Preface

The Programme Committee and the local organisers would like to thank you for attending the 11th Mediterranean Combustion Symposium and hope you will have a productive meeting.

The symposium is the eleventh one in a series on combustion and related topics, held by the scientific communities from countries around the Mediterranean. The first Mediterranean Combustion Symposium was held in Antalya, Turkey, June 1999, the second took place in Sharm El-Sheikh, Egypt, January 2002, the third in Marrakech, Morocco, June 2003, the fourth in Lisbon, Portugal, October 2005, the fifth in Monastir, Tunisia, September 2007, the sixth in Corsica, France, June 2009, the seventh in Chia Laguna in Sardinia, Italy, September 2011, the eighth in Cesme, Turkey, September 2013, the ninth in Rhodes, Greece, June 2015 and the tenth in Naples, Italy, September 2017.

The aim of the MCS conferences is to promote the collaborative efforts of the scientific communities from countries around the Mediterranean Sea by seeking contributions from, and encouraging the participation of, scientists, engineers and students from the region.

The technical program in MCS11 consists of about 200 papers, 35 posters, and 8 plenaries on a range of important and current topics. The Symposium has therefore grown to become an important regional conference in Combustion.

The Symposium is structured so as to maximise contact and interactions among participants and includes an interesting social program.

We wish to thank the Combustion Institute and the International Centre for Heat and Mass Transfer for supporting this meeting. We acknowledge the silver sponsorship of Cabildo de Tenerife and the bronze sponsorship of the LaVision. We also wish to acknowledge the professional work of our Logistics Secretariat, VIACONTE. And finally, we thank the staff and students from the GFN and LCI research groups (University of Zaragoza and LIFTEC, Spain) who have helped in the preparation and during the Symposium.

