EXHAUST COMPOSITION AT LASER IGNITION IN A 2-STROKE AND WANKEL ENGINES [1]

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Compact piston engines are considered as an alternative for fuel elements and batteries for portable, automotive and UAV. Those are characterized by small combustion chamber comparable to spark plug inter-electrode gap in axial direction, and its low ratio to bore size. For Wankel engines this problem exists at any scale though. Multi-point ignition could be helpful, but is too complicated in electric spark way. To increase engines specific capacity, higher compression is needed. Unlike electric spark, laser ignition energy decreases with pressure increase in reasonable range up to ca. 100 bar. However, of piston engines, data regarding four-strokes only could be found [1], but those are not so compact as two-stroke and rotary (Wankel) ones. For the latter, laser ignition was only suggested by Mazda in 2011, but there are still no papers regarding this problem, except constitutive patent application [2]. The former, to the best of our knowledge, have been considered for the first time only recently, being fed by LPG [3].

Albeit two-stroke and Wankel engines have higher volume and mass specific power, comparatively simple construction and easy handing, those are now outweighed by high fuel consumption and harmful emissions rates. Since combustion is to be induced at every rotation unlike 4-srokes, this increases thermal load. Laser ignition of lean fuel mixtures in such engines could significantly improve performance by reduced fuel consumption and cleaner exhaust. Lower combustion temperatures also reduce thermal stabilization issues, which are more pronounced in compact systems. One more feature needed for portable and temporarily set engines is ability to use multiple and locally available low-quality fuels. E.g., in remote Arctic areas natural gas is available from the ground, but gasoline and diesel are brought from industrial centers, which can increase operating costs by an order of magnitude. Modern ecology standards for internal combustion engines leave a very small niche for high specific performance, but not so clean exhaust two-stroke and rotary engines. The former could be switched to gas feeding comparatively easily, but the latter has ignition and starting issues even with optimized fuels. Laser ignition could resolve these problems. So the aim of this work was to measure exhaust composition of laser ignited two-stroke and Wankel engines fed by different fuels.

We have used a custom-built laser spark plug (2.7 mJ, 0.5 ns at 1064 nm) to ignite hydrogen, methane, propane and butane fuel mixtures in model two-stroke and Wankel engines and measured exhaust composition with an industrial gas analyzer. Experimental setup is described in [3]. NO_x emission for stoichiometric C_3H_x/C_4H_x 81% / 16% based mixture combustion was 16 ppm and 6 ppm for idling two-stoke and Wankel engines, respectively. So poor ecological performance characteristic for two-stroke and Wankel engines could be fixed with laser ignition.

REFERENCES

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