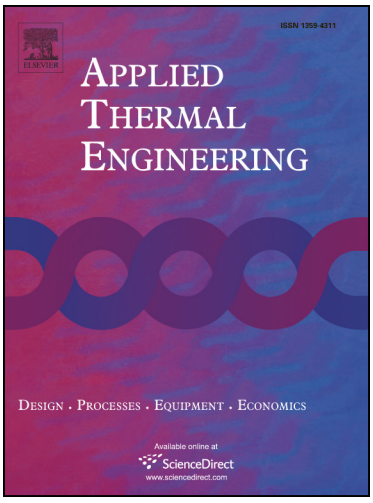

Research Paper

A theoretical and experimental study on the effects of parameters of two-stage turbocharging system on performance of a heavy-duty diesel engine

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A theoretical and experimental study on the effects of parameters of two-stage turbocharging system on performance of a heavy-duty diesel engine

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Abstract: The paper presents a theoretical analysis and experimental study on the effects of parameters of two-stage turbocharging system on engine performance. A thermodynamic model was developed base on the first and second laws of thermodynamic to analyze the effects of different turbocharging parameters on engine boost pressure and pumping loss qualitatively. The numerical analysis results show that pressure ratio distribution (PRD) of compressors, inter-stage cooler, total turbine expansion ratio and turbine bypass or equivalent efficiency are the dominant factors affecting engine boost pressure, pumping loss and consequently the engine performance. Subsequently, those theoretical findings were applied in the matching and architecture optimization of a regulable two-stage turbocharging system, which comprises a high-pressure variable geometry turbocharger (VGT), a low-pressure fixed geometry turbocharger and an inter-stage cooler, for a heavy-duty diesel engine. The experiment was designed with a well matched two-stage turbocharging system to validate the theoretical findings and to optimize the engine fuel efficiency. The results indicate that inter-stage cooler does improve engine fuel efficiency by increasing intake manifold pressure and reducing pumping loss. Increasing the total turbine expansion ratio by reducing flow area of high-pressure stage VGT led to higher engine boost pressure, increased PRD and turbocharging efficiency variation, which results in increased pumping loss. The best fuel efficiency can be realized by compromising the engine boost pressure and pumping loss.

Keywords : Two-stage turbocharging; inter-stage cooling; pressure ratio distribution; cooling efficiency; pumping loss;