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Investigation of the effect of turboexpander on NOx emissions from a diesel engine

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AGENDA

- Introduction
- Objectives
- Background
- Methods
- Results
- Conclusion

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INTRODUCTION

- Road transport is one of the biggest sources of harmful pollutants.
- NOx is one of the direct emissions from a vehicle.
- NOx is formed when combustion occurs in an internal combustion engine (ICE) at high temperature and pressure.

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OBJECTIVES

- Lower the charge air intake temperature in diesel engines.
- Reduce NOx emissions from as a result of lower intake temperatures.
- Develop an optimised charge air control system.

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BACKGROUND

- Air Cycle Technologies (ACT) have created a novel turboexpander which has previously been tested by ACT in gasoline race car engines to reduce pre-ignition.

- Current work is being carried out to prove the useability of the ACT turboexpander in diesel engines to reduce NOx formation by cooling the intake air.

- For this study, a 4.4 litre JCB-TCA 74 turbocharged diesel engine was retrofitted with an experimental ACT turboexpander.

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METHODS

The study has been conducted empirically using formulae; experimentation and simulation.

- Hand calculations - Resulted in a self-contained spreadsheet wherein input parameters of the engine can be fed to the system.
- Experimentation – Test cell was set up to test and validate the hand calculations and spreadsheet data for the engine.
- Simulation- Simcenter AMESim was used to validate the simulation model against test data and optimise the temperature control system.

