Bio-Green IC Engine

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Main outcomes of the project is the enhanced thermodynamic model developed in the framework of “Bio-Green IC Engine” has been incorporated into previously existed specialised software, Diesel-RK (see Fig. 1) for rapid optimization of biofuel engine design parameters and organization of its working process in order to achieve the highest possible efficiency and to satisfy NOx, CO, PM and smoke emission levels (http://www.diesel-rk.bmstu.ru/Eng/index.php?page=Download)

This programme has the following original features:

- In addition to catalogue of conventional diesel and petrol fuels, extensive database of advanced biofules has been created for modelling of IC engines. This includes physical and chemical properties of biofuels, e.g. RME, SME, biofule blends B5, B10, B20 etc., bio-ethanol and bio-methanol (Fig. 2);
- The capability of using a number of independent fuel injection systems with various geometry of fuel injectors and their operational parameter for supplying different types of fuels into the cylinder. A combined strategy for multi-stage injection process for each type of fuel can be optimised to achieve the highest possible engine performance (Fig. 3).
- Three-dimensional non-CFD modelling of evaluation of fuel sprays, supplied by independent fuel injection systems, and for visualisation of the fuel spray evolutions (see Fig. 4);
- Capability of thermodynamic modelling of dual-fuel diesel engines, operating on bio-methanol or bio-ethanol ignited with a pilot injection of diesel or biodiesel fuel. Previously this type of engines have been modelled using only CFD approach (Fig. 5).

Using this approach a concept of novel Z-engine has been investigated with a split compression process. In such engines the first stage of the compression takes place outside of the cylinder (external piston compressor) with the second stage carried out in the cylinder. Due to such the organisation of the compression process the injected fuel evaporation takes place at low pressure and high temperature conditions, making it possible to realise the HCCI process, which reduces emissions to levels which are achieved at modern engines with after treatment systems (Fig. 6).

Figure 1. Main Interface of Diesel-RK IC engine simulation software (freely available for academic use).

