Experimental and theoretical research to characterize radial heat fluxes inside automotive turbochargers

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INTRODUCTION

Heat transfer phenomena helps to evaluate and understand some of turbocharger damages which may affect the engine performance. Bearings clogged, damages in the shaft, oil coke formation and other failures are because of high temperatures inside the turbocharger at different operating conditions where cars are exposed daily.

- A turbocharger thermal characterization inside turbocharger under engine Hot-Stop cycle and different engine operating points is done by means of thermocouples distributed on the external and internal surface
- A thermal sensitivity by greater or lesser thickness of wall in the turbine housing is analysed through experimental tests and simulations.

OBJECTIVE

To measure the maximum level of temperature in different parts of the bearing system and turbocharger in an engine cycle which has a stabilization phase, transient phase and hot stop (cut of oil and water cooling system).

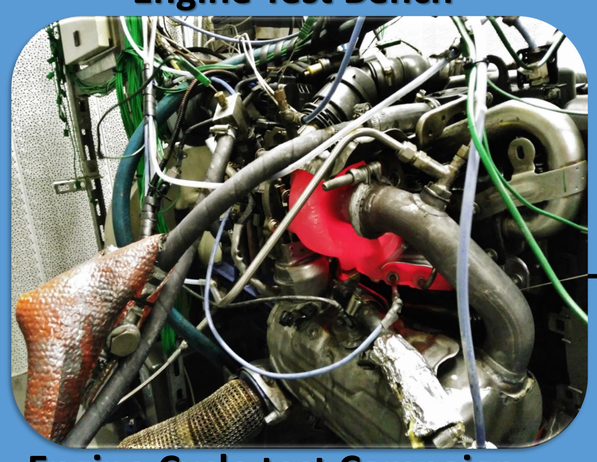
Specific objectives

- To analyse the internal temperature trends inside the turbocharger during the engine hot stop.
- To complete a thermal characterization in the turbocharger when it comes to a different engine operating points.

