Particle number emissions from a hydrogen-fueled Turbulent Jet Ignition engine with a passive prechamber

Jacek Pielecha, Ireneusz Pielecha, Filip Szwajca

Institute of Combustion Engines and Powertrains, Poznan University of Technology,
Pl. M. Sklodowskiej-Curie 5, 60-965 Poznan, Poland
jacek.pielecha@put.poznan.pl

Modern combustion systems are increasingly being used to burn hydrogen. In such a direction, research has been conducted using a Turbulent Jet Ignition (TJI) system with a passive prechamber. The TJI system allows the combustion of lean mixtures and such a solution was used in the current work.

The purpose of the work was to analyze particle number emissions using the TJI system under passive chamber conditions. The work was conducted with:

- two engine speeds (n = 1200; 1500 rpm)
- high value of the excess air coefficient (λ = 1.65; 2.0; 2.2)
- varying values of the indicator referred to as the center of combustion (CoC = 6; 8; 10 deg aTDC).

The study used a single-cylinder AVL5804 research engine with a two-stage combustion system equipped with a hydrogen injection system (P = 9 bar) into the intake channel. The prechamber was equipped with a spark plug.

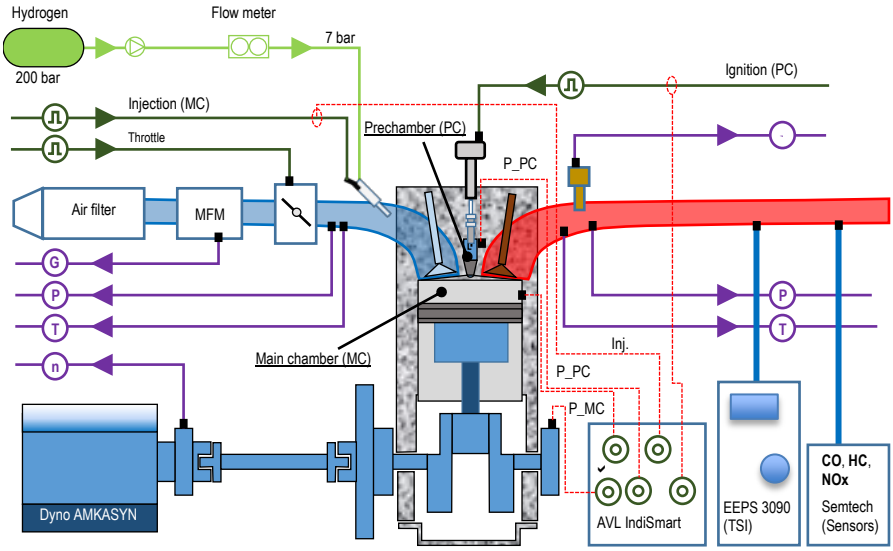

Fig. 1. Scheme of the test stand with measuring apparatus

The concentration of gaseous toxic components and the concentration of particle number were analyzed under static conditions. The analysis of the concentration of gaseous components shows their global reduction when the angle of the center of combustion (CoC) is increased (related to ignition retardation). The largest reduction is in the concentration of nitrogen oxides. Change in λ-coefficient from 1.65 to 2.20 results in a more than 5-fold reduction in their concentration. The carbon monoxide content is mainly due to the combustion of lubricating oil (consider that this is a single-cylinder engine). Analysis of the test results indicates that there is a relationship between the excess air factor and the

concentration of particle number. The total number of particles in the range λ > 2.0 indicates a higher number at lower engine speed. The effect of CoC is ambiguous when changing engine speed and excess air ratio. At low λ, it has been shown that engine speed has a much greater effect on particle number than combustion center angle (CoC).

