NUMERICAL SIMULATION OF COMBUSTION PROCESS IN ROTARY RANGE EXTENDER WITH HYDROGEN DIRECT MULTIPLE INJECTION*

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The range extender is used for recharge batteries of electric vehicles in order to increase driving range. The range extender typically uses a combination of an internal combustion engine and an electric generator. In this study the rotary engine was studied because this type of engines has valuable advantages: low weight and dimensions, large specific power and excellent engine balance [1]. The choice of the fuel type is crucial for the range extender due to the world emission concern. Application of the hydrogen as an energy carrier can provide near-zero emissions of carbon and reduced emission of nitrogen oxides (NOx) [2]. The multiple direct injection of hydrogen was investigated [3]. Three types of injection with different injection pressure, duration, timings and quantity of injections were analyzed.

The alternative method for the quantitative analysis of the process parameters was proposed. Instead of the volumetric region where the averaged values can be calculated we created a probe surface offset from the flame front at the distance of *s* as it is shown in Fig. 1a. The probe surface was split into two sub-surfaces from leading (L) and trailing (T) spark plugs. The flame offset distance *s* was defined with using Göttgens et al. [4] correlation for the preheat zone thickness in hydrogen flames.

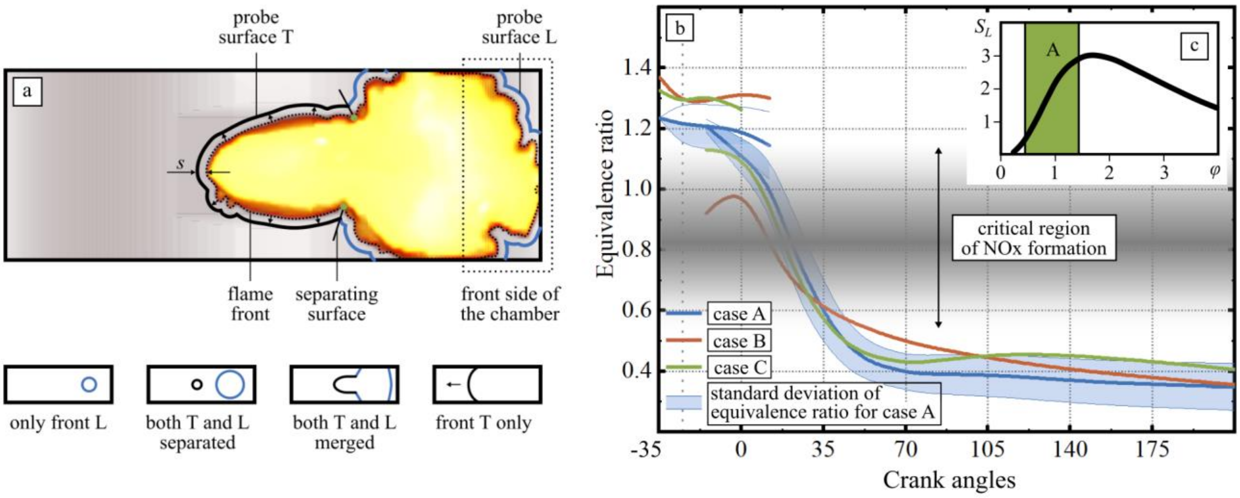

Fig.1. Method of flow parameters estimation ahead of the flame front and equivalence ratio evolution.

The evolution of the averaged equivalence ratio (φ) near the L and T flame fronts during is shown in Fig. 1b. The hydrogen concentration near the L and T is different. The dependency of the laminar flame speed S_L to the φ is shown in Fig. 1c. The range of the maximum φ variation is shown with the region A. In this region the dependency can be approximated fairly well by a linear and the relation between S_L and φ. The flame fronts initiated by the L and T are characterized by significantly different parameters which is conditioned not only by different locations and ignition timing delay but also by local hydrogen distribution. The considered injection system provides a rich mixture composition near the LSP and a stoichiometric to lean composition near the TSP. The direct multiple injection strategy allows using higher integral equivalence ratio up to 0.8 that results in larger power density in combination with low NOx emission.

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