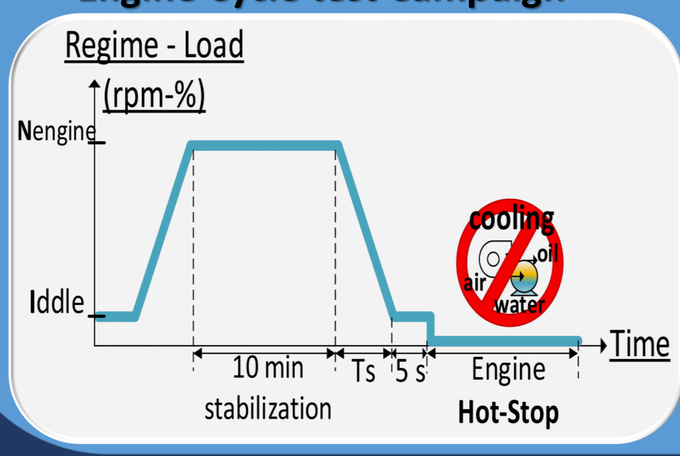
METHOD AND TERMS

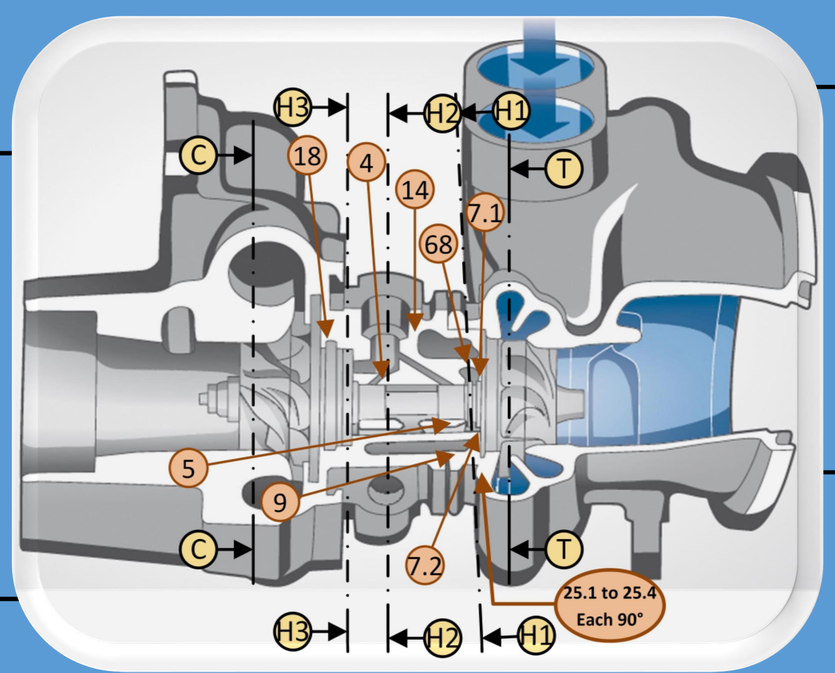
EXPERIMENTAL TEST ⟷ MODEL STUDY

Engine Test Bench



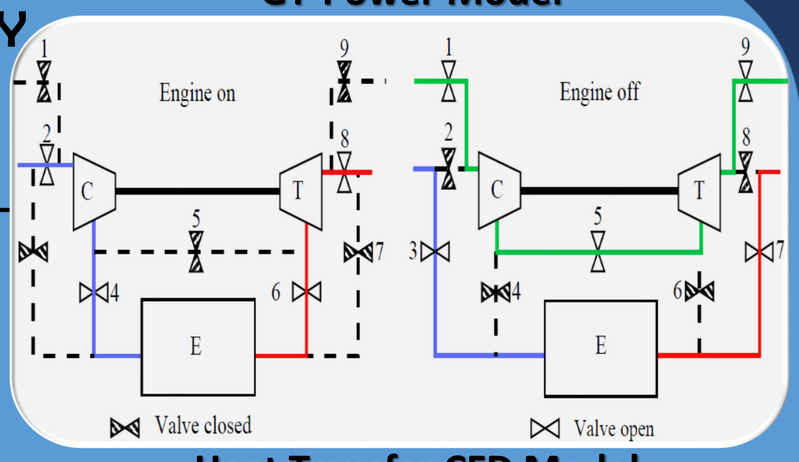
Engine Cycle test Campaign



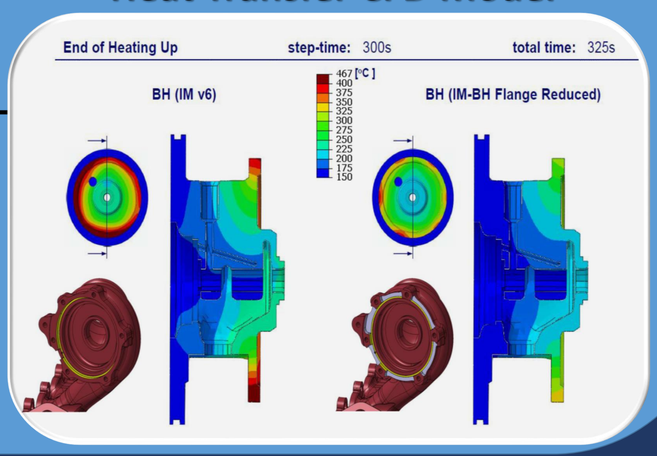


THERMOCOUPLES TURBOCOMPRESSOR

GT-Power Model

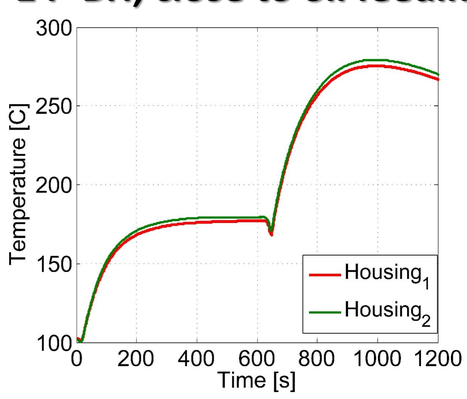


Heat Transfer CFD Model

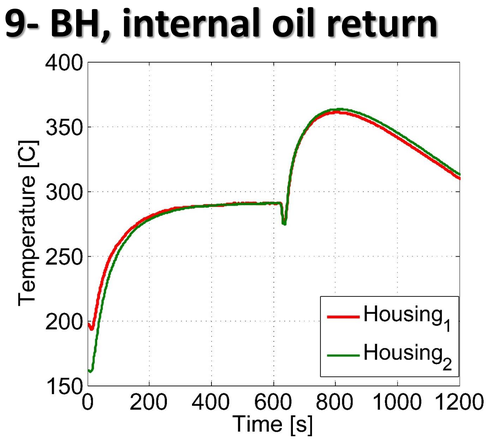


RESULTS

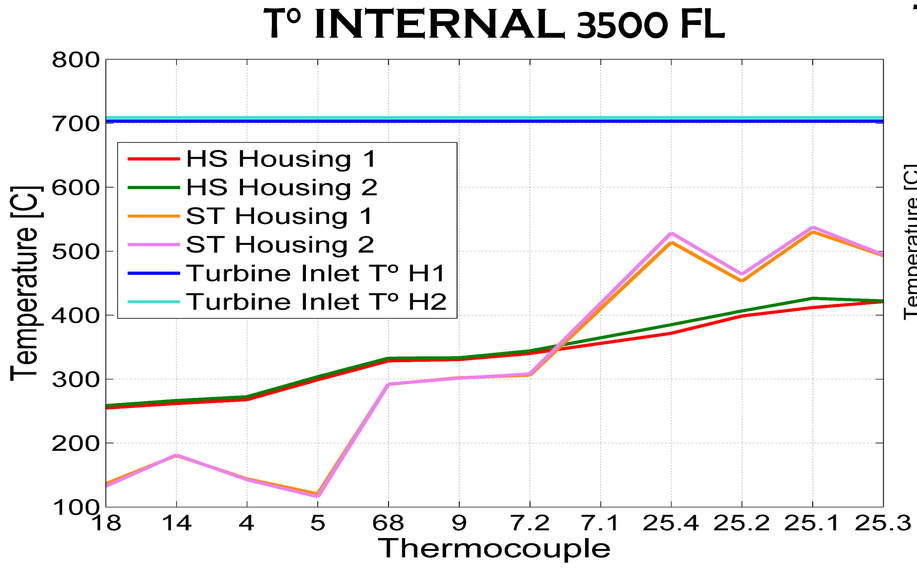
14- BH, close to oil feeding



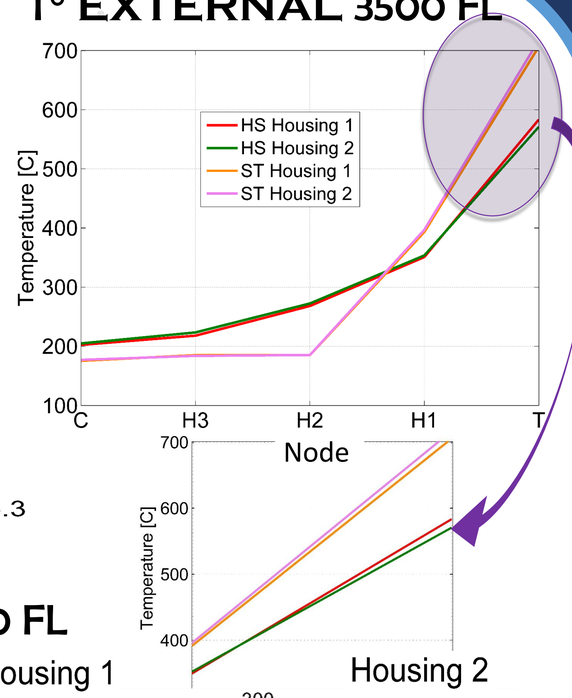