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RESULTS

Hand Calculations

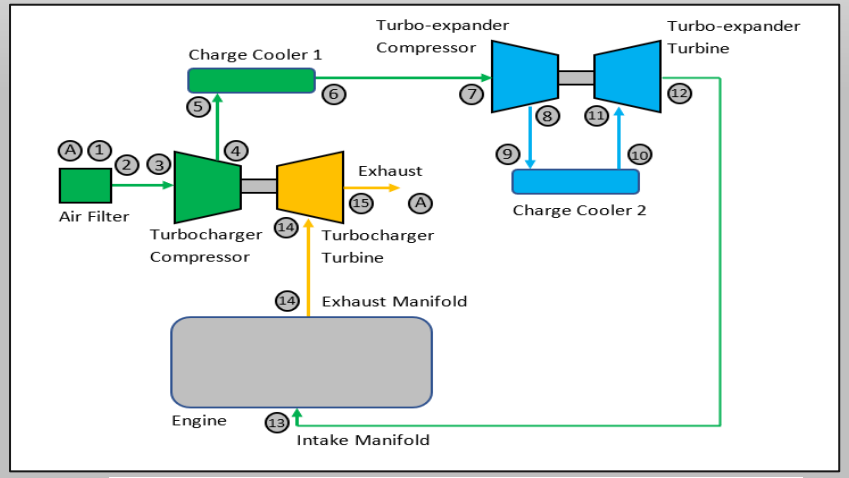

Figure 1 – Schematic of Engine with turbo-expander fitted

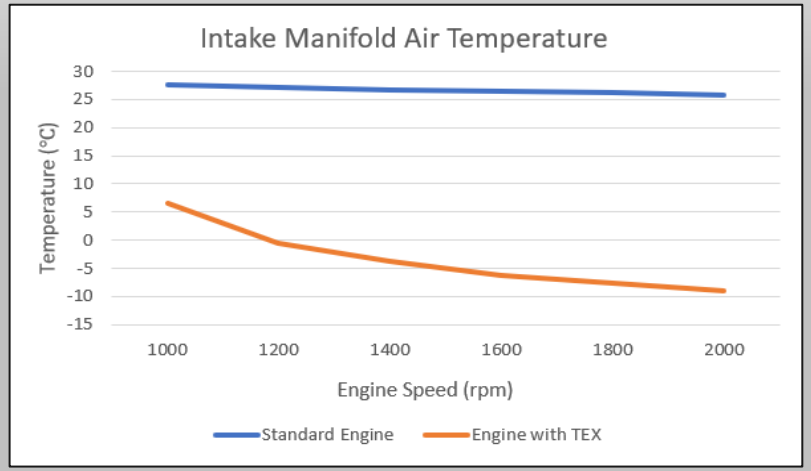

Figure 2. Calculated intake manifold air temperature

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RESULTS Cont'd

Experimentation

Figure 3 – Test cell setup

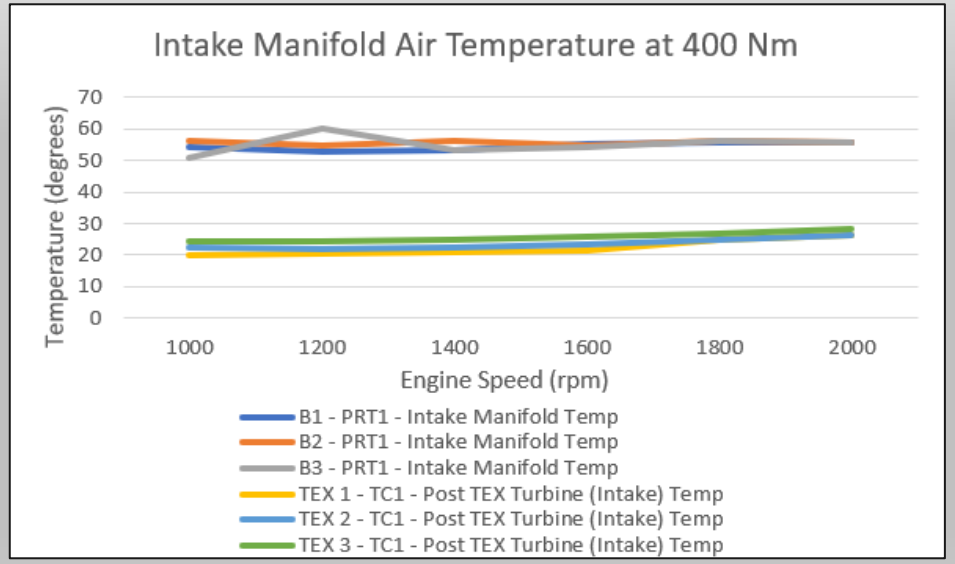