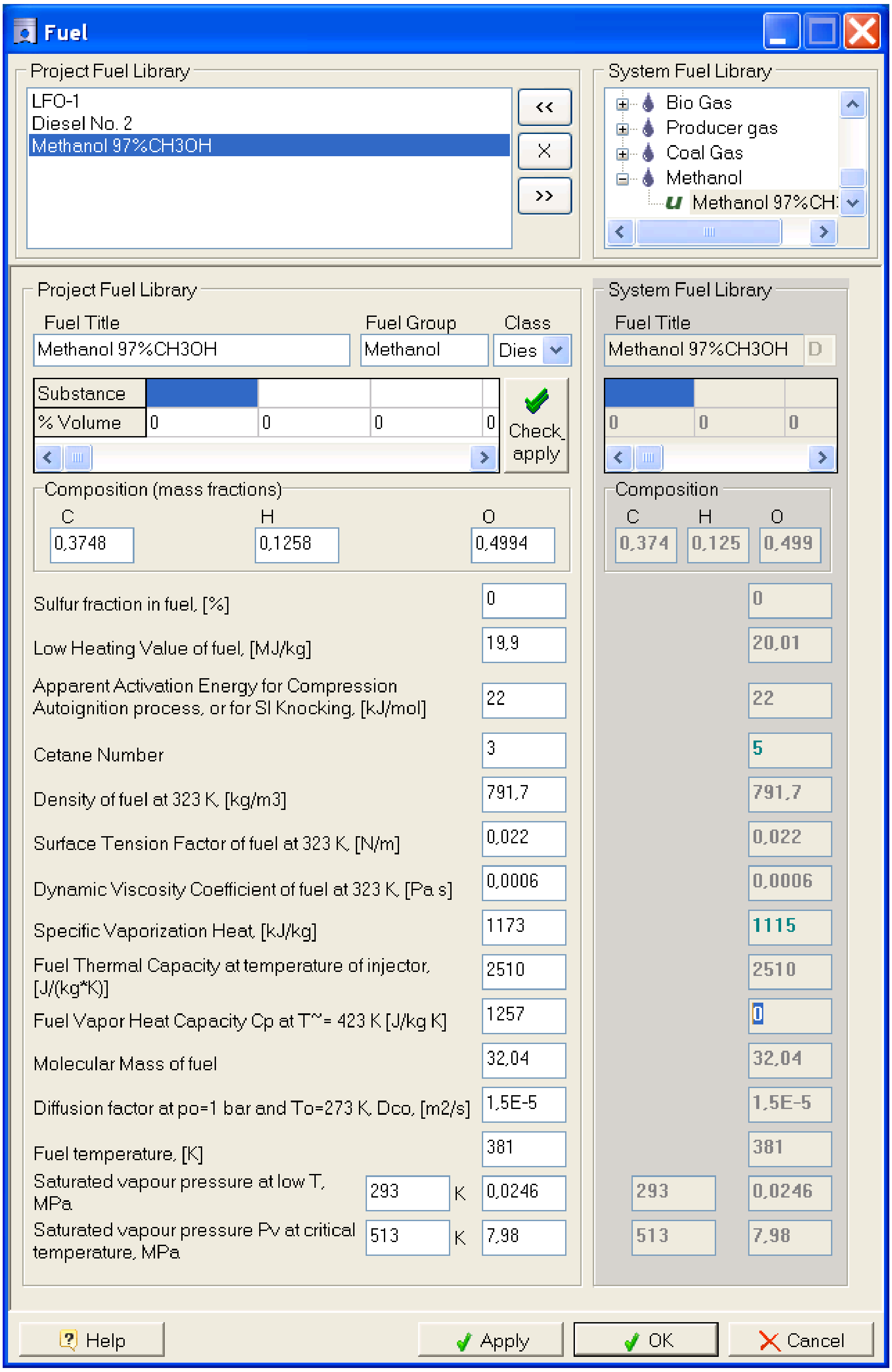


Fig. 2. Fuel Library with database of physical and chemical properties of advanced fuels in Diesel-RK software.

