Abstract

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Impact of turbocharger non-adiabatic operation on engine volumetric efficiency and turbo lag

Turbocharger performance significantly affects the thermodynamic properties of the working fluid at engine boundaries and hence engine performance. Heat transfer takes place under all circumstances during turbocharger operation. This heat transfer affects the power produced by the turbine, the power consumed by the compressor, and the engine volumetric efficiency. Therefore, non-adiabatic turbocharger performance can restrict the engine charging process and hence engine performance. The present research work investigates the effect of turbocharger non-adiabatic performance on the engine charging process and turbo lag. Two passenger car turbochargers are experimentally and theoretically investigated. The effect of turbine casing insulation is also explored. The present investigation shows that thermal energy is transferred to the compressor under all circumstances. At high rotational speeds, thermal energy is first transferred to the compressor and latter from the compressor to the ambient. Therefore, the compressor appears to be “adiabatic” at high rotational speeds despite the complex heat transfer processes inside the compressor. A tangible effect of turbocharger non-adiabatic performance on the charging process is identified at turbocharger part load operation. The turbine power is the most affected operating parameter, followed by the engine volumetric efficiency. Insulating the turbine is recommended for reducing the turbine size and the turbo lag.