Figure 4 – Intake manifold temperature comparison at 400 Nm

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RESULTS Cont'd

Simulation

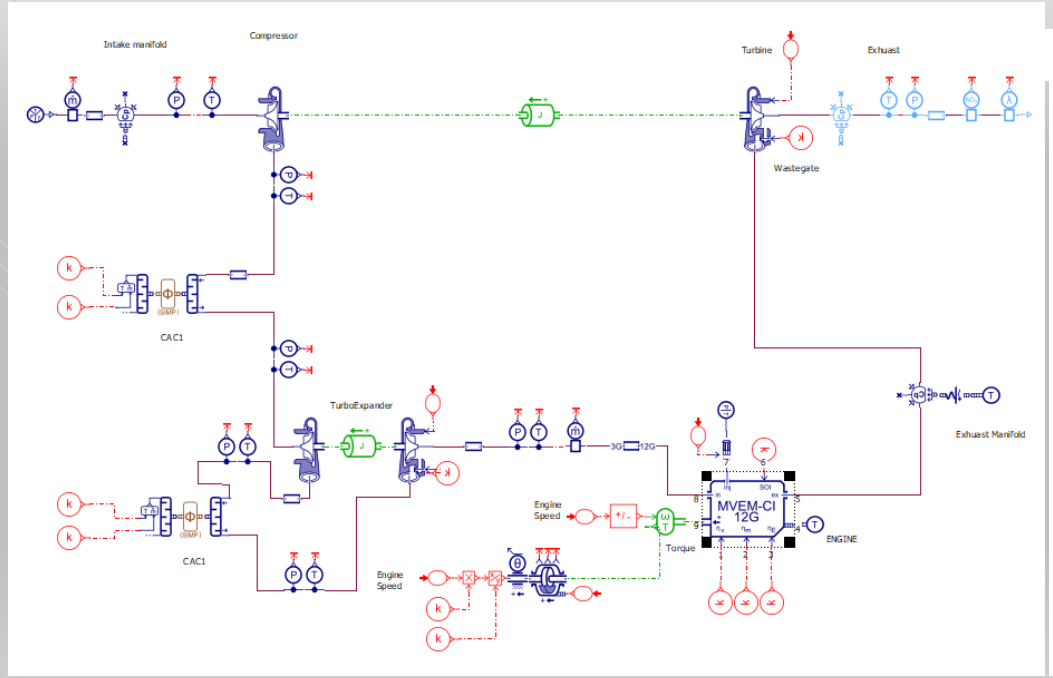

Figure 5 – Simulation setup

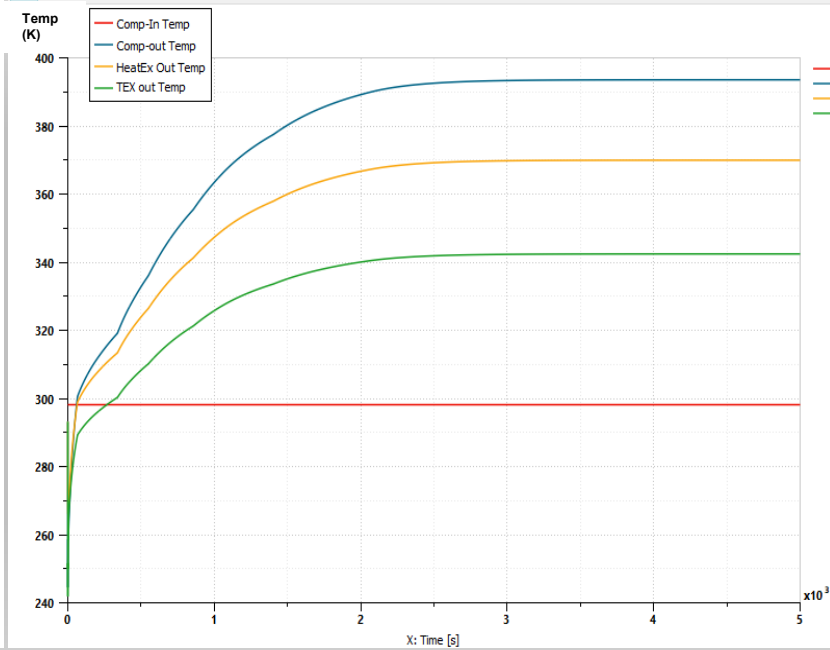

Figure 6 – Temperature reduction using a turboexpander

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RESULTS Cont'd

- A reduction in intake temperature of up to 34 ℃ at 2000 rpm has been predicted.

