

ANNUAL REPORT FOR THE YEAR 2006

OF THE

INTERNATIONAL ENERGY AGENCY IMPLEMENTING AGREEMENT FOR ENERGY CONSERVATION AND EMISSIONS REDUCTION IN COMBUSTION

prepared by the
Executive Committee Secretariat

for

Jay Keller, Agreement Operating Agent
Sandia National Laboratories - California

Program of Research

Published by the
Executive Committee Secretariat
for
Jay Keller, Agreement Operating Agent
Sandia National Laboratories - California

* * *

EXECUTIVE ABSTRACT

YEAR 2006 ACTIVITIES OF THE EXECUTIVE COMMITTEE

A SUMMARY OF RESEARCH ACTIVITIES

EXECUTIVE ABSTRACT

The purpose of the IEA Implementing Agreement on Energy Conservation and Emissions Reduction in Combustion program is to improve fundamental and applied combustion technology which is developed to provide predictive design capabilities for internal combustion engines, furnaces and gas turbines. This document summarizes the progress made in FY 2006.

Since 1978, IEA cooperative research by program participants has focused on developing experimental and computational tools to aid combustion research and on developing advanced laser-optical diagnostic tools that permit in situ, time- and space-resolved measurements of combustion phenomena for achieving this end. The Agreement's Annex 1 has been planned to improve the modeling and simulation processes as well as the instrumentation required for the supporting experimental activities.

Programs of applied research are carried out in one or more of the following areas:

- Advanced piston engine technology
- Furnaces and boilers
- Fundamentals
- Advanced turbine technology

New collaborative multi nation initiatives are under way in the areas of hydrogen enriched lean premixed combustion for ultra-low emission gas turbines, fuel sprays, hydrogen-fueled internal combustion engines, and fuels for homogeneous charge compression ignition (HCCI) engines. Others are being planned to investigate soot formation, develop particulate diagnostics, and improve efficiency while reducing emissions from boilers and furnaces.

YEAR 2006 ACTIVITIES OF THE EXECUTIVE COMMITTEE

The Executive Committee (EC) of the International Energy Agency's (IEA) Program of Research, Development and Demonstration on Energy Conservation and Emissions Reduction in Combustion coordinates the cooperative efforts undertaken by participating institutions. The Committee met twice during the business year 2006. The first meeting was held at IEA Headquarters in Paris, France, in May; the second took place following the Agreement's Twenty Eighth Task Leaders Meeting in August in Heidelberg, Germany

Actions taken by the Executive Committee this year include:

- the successful submittal of a request for a five year extension to the Agreement;
- the launch of three new multi nation collaborative research tasks at the Heidelberg Task Leaders Meeting The concept behind collaborative work is to enlist researchers in member countries to contribute their efforts on various phases of the problem to achieve a common set of objectives;
- the approval of a plan presented by the Operating Agent to update the Agreement's public web site and to create a new password protected web site for Executive Committee use.

The Twenty Eighth Task Leaders Meeting, sponsored by the EC was held at the NH Hotel in Heidelberg, Germany in mid-August. Principal Investigators, EC members and invited guests gathered to hear papers presented on the Agreement's research. Poster sessions provided another opportunity for one-on-one exchange of technical information on research being conducted within the Program. The number of attendees and papers presented were both the highest in at least a decade attributable in large measure to the considerable interest shown in the newly launched multi nation collaborative research tasks.

- Minutes of the Committee's meetings of May and August have been published and distributed to the IEA and to participants. The Proceedings of the Twenty Eighth Task Leaders Meeting were published and distributed to IEA Headquarters and Executive Committee members for distribution to participants. The Agreement's 2005 Annual Report was distributed last fall;
- At its August meeting, the Executive Committee unanimously chose as Chairman Prof. Juergen Warnatz of Germany to direct the Agreement's activities for the forthcoming year, 2006 - 2007. Prof. Douglas Greenhalgh of the United Kingdom was elected vice-chair. Dr. Robert J. Gallagher of the US began his appointment as Secretary of the Executive Committee effective October 1, 2005.

Executive Committee members and their alternates as of September 30, 2006 were:

BELGIUM	Dr. Philippe Ngendakumana
Alternate:	Dr. Barbara Pesenti
CANADA	Prof. Ömer L. Gülder
Alternate:	Mr. Gregory J. Smallwood
FINLAND	Prof. Martti Larmi
GERMANY	Prof. Jürgen Warnatz
ITALY	Prof. Felice E. Corcione
Alternate:	Dr. Gerardo Valentino
JAPAN	Prof. Tomio Obokata
Alternate:	Prof. Yasuo Moriyoshi
NORWAY	Prof. Ivar S. Ertesvag
Alternate:	Prof. Inge R. Gran
SWEDEN	Dr. Bernt Gustafsson
Alternates:	Prof. Marcus Alden and Dr. Sven-Inge Moller
SWITZERLAND	Mr. Fabrice Rognon
Alternates:	Mr. Stephan Renz and Dr. Peter Jansohn
UK	Prof. Douglas Greenhalgh
Alternate:	Prof. Phillip Hutchinson
USA	Mr. Gurpreet Singh
Alternate:	Dr. Jay Keller

The operating Agent for the Energy Conservation and Emissions Reduction in Combustion Implementing Agreement is Dr. Jay Keller, Sandia National Laboratories, Livermore, California, USA.

Dr. Robert J. Gallagher has been engaged by the Executive Committee to fulfill the administrative responsibilities of the Operating Agent.

The Agreement's administrative liaison at IEA Headquarters, Paris is Mr. Thomas Kerr.