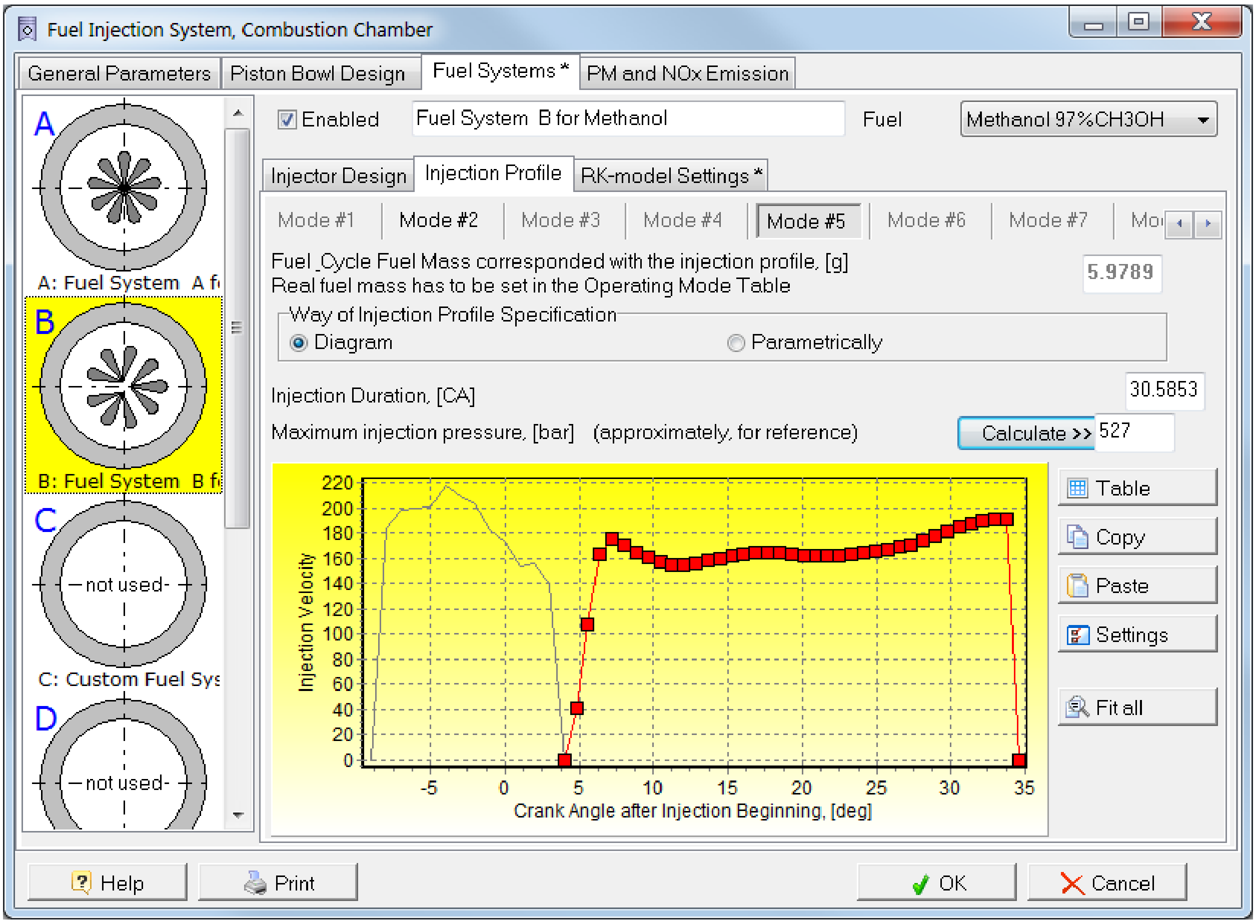


Fig. 3. The use of independent fuel injection systems with various geometry of fuel injectors and their operational parameter for supplying different types of fuels into the cylinder.