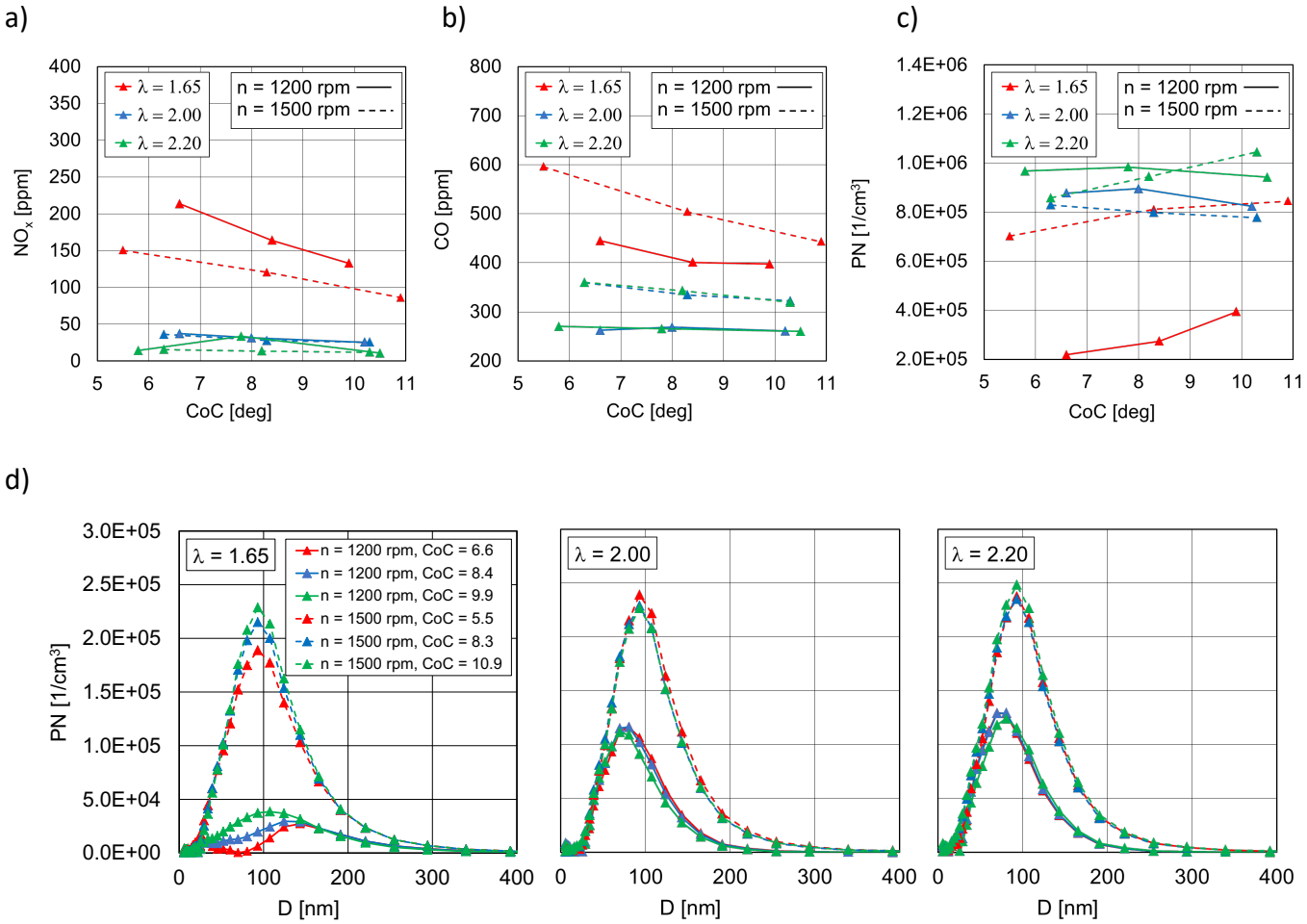

Fig. 2. Results of tests of exhaust gas components under different operating conditions of a hydrogen-fueled engine: a) concentration of nitrogen oxides; b) concentration of carbon monoxide; c) concentration of particle number; d) concentration histogram particle number at different values of excess air coefficient – λ

Analysis of the test results indicates that increasing the speed of rotation results in a more than 2-fold increase in the number of particles. It should be noted that changing the angle of the center of combustion has little effect on changes in the characteristic diameter of particles. Although the increase of λ affects the reduction of the concentration of all analyzed gaseous components, it does not affect the shape of the particle number histogram. It can be concluded that increasing the excess air ratio slightly increases the maximum values of particle number concentration in the range of 80–100 nm (regardless of the speed). For the SIDI engine, other researchers also obtained a 2-fold increase in particle number (relative to the PFI engine) in the range of about 10 nm [5].

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