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Posters

- WiP-02: MODELING LOW TEMPERATURE AUTOIGNITION DURING FLAME-VORTEX INTERACTION - M. Arias-Zugasti, J. Castillo and P. Garcia-Ybarra
- WiP-03: LARGE EDDY SIMULATION OF N-HEPTANE SWIRL SPRAY FLAME APPROACHING BLOW-OFF - A. Both, D. Mira, and O. Lehmkuhl
- WiP-04: LEGITIMACY OF THE NARROW-CHANNEL APPROXIMATION FOR THE STUDY OF FLAMES PROPAGATING BETWEEN TWO CLOSELY-SPACED PARALLEL PLATES - A. Dejoan, J. Melguizo-Gavilanes, D. Fernández-Galisteo and V.N. Kurdyumov
- WiP-05: DETAILED CHEMISTRY LES-CMC SIMULATIONS OF KEROSENE SWIRLING SPRAY FLAMES - J.M. Foale, A. Giusti, and E. Mastorakos
- WiP-06: EXPERIMENTAL INVESTIGATION OF CONTROLLED THERMAL DEGRADATION OF UNCONVENTIONAL FUELS - G. Gianfelice, M. Della Zassa and P. Canu
- WiP-07: NUMERICAL STUDY OF NOX, CO AND CO2 FORMATION IN A LAMINAR DIFFUSION FLAME FOR DIFFERENT HYDROGEN-METHANE MIXTURE RATIOS, BASED IN THE FINITE-RATE AND STEADY FLAMELET COMBUSTION MODELS - G. Lopez-Ruiz, I. Álava, I.Urresti and J. M. Blanco
- WiP-08: STABILITY AND SPECIES INVESTIGATION OF LAMINAR OXY-FUEL FLAMES IN CO2 ENVIRONMENTS AT HIGH TEMPERATURES - Fares Maimani, Gaetano Magnotti, Robert Dibble
- WiP-09: ONE-DIMENSIONAL SIMULATIONS ON IGNITION USING NRPD UNDER UNIFORM FLOW - Y. Morii, H. Nakamura, and K. Maruta,
- WiP-10: DEVELOPMENT OF A NEW SAMPLING METHOD TO MEASURE CONDENSABLE PM - C. Morreale, F. Hugony, G. Migliavacca, S. Tamburrino, M. Gualtieri
- WiP-12: TEMPERATURE MEASUREMENTS OF WATER EMBEDDED DROPLETS USING 2CLIF TECHNIQUE - O.Moussa, D.Tarlet, P.Massoli and J.Bellettre
- WiP-13: COMPUTATIONAL OPTIMIZATION OF THE FUEL COMPOSITION AND COMBUSTION SYSTEM OF A SPARK IGNITION ENGINE OPERATING WITH METHANE/HYDROGEN BLENDS - A. Paykani, C.E. Frouzakis, K. Boulouchos
- WiP-14: A GENERALIZED PARTIALLY STIRRED REACTOR COMBUSTION CLOSURE MODEL USING COMPUTATIONAL SINGULAR PERTURBATION ANALYSIS - E.Quadarella, A. Stagni, EA. Tingas, A. Cuoci, A. Parente, T. Faravelli, H. G. Im
- WiP-15: ON THE IMPLEMENTATION OF DILUTED-AIR-FGM TURBULENT COMBUSTION MODEL IN ANSYS-FLUENT - N. Romero, K. Martin, E. Salazar, L.A. del Portillo and Dirk Roekaerts
- WiP-16: HEAT-CHEMISTRY INTERACTION IN THE OSCILLATING COMBUSTION OF HYDROCARBONS - A. Stagni, Y. Song, L.A. Vandewalle, K.M. Van Geem, G.B. Marin, O. Herbinet, F. Battin-Leclerc, T. Faravelli
- WiP-17: MEASUREMENTS AND MODELING OF FREE-FALLING DROPLET EVAPORATION APPLIED TO CLASSICAL AN ALTERNATIVE JET FUELS - M. Stöhr, S. Ruoff, B. Rauch and W. Meier
- WiP-18: NUMERICAL STUDY ON THE EFFECTS OF FUEL INJECTION PRESSURE ON GASOLINE SPRAY CHARACTERISTICS - S. Wadekar and M. Oevermann
- WiP-20: DEVELOPMENT AND VALIDATION OF A NEW MATLAB/GUI BASED THERMOCHEMICAL CODE - A. Cuadra-Lara and M. Vera
- WiP-21: TORREFACTION AS A VERSATILE PRETREATMENT FOR MULTIPURPOSE BIO-FEEDSTOCK TRANSFORMATIONS - P. Brachi, M.E. Russo, G. Ruoppolo
- WiP-22: COMBUSTION BEAHVIOUR OF FAST PYROLYSIS OIL SURROGATE - R. Calabria, F. Chiariello, P. Massoli, C. Tornatore, A. Frassoldati, A. Cuoci, T. Faravelli, A.E. Saufi
- WiP-23: COMPUTATIONAL FRAMEWORK FOR LARGE-SCALE SIMULATIONS OF REACTING FLOW PROBLEMS WITH DETAILED CHEMISTRY IN COMPLEX GEOMETRIES - D. Mira, A. Surapaneni, M. Zavala, A. Both, O. Lehmkuhl, R. Borrell, A. G. Rao, M. Vázquez and G. Houzeaux
- WiP-24: A NUMERICAL SIMULATION STUDY OF COMBUSTION CYCLIC VARIATION IN A SI-ENGINE - S. Wadekar, P. Janas and M. Oevermann
- WiP-25: DROPLETS AUTOIGNITION SIMULATIONS OF ETHANOL MIXTURES WITH A REDUCED KINETIC MECHANISM - A. Millán-Merino, E. Fernández-Tarrazo, M. Sánchez-Sanz and F.A. Williams
- WiP-26: MODELING AND SIMULATION OF SINGLE ETHANOL/WATER DROPLET EVAPORATION IN AIR - Praveen Narasu, Philipp Pöschko, Fulong Zhao, and Eva Gutheil

