D4.2 – CFD simulations and single-cylinder test bench activity

Research Innovation Action

EUROPEAN COMMISSION
Grant Agreement No. 874972

HORIZON 2020 PROGRAMME
Topic LC-GV-04-2019
Low-emissions propulsion for long-distance trucks and coaches

Deliverable No.	**LONGRUN D4.2**	
Related WP	WP4	
Deliverable Title	CFD simulations and single-cylinder test bench activity	
Deliverable Date	2022-08-30	
Deliverable Type	REPORT	
Dissemination level	Confidential – member only (CO)	
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Status	Final	2022-12-05

1 Publishable summary

In Task 4.2, a new system of combustion for Heavy Duty engine fueled by Natural Gas has been developed and evaluated by IFPEN, based on an innovative high efficiency lambda one combustion concept, so-called Swumble™ concept, developed by IFPEN.
The development process has been divided into separate activities, starting from the same base engine, the FPT Cursor 13 NG engine. The aim of the development plan was to demonstrate finally by Single Cylinder Engine tests the benefits induced by this new approach of high efficiency combustion system and the achievement of the final target: an improvement of efficiency higher than 10% compared to the Cursor 13 NG engine.
The complete development of the combustion system and the integration of the Swumble™ concept has been performed through an intensive campaign of 3D CFD calculations. Several loops were necessary to obtain the final Swumble™ version of the combustion system, V5.5, which has the correct trade-off between intake flow capacity and production of turbulence.
Globally, four main conclusions on the performances obtained with the Swumble™ concept can be drawn on both in-cylinder fluid motion and combustion aspects:

- High levels of Tumble and fluid motion, offering strong turbulence for the combustion using both Atkinson and Miller valve profiles were demonstrated;
- Intake flow capacity remains unchanged on all operating points and for both valve profiles;
- Very rapid combustion is observed offering the possibility to run this engine with Miller valve strategy and interesting rates of EGR;
- Strong reductions of knock level are also observed with the possibility to better calibrate the CA50 and therefore increase the indicated efficiency by around 5 to 6 % for all the operating points and both valve profiles.

The optimization phase of this innovative system of combustion at the test bench has been performed on a single cylinder engine with various technological packages (VVT, LP EGR) and compared to the production Cursor 13 NG configuration. Very high performances have been demonstrated:

- with EGR, efficiency has increased more than 15% on the whole engine map
- 45% max indicated efficiency has been obtained.