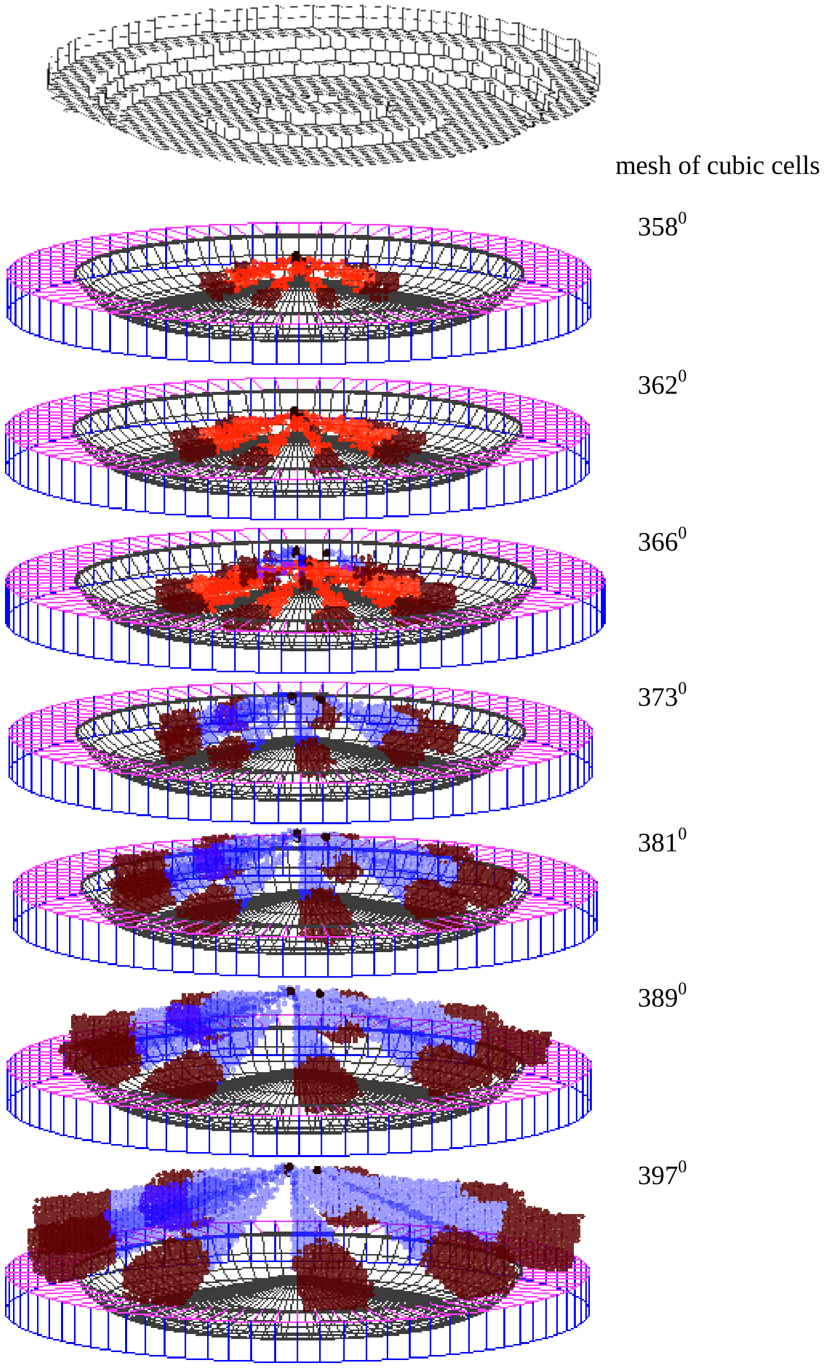


Fig. 4a. 3D visualization of evolution of diesel fuel (red) and methanol (blue) sprays in the engine's cylinder for various instances in the cycle (the CA) using non CFD method (Spray fronts are shown in brown).

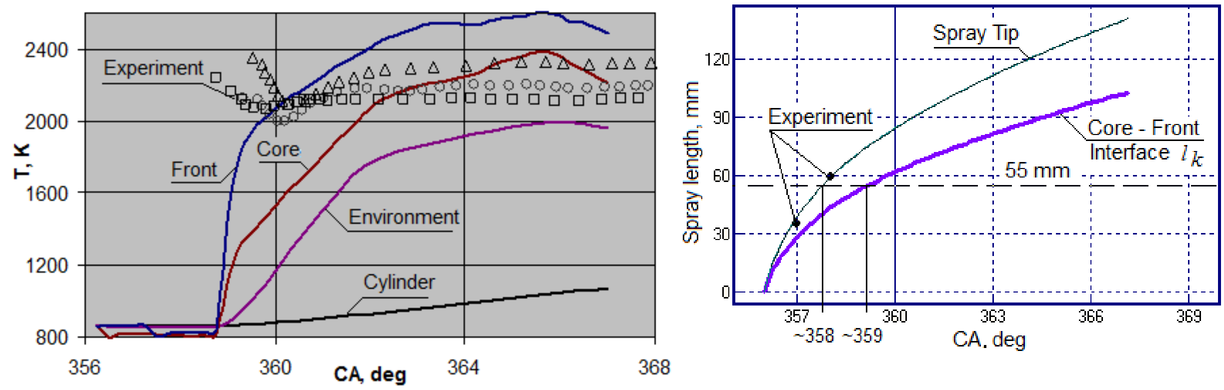
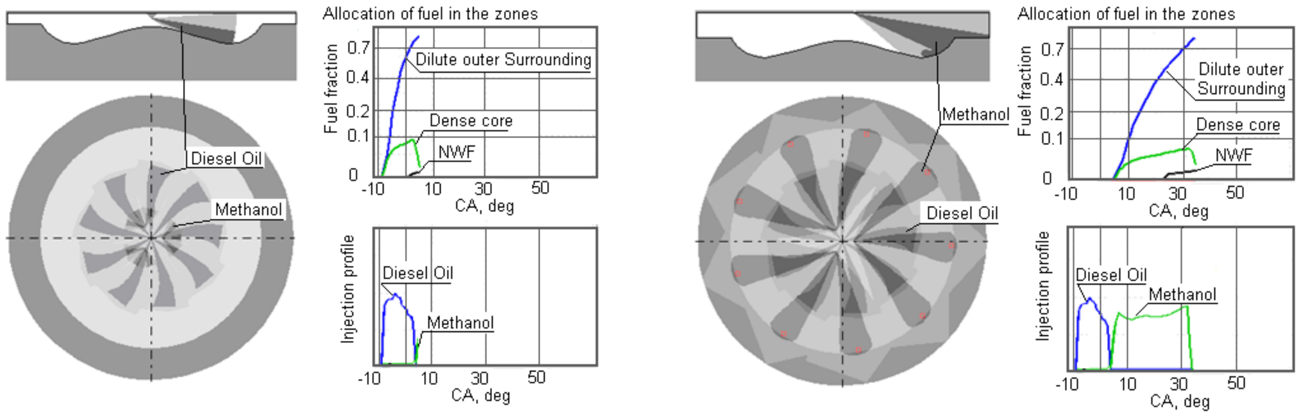