- WiP-27: GASOLINE DIRECT INJECTION ENGINE EMISSION STUDY SHOWING HIGH NUMBER CONCENTRATIONS OF NON-VOLATILE SUB – 3NM AEROSOL PARTICLES - Joonas Vanhanen, Silvana Di Iori, Francesco Catapano, Pekka Salo, Joonas Enroth, and Minna Väkevä
- WiP-28: CONTINUOUS ROTATING DETONATION IN ANNULAR CHAMBER: PRESSURE, VELOCITY AND STABILITY - R. Zitoun, P. Vidal and S. Hansmetzger
- WiP-29: NEAR-LIMIT FINGER-LIKE PREMIXED HYDROGEN-AIR FLAMES PROPAGATION IN NARROW CHANNELS - F. Veiga-López, D. Martínez-Ruiz, M. Kuznetsov, E. Fernández-Tarrazo and M. Sánchez-Sanz
- WiP-30: KETOHYDROPEROXIDES AND KORCEK MECHANISM IDENTIFIED DURING THE OXIDATION OF DIPROPYL ETHER IN A JET-STIRRED REACTOR BY HIGH-RESOLUTION MASS SPECTROMETRY - P. Dagaut, N. Belhadj, R. Benoit, G. Dayma, M. Lailliau and Z. Serinyel
- WiP-31: MIXING FIELD AND FLAME STRUCTURE OF TURBULENT PARTIALLY PREMIXED FLAMES IN A CONCENTRIC FLOW SLOT BURNER - M. S. Mansour, A. M. Elbaz, M. F. Zayed, Alaa M. Khedr, B. M. Akoush, H. M. Al-Bulqini, M. S. Abdallah, M. Kiriakos, M. Juddoo, A. R. Masri and W. L. Roberts
- WiP-32: PRODUCTION AND CHARACTERIZATION OF SUPERHYDROPHILIC TIO2 NANOPARTICLE COATINGS VIA FLAME AEROSOL SYNTHESIS AND THERMOPHORETIC DEPOSITION - Gianluigi De Falco, Mario Commodo, Mario Francesco De Santis, Pasquale Del Gaudio, Annantonia Cappelli, Alessia Ottieri, Patrizia Minutolo, Andrea D'Anna
- WiP-33: ASSESSMENT OF UNCERTAINTIES IN PREDICTED EVAPORATION RATES OF DIESEL DROPLETS - Mohamad Asrardel, Álvaro Muelas, Javier Ballester
- WiP-34: EFFECT OF OXYGEN CONCENTRATION ON DYNAMIC BEHAVIOUR OF COMBUSTION INSTABILITY IN A TURBULENT COMBUSTOR - Naohiro Takeda, Satoshi Kinoshita, Hiroshi Gotoda
- WiP-35: DETECTION METHODOLOGY OF THERMOACOUSTIC COMBUSTION INSTABILITY IN A TURBULENT COMBUSTOR USING COMPLEX NETWORKS AND MACHINE LEARNING - T. Hachijo, T. Kobayashi and H. Gotoda
- WiP-36: SPATIOTEMPORAL STRUCTURE AND EARLY DETECTION OF THERMOACOUSTIC COMBUSTION OSCILLATIONS IN A MODEL ROCKET COMBUSTOR - Hajime Shibuya, Hiroshi Gotoda,Yuya Ohmichi, and Shingo Matsuyama

NUMERICAL STUDY OF NOx, CO AND CO_2 FORMATION IN A LAMINAR DIFFUSION FLAME FOR DIFFERENT HYDROGEN-METHANE MIXTURE RATIOS, BASED IN THE FINITE-RATE AND STEADY FLAMELET COMBUSTION MODELS.

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Work-In-Progress Abstract

A laminar diffusion flame confined in a cylindrical combustion chamber is studied through different hydrogen-methane mixture ratios. It can be considered as an individual flame from an array diffusion burner designed for domestic boilers. The analysis is performed through CFD modeling by means of ANSYS-FLUENT 19.0®. Detailed chemical, thermal, and transport parameters are implemented through the finite-rate chemistry model, based in the Arrhenius formulation, as well as through the steady flamelet model. Results from both models are carefully compared and discussed. The flow field is solved using laminar and low-Reynolds turbulence models, with no much relevant evidences in literature. The NOx, CO and CO_2 species formation characteristics are analysed for several power levels, so as to demonstrate the effect of the inlet fuel composition as well as the effectiveness of the flame-splitting method aiming to reducing the formation of EINOx in the abovementioned array burner when the inlet power for high hydrogen content mixtures increases. Since high hydrogen content fuels yield to higher adiabatic flame temperatures, the NOx formation is carefully analyzed, decoupling the NOx chemistry from the main chemical mechanism as well as regarding partial equilibrium assumptions. The experimental setup for validation purposes is presented where several measurements will be carried out for the studied power levels and inlet fuel compositions.