A SUMMARY OF RESEARCH ACTIVITIES

AREA 1 ADVANCED PISTON ENGINE TECHNOLOGY

SUBAREA 1.1 INDUCTION PROCESSES

No active Subtasks

SUBAREA 1.2 FUEL-AIR MIXING

1.2C Italy

[Air Motion Investigation in Diesel Engines](#)

1.2H Finland

[Fuel Spray Modeling for Diesel Combustion Simulation](#)

1.2J Finland

[In-cylinder Flow Fields of Diesel Engines](#)

1.2K1 Collaborative Task

[Sprays in Combustion](#)

1.2K2 UK

[Studies of Evaporating Sprays Issues & Diagnostic Tools](#)

1.2K3 Japan

[An Experimental and Theoretical Study of Engine Sprays](#)

1.2K4 Switzerland

[Low Emission Combustion Technologies for High Efficiency Energy Converters](#)

1.2K5 Finland

[Past and Future Research Activities in Spray Simulations at TKK/ICEL](#)

SUBAREA 1.3 IGNITION

No active Subtasks

SUBAREA 1.4 FLAME PROCESSES

1.4G Japan

[Investigate Combustion in Premixed Charge Spark / Compression Ignition Engines](#)

SUBAREA 1.5 EXHAUST PHENOMENA

1.5F Japan

[Spray and Combustion in Diesel Engine](#)

SUBAREA 1.6 COMBUSTION PERFORMANCE AND CHARACTERISTICS OF FUELS

1.6A1 Collaborative Task

[Homogenous Charge Compression Ignition \(HCCI\) Fuels](#)

1.6A2 Japan

[Fuel Design Approach for Low Emission in Engine Systems - Application of Flash Boiling Spray Into HCCI](#)

1.6A3 Sweden

[HCCI Fuel Activities in Lund](#)

1.6A4 UK

[Fuel Requirements in engines using premixed and partially premixed remixed compression ignition Combustion](#)

1.6A5 Japan

[Dual fuel HCCI combustion “High octane and High cetane number fuels“](#)

1.6A6 UK

[Dieseline Combustion - a logic way to expand the HCI window](#)

1.6B1 Collaborative Task

[Advanced Hydrogen Fuel Internal Combustion Engines](#)

1.6B2 Japan

[Auto-Ignition and Burning Characteristics of Unsteady Hydrogen Jet](#)

1.6B3 Norway

[Numerical and Experimental Study of Hydrogen Combustion at High Pressures](#)

1.6B4 Switzerland

[Emission optimized combustion of H₂-containing reformer gas in Internal Combustion Engines](#)

1.6B5 Japan

[Hydrogen Fueled Internal Combustion Engines \(H₂ ICE\)](#)

1.6B6 Belgium

[Hydrogen-fueled internal combustion engines: Research at Ghent University](#)

1.6B7 US

[Mixture formation and Combustion in a Hydrogen-Fueled Internal Combustion Engine](#)

AREA 2

ADVANCED FURNACE TECHNOLOGY

SUBAREA 2.1

BURNER PHENOMENA

2.1H Belgium

[Investigation on Combustion in Oil Burner Flames](#)

2.1I Belgium

[Study of Combustion and Heat Transfer Phenomena in Industrial Furnaces Fired with Gas Burners using Preheated Air](#)

SUBAREA 2.2

GAS FLOWS

No active Subtasks

SUBAREA 2.3

FUEL-AIR MIXING

No active Subtasks

SUBAREA 2.4 FLAME PROCESSES

2.4F Belgium

[Chemical Kinetics Studies of Flames and Soot Formation](#)

SUBAREA 2.5 POSTFLAME PROCESS

2.5A Japan

[Combustion Technology Reducing Environmental Impact](#)

AREA 3 FUNDAMENTALS

SUBAREA 3.1 TURBULENT REACTING FLOWS

3.1C Norway

[Experimental and Theoretical Investigation of Interaction Between Turbulent Structure and Chemical Kinetics in Flows](#)

3.1D Japan

[Analysis of Turbulent Combustion Flows](#)

3.1E Japan

[Experimental Study of High Intensity Combustion in Real Burner](#)

SUBAREA 3.2 PHYSICAL AND CHEMICAL PROCESSES

No active Subtasks

SUBAREA 3.3 NUMERICAL MODELING

No active Subtasks

SUBAREA 3.4 DIAGNOSTICS

3.4B Japan

[Investigate Dynamic Spray Characteristics by Image Processing](#)

3.4D Sweden

Application of Laser Techniques for Combustion Diagnostics

3.4S U.S. / Canada

[Development of Laser-based Diagnostics for Soot Particulate Matter from Internal Combustion Engines](#)

AREA 4 ADVANCED GAS TURBINE TECHNOLOGY

SUBAREA 4.1 COMBUSTION MODELING AND VERIFICATION Hydrogen Enriched Lean Premixed Combustion for Ultra-Low Emission Gas Turbine Combustors (Collaborative Task)

4.1A U.S.
[Hydrogen Combustion Research for Gas Turbine Engines](#)

4.1B UK / Cranfield University
[Cranfield contribution to CRF Hydrogen Enriched Investigation](#)

4.1C Switzerland / PSI
[Flame characteristics of Hydrogen-enriched Methane/Air Flames at High Pressure](#)

4.1D Canada / University of Toronto / NRC
[Targeted Collaboration on Gas Turbine Combustion: Turbulent Lean Premixed Combustion with Hydrogen Enrichment](#)

4.1E Sweden / Lund Institute of Technology
[Optical Diagnostics in a Swirl Stabilized Flame and the High Pressure Combustion Rig in Lund](#)