DIPARTIMENTO DI INGEGNERIA
CORSO DI DOTTORATO IN INGEGNERIA INDUSTRIALE E DELL'INFORMAZIONE -
PHD COURSE IN INDUSTRIAL AND INFORMATION ENGINEERING - 35TH CYCLE

Title of the research activity:	Development of innovative Gasoline Direct Injection systems for the reduction of polluting emissions and energy consumption by ICEs, and of methodologies for the analysis of their behavior and their manufacturing.
State of the art:	The process of technological development of internal combustion engines (ICEs) is nowadays driven by two main factors consisting in the need to reduce polluting emissions harmful to human health, and the need to reduce the specific consumption of the engines and therefore to limit CO2 production. This development is the consequence of the imposition of increasingly stringent regulations concerning emissions (carbon monoxide, unburnt hydrocarbons, particulates and nitrogen oxides [1]), both for engines used for transport vehicles and for stationary power plants for electricity generation or cogeneration systems. The transition to a type of economy completely independent of fossil fuels is not possible immediately; therefore, a phase of gradual transition from internal combustion engines to the large-scale use of electric motors and the exploitation of renewable energy sources is necessary. In the context of this transition, there is a need to pursue a research work on the various types of ICEs in order to understand even more deeply the various phenomena underlying the conversion of energy, with a view to developing subsystems aimed at maximizing the efficiency (with lower CO2 production) and the limitation of the production of pollutants in the combustion chamber in order to reduce the quantity of chemical species to be converted in the aftertreatment systems.
Short description and objectives of the research activity:	The research project concerns the study of physical phenomena occurring inside the engine, with particular reference to ignition systems and low temperature combustion systems, and their optimization through the use of advanced concepts. This path will be divided into an initial phase of analysis of publications on the state of the art in the ICEs industry, as far as the Gasoline Direct Injection [2-4] systems are concerned. Particular attention will be given to systems innovations, to instruments, techniques and methodologies for their behavior analysis, to the related industrial production methodologies. Since GDI systems are used in gasoline engines that often exploit the obtainment of a stratified charge, in order to limit the engine emissions, particular attention will be paid to the injection pressure parameter. As a matter of fact, the problem of the particulate matter generation, caused by the fuel droplets presence in the combustion chamber and their subsequent diffusive combustion, is considered to be limited by the reach of very high pressure levels that allow a finer atomisation of the spray. Particular attention will also be given to the development of methodologies and tools for the analysis of systems behavior, as long as to related industrial production systems.
Bibliography:	1. Mariani, F.; Grimaldi, C.N.; Battistoni, M.; 2014, "Diesel engine NOx emissions control: An advanced method for the O2 evaluation in the intake flow", Applied Energy, 113, 576-588. 2. Zhao, F., Lai, M., and Harrington, D., "A Review of Mixture Preparation and Combustion Control Strategies for Spark-Ignited Direct-Injection Gasoline Engines," SAE Technical Paper 970627 3. Bermúdez, V., Luján, J., Climent, H., Soto, L. et al., "Analysis of Regulated Pollutant Emissions and Aftertreatment Efficiency in a GTDi Engine Using Different SOI Strategies," SAE Int. J. Engines 11(3): 4. Verma, I., Bish, E., Kuntz, M., Meeks, E. et al., "CFD Modeling of Spark Ignited Gasoline Engines- Part 2: Modeling the Engine in Direct Injection Mode along with Spray Validation," SAE Technical Paper 2016-01-0579
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