WHERE TECHNOLOGY IS AN ATTITUDE

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NUMERICAL STUDY OF NO_x, CO AND CO_2 FORMATION IN A LAMINAR DIFFUSION FLAME FOR DIFFERENT HYDROGEN-METHANE MIXTURE RATIOS, BASED IN THE FINITE-RATE AND STEADY FLAMELET COMBUSTION MODELS

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CONTEXT

The hydrogen economy will form an integral part of renewable energy sources and will complement others, such as solar or wind energy that require complex mechanisms to store excess energy generated during periods of low demand. Different future scenarios have been proposed for the implementation of hydrogen in the energy grid, from NG-hydrogen blends to pure hydrogen. In this sense, hydrogen is presented as a near-future opportunity avoiding exhaust gases such as CO_2, CO and SO_x. The aim of the present study is to develop a design methodology for domestic hydrogen burners based in numerical and experimental models in order to ensure low emissions, safe operating and high efficiency.

OBJECTIVES

- Asses the capability of laminar non-premixed H_2 – CH_4 flames for domestic boiler burners
- Evaluate NO_x, CO_2 and CO formation through experimentally validated numerical models
- Estimate the NO_x emission index ($EINO_x$) in such laminar flames
- Determine the most appropriate flow field and chemistry models

METHODOLOGY

CHEMISTRY TREATMENT 1

FINITE RATE [1]

Kinetic-thermal-transport data [2]

Coupled mechanism:

H_2/Air + Zeldovich NOx

Arrhenius formulation

$$k_{f,r} = A_r T^{\beta_r} e^{\left(\frac{-E_r}{RT}\right)}$$

Multicomponent diffusion

Lennard-Jones transport parameters

$$D_{AB} = \frac{0.001858\, T^{3/2} \left(\frac{1}{M_A} + \frac{1}{M_B}\right)^{1/2}}{P_{abs}\ {\sigma_{AB}}^2\ \Omega_D}$$

STEADY LAMINAR FLAMELET

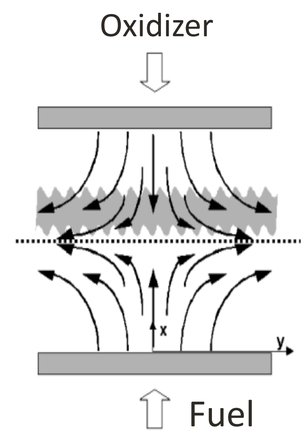
ANSYS CHEMKIN

Kinetic-thermal-transport data [2]

