Thermo- and Fluid-Dynamic Processes in Direct Injection Engines. THIESEL2016 special issue

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The THIESEL 2016 International Conference on Thermo-and Fluid Dynamic Processes in Direct Injection Engines (13th to 16th September 2016) is the ninth edition of this conference and it has gained a consolidated position as a meeting point between industry, research institutions and academia involved in R&D for automotive engines.

Its main objective remains unchanged since its first edition in 2000, namely present the latest developments for the adaption of the automotive internal combustion engine to new environmental challenges. These developments come from all over the world, so that one of the characteristics of this conference is to gather contributions not only from Europe, but also from the United-Sates of America and from the main Asian countries, such as Japan, Korea and China. It is also a forum where OEMs, research organizations and university groups concerned by the 'green car' communicate their ideas to find relevant solutions.

THIESEL's success may lie in its balance between papers on fundamental aspects of all thermo- and fluid processes occurring in ICEs and those describing some new application about to enter or already on the market. People familiar with this conference will know that its topics include all thermo-and fluid dynamics processes affecting the engine, ranging from the intake and injection systems, to novel combustion concepts and to the turbo-charging and after-treatment technologies [1].

Progress on injection strategies and understanding of mixture formation - which is key to combustion improvement and emissions control [2][3] relies nowadays strongly on modelling performance, especially as modern computer technology allows for serious cost reduction. Hence, much effort is put on the development of reliable spray and combustion models that include detailed kinetics and better turbulence models[4][5][6][7]. One main advantage of CFD is that it becomes possible to identify not only the processes that lead to NOx and soot emissions, but also those contributing to combustion noise levels [8]. At the same time, experimental studies are still very necessary to provide validation of these models and ensure adequate representation of the phenomena **¡Error! No se encuentra el origen de la referencia.¡Error! No se encuentra el origen de la referencia.**. Hence, LIF-PIV, high-speed UV Chemiluminescence Imaging and X-ray radiography techniques have to be adapted to obtain all relevant information [11][12][13][14].

New injection strategies [14][15], new combustion concepts (RCCI, PCCI, gasoline lean combustion, stratified-charge operation, low temperature combustion [16][17][18] and alternative fuels such as natural gas and biofuels [19][20][21] are currently being explored, on the one hand in order to improve mixture formation for both CI and SI engines, and on the other hand, in the context of engine downsizing.

Engine downsizing requires solving some challenging problems in order to improve engine efficiency. Technology has to follow, on the injection and combustion front [22], but also for the intake [23][24], turbocharging [25][26] and exhaust after-treatment [27]. It is hoped that techniques such as waste heat recovery [28] and supercharging, and studies on thermal efficiency [29] will help.

No matter the progress of the past few years, emissions legislation is bound to become stricter and stricter, as more countries become aware of the consequences of air pollution. New efforts are therefore requested. Most engine developers agree that in the future small engines will

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Published at International Journal of Engine Research, 2017. Doi : 10.1177/1468087416680663

probably be gasoline and hybrid, and this conviction was voiced by Dr. Krüger in the closure sum-up of the THIESEL 2016 conference, though Diesel engines will certainly remain in the next decades for large vehicles. Still according to Dr. Krüger, one of the main challenges nowadays for engine development lies in the system optimization for the different operation modes, and in particular for the transients.

Innovation and future developments call for important research efforts, and require the exchange of valuable knowledge and experience between the main actors of the automotive R&D sector. The THIESEL Conference on Thermo-and Fluid Dynamics Processes in Direct Injection Engines aims at providing Academia researchers and Industry developers the ideal setting for these high tech exchanges. The selection of papers from this conference presented here is a good representation of these exchanges, since six out of 13 reflect industry-university collaborations [7][14][16][23][24][25], while two more are collaborations between various research organizations [6][12].

Traditionally, over half the papers deal with injection and combustion issues, as well from the modelling as from the experimental side, and this is also well reflected in the current selection of 'best' papers.

It is important to point out that most of the 40 papers presented at the THIESEL 2016 conference were of high quality, so that deciding on the 'best' papers has not been easy. 'Best' may be an arguable term, as quite a few others deserve this qualification too. However, the selection of the papers for this special issue has been made on the basis of the opinion of four independent experts in the engine field. In addition, each paper has undergone two review processes, the first one by two referees for the Conference selection itself, and a second review by two peers for the IJER special issue.

Summarizing the contents of this special issue, we can classify the papers selected in four main categories: Modelling ([5][6][7]), Injection ([12][13]), Compression Ignition ([14][16][23][25]) and Spark Ignition ([17][22][24][29]).

As mentioned above, modelling of combustion processes has progressed considerably in recent years thanks to the development of better spray and combustion models and the extensive use of parallel computing. Even so, the difficulty lies in choosing the most representative chemistry, as these calculations are rather time-consuming. Bolla et al [5] perform RANS numerical simulations of the combustion for multiple injection strategies for a case defined in the ECN consortium database [30]. Ma et al [6] have developed a non-equilibrium differential wall model based on the evaluation of the more traditional algebraic equilibrium wall-functions commonly used in RANS and LES IC-engine simulations. In the work by Lucchini et al [7] CFD engine simulations are performed using the Lagrangian approach to describe the spray evolution and detailed chemistry to model the combustion process.

On the topics relative to fuel injection systems and sprays, Duke et al. [12] study the cavitation formation in a real size beryllium nozzle and perform a quantitative analysis of the vapor and liquid phases formed inside. Nishida et al [13] present new experimental data with micro-hole nozzles at very high injection pressure (up to 3000 bar) and demonstrate that these conditions enhance fuel mixing and reduce soot formation.

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Topics about compression ignition engines have been the main focus of the THIESEL conference until recently and still bring in many papers, though they combine now gasoline direct injection. An example is the study by Benajes et al. [16], which explores the limits of the RCCI combustion mode when implemented in a medium-duty engine. Another hot topic for the engine community is the improvement of the engine thermal efficiency, and this is addressed by Olmeda et al. [23] who analyze the effect of swirl on heat rejection. The work by Kondo et al [14] provides a valuable insight into late combustion Diesel flames. Bermúdez et al. [25] present emissions measurement results obtained with a novel dedicated altitude simulation equipment capable of reproducing high altitude conditions on an engine test bench.

With respect to spark ignition engines, Catapano et al [22] show an optimization of natural gas direct injection in a transparent engine, while Zeng et al [17] use double injection strategies to increase the operating range of DISI stratified operation. Krüger et al [24] present a combination of experiments and modelling to study the effect of SI dispersion during lean combustion. And finally, the last paper selected for this special issue by Wissink et al [29] presents a comparative study of the thermodynamic characteristics of different engine operating modes with the aim to provide insight into the limits they offer in terms of efficiency.

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