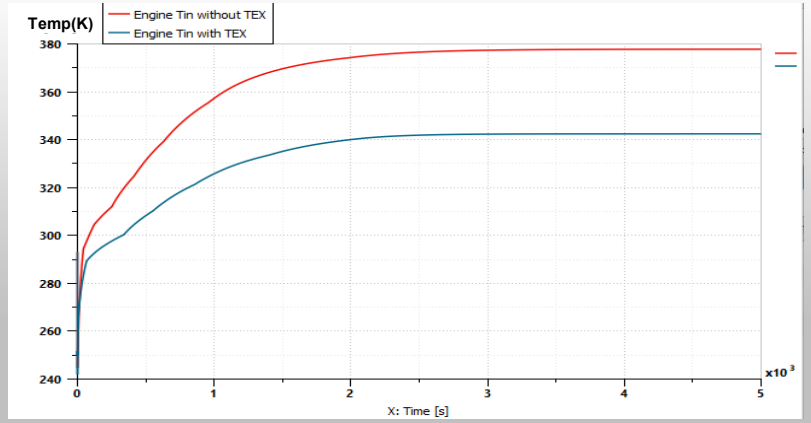
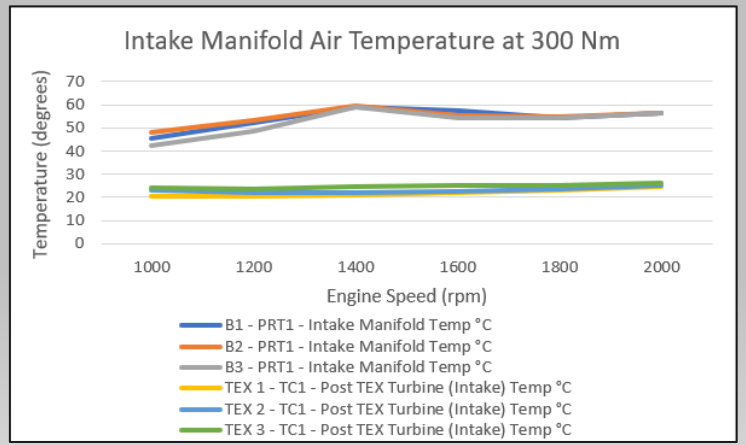
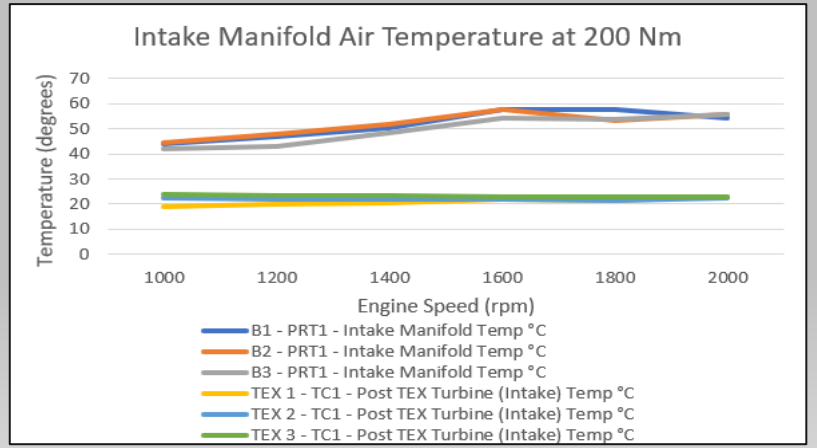