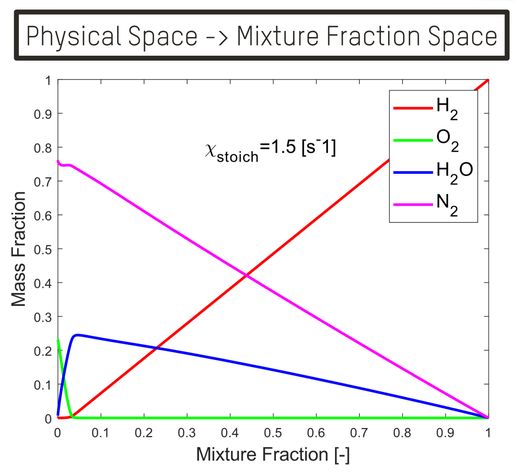
Flamelet Equations

Multicomponent diffusion

Define Models



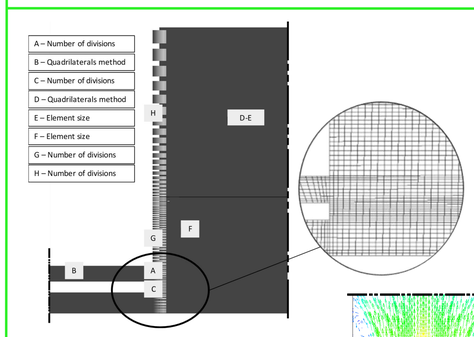
1D-Counterflow Flame



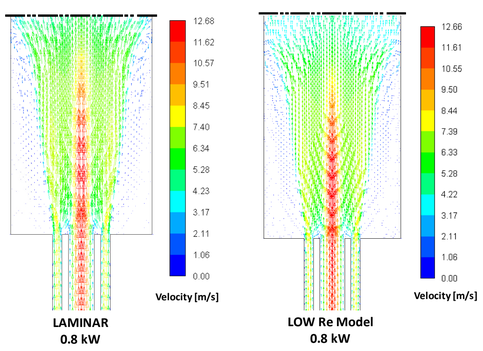
Chemistry Look Up Tables

CFD MODELLING 2

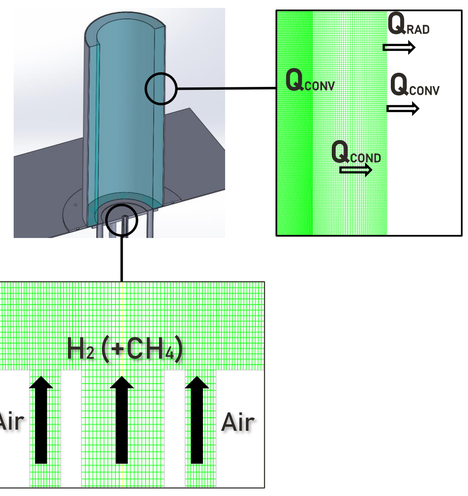
ANSYS FLUENT



FLOW FIELD
- Low Reynolds Model
- Laminar Model



FLOW FIELD
- k-ε Realizable



NO_x Post-processing

- Temperature and species concentrations

$$Y_i = f(Z,h)$$
$$T = f(Z,h)$$

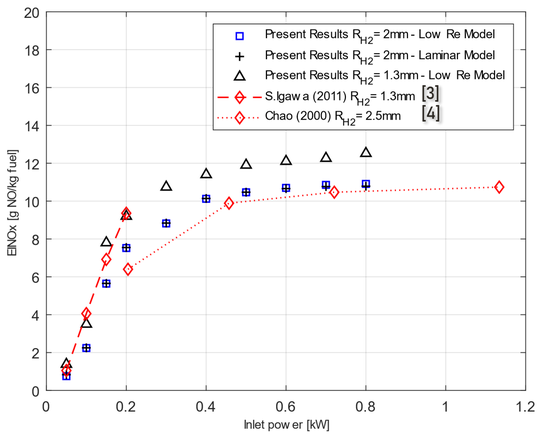
- Quasi-Steady assumption for N atoms

$$\frac{d[NO]}{dt} = 2\, k_{f,1}[O][N_2] \frac{\left(1 - \frac{k_{r,1}\, k_{r,2}[NO]^2}{k_{f,1}[N_2] k_{f,2}[O_2]}\right)}{\left(1 + \frac{k_{r,1}\,[NO]}{k_{f,2}[O_2] + k_{f,3}[OH]}\right)}$$

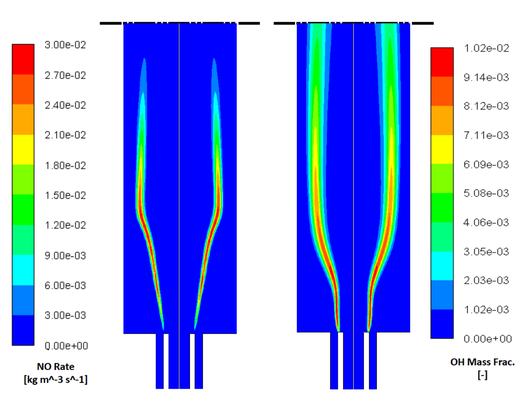
EXPERIMENTAL VALIDATION 3

RESULTS

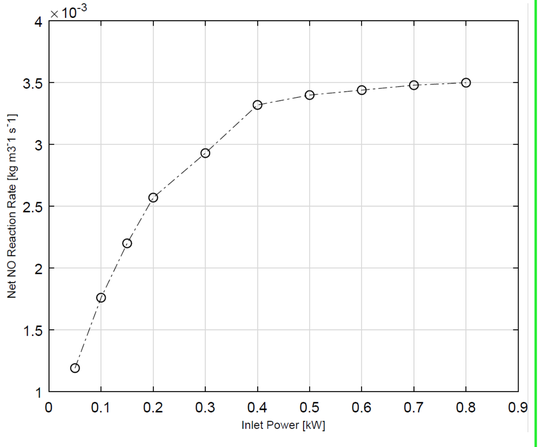
FRM- $EINO_x$ vs Power



FRM- NO Rate and OH Mass Fraction (0.5 kW)



FRM- NO Rate vs Power



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