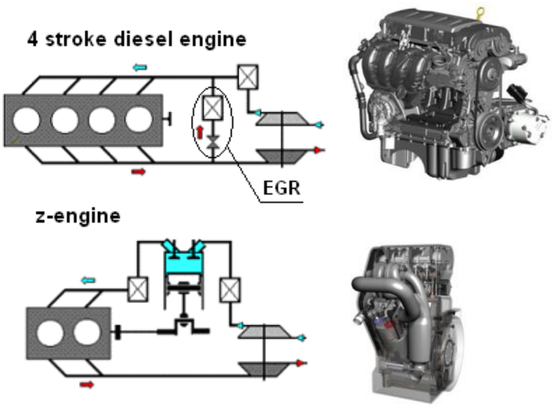
Fig 4b. Comparison of theoretical and experimental results for 3D non CFD modelling of fuel spray evolution.



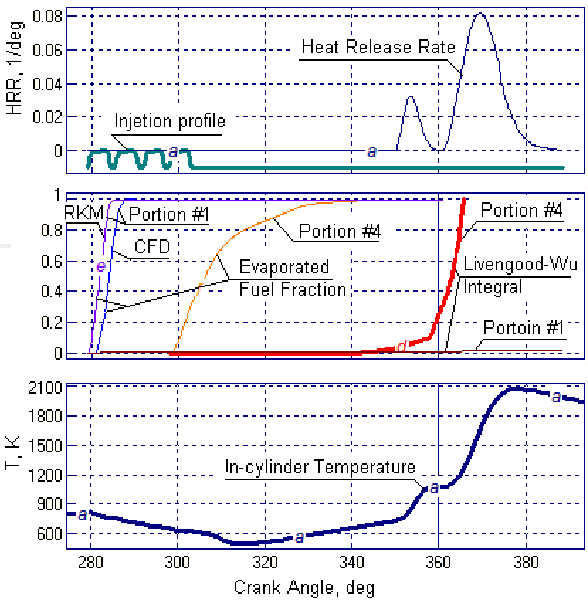
Result of simulation of Diesel oil spray evolution at the end of Diesel oil injection and the diesel oil distribution in the characteristic zones of the spray.

Result of simulation of methanol spray evolution at the end of methanol injection and the methanol distribution in the characteristic zones of the spray.

Fig. 5. The use of independent fuel injection systems with various geometry of fuel injectors and their operational parameter for supplying different types of fuels into the cylinder.



The schematic of the z-engine in comparison with a 4 stroke 4 cylinder diesel engine of the same power output



Mixture formation and combustion phenomena in the cylinder of the z-engine in SA HCCI conditions (BMEP=31.1 bar @ 2800 RPM)

Fig 6. A concept of novel Z-engine with a split compression process and the HCCI process with reduced emissions