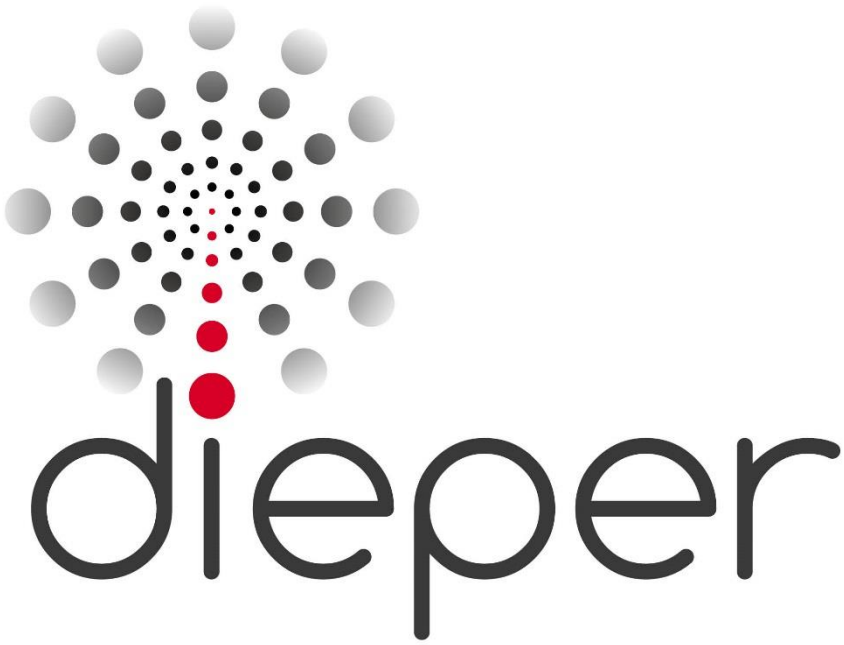

Diesel efficiency improvement with Particulates and emission Reduction

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Publishable Executive summary

The objective of this subtask and the associated deliverable is the study and definition of the optimal thermodynamics approach for obtaining extreme engine efficiency over the entire engine map, for both PC and LCV application.

In order to explore a wide range of the possible technical approaches, a specific simulation process has been defined. This process is based on a DoE approach and 0D simulations. By taking into account different input factors and by considering several optimization strategies, it has been shown that the fuel consumption could be reduced by up to 15%, thanks to the optimization of the compression ratio, but also thanks to the global synergy between the compression ratio, the EGR rate, and the fuel-air equivalence ratio.

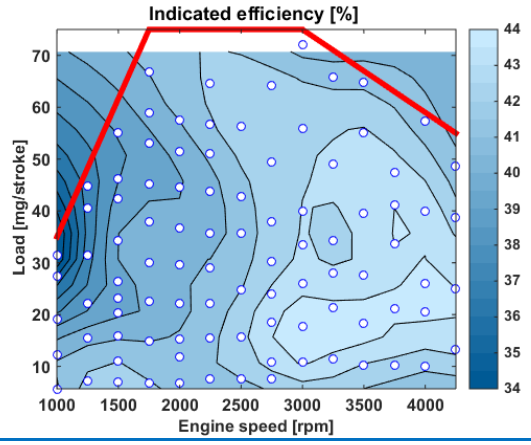
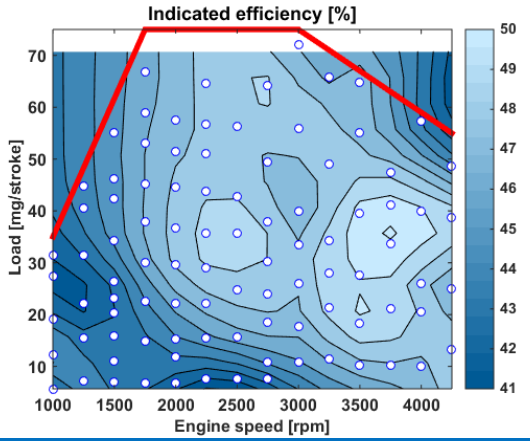
Based on these simulation results, when considering an optimized turbocharging system (strategy #2.1.9), the compression ratio should be ideally varied between 14:1 to 19:1 to increase the indicated efficiency while complying with NOx and noise constraints for the RSA PC application, and between 15:1 to 19:1 for the FMF LCV application (see table here below**Error! Reference source not found.**). With current turbocharging technology (strategy #2.1.2), the compression ratio ranges result wider, as showed in the table.

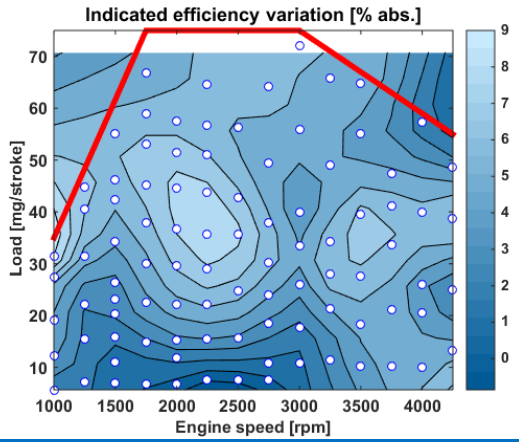
Compression ratio variation ranges.

	Optimization strategy 2.1.2 Reference turbocharging system	Optimization strategy 2.1.9 Optimized turbocharging system
LCV application	13.5:1 → 22:1	15:1 → 19:1
PC application	12.5:1 → 22:1	14:1 → 19:1

In these conditions, the indicated efficiency can be significantly increased as shown in the figures here below: the maximal indicated efficiency obtained is around 51%, against 44% for the reference configuration.

Comparison of the indicated efficiencies obtained for the reference configuration and for the optimization strategy 2.1.9.

Reference	Strategy #2.1.9
	



However, the compression ratio variation range is linked to the assumptions that are made regarding the turbocharging capabilities. If higher EGR rates can be used for instance at low engine loads while keeping the same fuel-air equivalence ratios, then higher compression ratios might be advantageous in terms of fuel consumption. On the contrary, if the considered exhaust after-treatment systems have a very high efficiency and if the EGR rates required to decrease the NOx emissions can be lowered, then it might be unnecessary to increase too much the compression ratio because of the consequences on the cooling losses. This specific trade-off should be particularly analyzed during the next Task 2.2 dedicated to the combustion system design based on detailed 3D calculations.

Some vehicle simulations have finally been carried out to obtain a first estimation of the potential benefits in terms of fuel consumption over the WLTC (see table here below). The two vehicle applications have been considered:

- RSA PC with a stop & start system, and with a 2.0 L engine
- FMF LCV without stop & start system, but with 3.0 L engine achieving the same full load performance of the 2.0 L engine (lower maximal BMEP values).

Vehicle fuel consumption reduction with optimized VCR and turbocharging systems.

	Optimization strategy 2.1.9 Optimized turbocharging system
LCV application (w/o. S/S)	-14%
PC application (w. S/S)	-11%

At this stage, the simulations have been performed for warm conditions, and by assuming similar friction losses for the reference and the optimized VCR engine. The strong fuel consumption reductions that are obtained are not only due to the VCR approach, but also to an optimized turbocharging system, and also to the fact that the optimization strategy reported here allows a slight increase in the NOx emissions. Of course, these are only preliminary results that will have to be confirmed as the following tasks of WP2 progress.

1 Acknowledgment

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