  
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University of California, Irvine

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

This book is part of a series. The publisher will accept continuation orders which may be cancelled at any time and which provide for automatic billing and shipping of each title in the series upon publication. Please write for details.

## 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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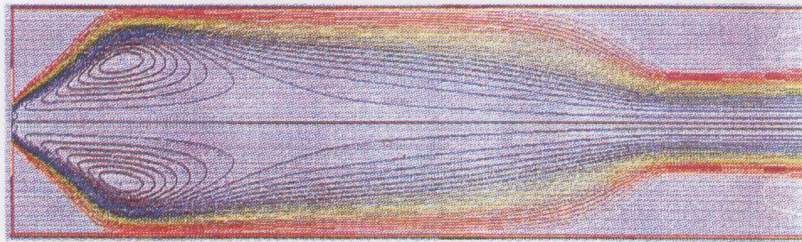
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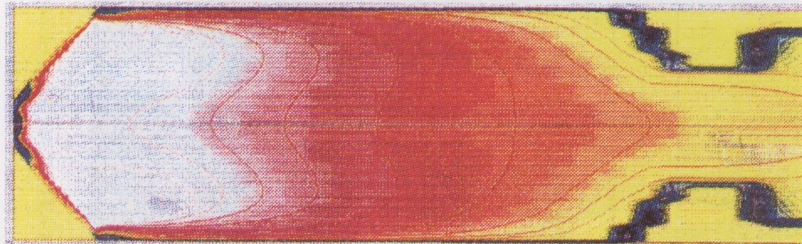
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- IST–Instituto Superior Técnico
- ITEC–Instituto Tecnológico para a Europa Comunitária
- JNICT–Junta Nacional de Investigação Científica e Tecnológica
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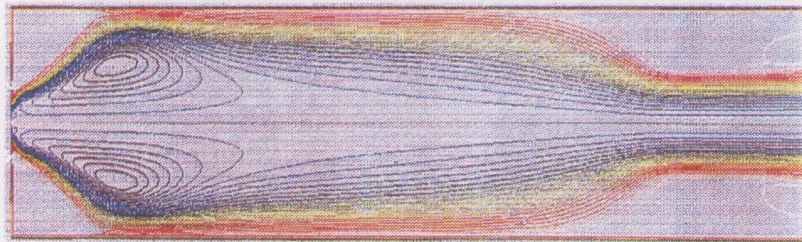
Flow Pattern



Temp. Distribution



Flow Pattern



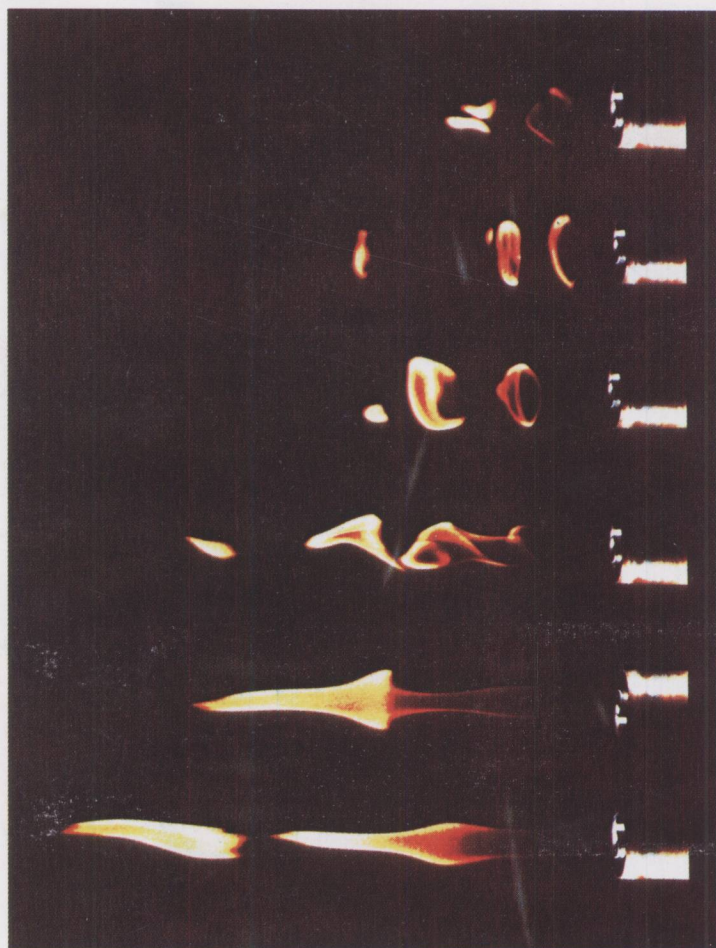
Temp. Distribution



Small furnace ( $\phi 550 \times 1\,210$ )

Large furnace ( $\phi 900 \times 1\,980$ )





COLOR PLATE II. See D. Proctor *et al.*, Figure 2, page 1048.

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