Experimental Analysis of Combustion Parameters, Performance, Pollutant and CO2 Emissions in a New Turbocharged CNG SI Engine

List of proponents (with e-mail address of the responsible person)
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Description of the international background of the proposal
In recent years, air pollution control and energy supply security have increasingly turned out into two fundamental issues for industrialized countries. Natural gas (NG) emerged as the most promising energy source capable of matching both issues in the short and medium terms, thanks to its inner environmental features and to the favourable geopolitical distribution of reservoirs. In fact, NG combustion produces the lowest greenhouse gas emissions among fossil fuels together with negligible amounts of suspended particles and photochemical smog promootors. Besides, NG reserves are not so concentrated in a small number of unstable countries as oil reservoirs are. NG has not largely been exploited in the transportation sector yet, due to the fuel gaseous state, which requires high-pressure tanks on-vehicle and reduces engine volumetric efficiency with a decrease in engine power output.

Although considerable R&D activity has been carried out to overcome such limitations, further work is still required to fully exploit NG potential as a transportation fuel, primarily for urban mobility. Compensation for power reduction can be achieved by boosting, as well as by new concept NG direct injection. Vehicle weight and volume reductions may require engine downsizing and the development of advanced high-boost concepts. In particular, the optimisation of advanced high-boost combustion systems requires a better understanding of the effects of the fuel, engine design and operating variables on heat release, flame propagation parameters and pollutant emissions.

Research program objectives (intermediate and final) and expected results
The proposed Ph.D. thesis program, to be carried out in cooperation with Fiat Research Center, concerns the development of a new downsized turbocharged SI CNG (Spark Ignition Compressed Natural Gas) engine with a high-turbulence combustion chamber. The research activities comprise both an experimental investigation on the test bench and a theoretical activity for combustion diagnostics in a prototype small-displacement (~ 1200 cc) CNG engine featuring high-boost turbocharging and a fast-burn combustion chamber. More specifically, the experimental activity will consist in carefully developing and setting-up the engine. The parallel theoretical activity will consist in analyzing experimental data through the application and the development of tailored ‘homemade’ combustion diagnostics tools. In particular, since the engine turbocharger optimization will be of fundamental importance in order to fully exploit CNG potential and thus achieve a good compromise between high performance, efficiency and low pollutant emissions, a strong interrelation between experimental and theoretical activities is necessary.

List of publications of the proponents and/or specific references (with titles)