Estimation of the Composition of Methane-Hydrogen Mixtures from Engine Control Variables

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Abstract.

Low Carbon fuels will play a relevant role in the transportation sector contributing, over the powertrain technology progress, to mitigate global CO_2 emissions. Compressed Natural Gas (CNG), mainly composed by methane, is one of the best candidate thanks to its chemical composition and to its wide diffusion and use. Blending Hydrogen in Natural Gas could represent a further step for a better CO_2 footprint (considering renewable or biohydrogen) but also to optimize the combustion process, increasing the engine thermal efficiency and reducing pollutant formation. On the other hand, capability to automatically adapt the engine parameters to variable concentrations of Hydrogen in Natural Gas (in the range from 0% to 40% by volume) is a mandatory step to maintain engine performance, emissions and efficiency The activities described in this paper are part of a large collaborative project, "Biomethair", funded by Regione Piemonte, where material specifications on gas tanks, valves, feeding lines, gas pressure regulator, engine pipes and injectors have been set and prototype components procured and implemented into the demonstrator vehicle to ensure safe operating conditions.

In this paper a software algorithm is presented, able to provide, during normal car operation, real time estimates of methane-hydrogen composition, allowing the engine control system to adapt the control parameters engine. The algorithm is based on the innovative data-driven technology Direct Virtual Sensor, which allows to design the Virtual Sensor from the experimental data collected from a testing car, subject to suitable manoeuvres in different operational conditions, without requiring deep first principle modelling of the involved systems.

The Virtual Sensor has been designed and implemented on the Electronic Control Unit of the demonstrator vehicle, giving suitably discretized estimates of Methane-Hydrogen composition, using measurements of engine revolution speed, of the lambda probe value and a variable from engine control unit. Experimental results of the Virtual Sensor performance evaluated in different operational conditions are presented.