9- BH, internal oil return



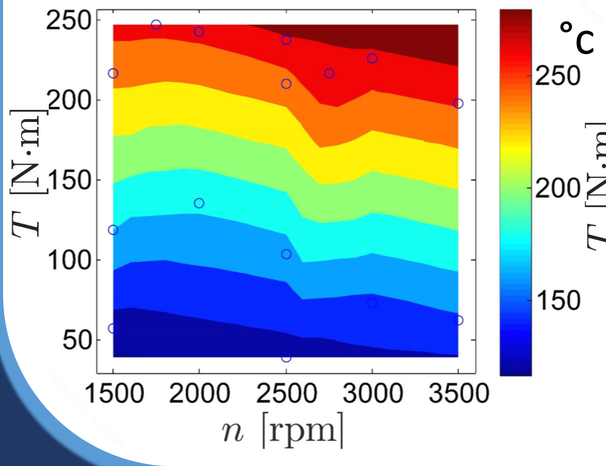
T° INTERNAL 3500 FL



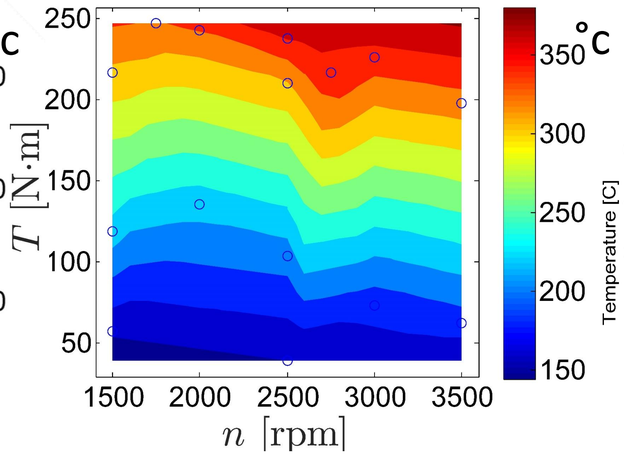
T° EXTERNAL 3500 FL



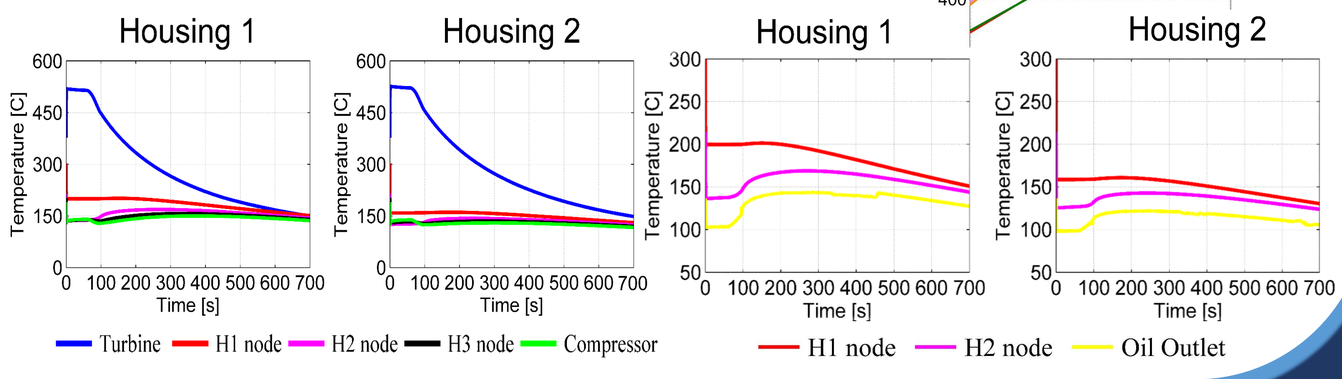
14- BH, close to oil feeding



9- BH, internal oil return



GT-Power Simulation at 3500 FL



DISCUSSION

- Cut of oil cooling inside the turbocharger produces a notable heat exchange. Maximum level of temperature in different parts of the bearing system and turbocharger for the engine hot-stop are at 2750-Full Load and 3000 Full Load.
- Internal temperatures are higher than the external for the sweep of engine operating points tested in the test bench under the hot stop engine cycle.
- Less heat becomes inside the turbocharger with the normal turbine housing1 (without any flange) that with the thermal decoupling turbine housing according experimental tests. Opposite behavior is obtained with gt-power and 3D simulations exposed by turbocharger manufactures. Future works are focused in the study on the implementation of radiation as a heat transfer phenomena present between the engine exhaust manifold and the turbocharger.