Figure 7 – Temperature comparison





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RESULTS Cont'd

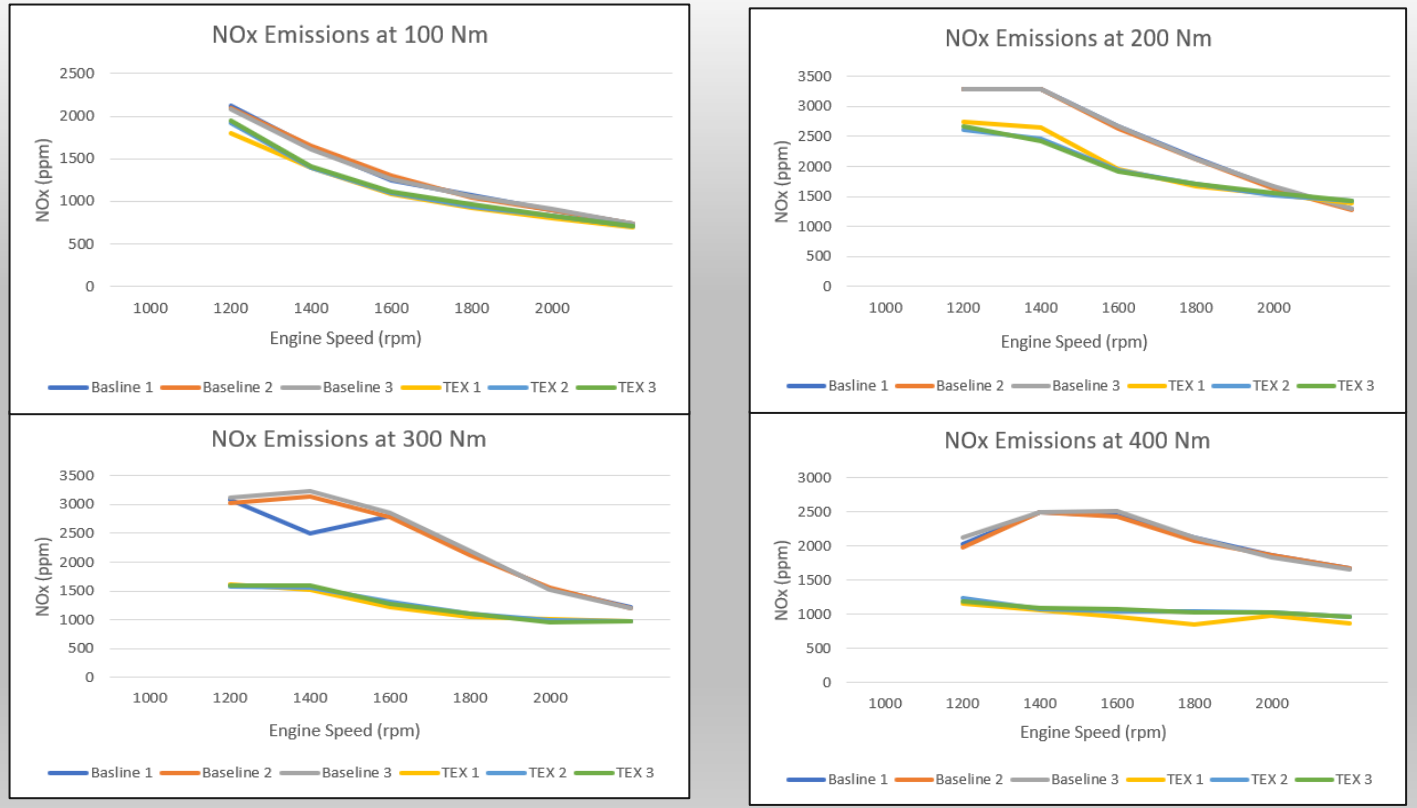

Figure 8 – NOx emissions comparison between engine with and without TEX

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CONCLUSION

- This study employs empirical formulae and simulation techniques via a spreadsheet and simulation software.
- The analysis presented in the study demonstrates a significant reduction of overall intake air temperature using the ACT turboexpander and subsequent reduction in NOx emissions.
- Considering the escalating stringency of emissions standards, the findings propose a forward-thinking approach to address the challenge of NOx emissions from internal combustion engines.

THANK YOU

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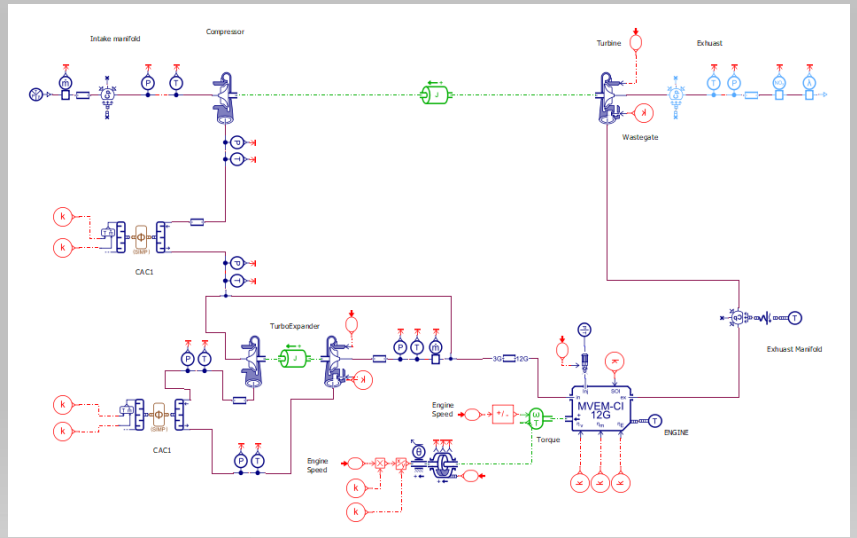

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