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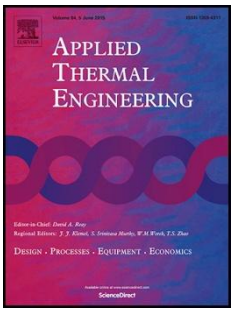


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# Comparison and Analysis of the Effects of Various Improved Turbocharging Approaches on Gasoline Engine Transient Performances

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## Highlights

（1）The transient response time follows the descending sequence of EGT, SAT, ECT and SET.

（2）The SAT and ECT engines have higher efficiency than the EGT and SET engines.

（3）The PMEP of SAT and ECT engine can be reduced compared with EGT engine.

（4）The performances of SAT and ECT engines can be improved by re-matching a larger turbine.

**Abstract:** In this paper, several kinds of improved modes for exhaust gas turbocharging (EGT) have been investigated on the transient performances, including steam-assisted turbocharging (SAT), electronically controlled turbocharging (ECT) and supercharger-exhaust gas turbocharging (SET). A turbocharged gasoline engine was employed as the study object, which was conducted bench test firstly to get basic data for building and calibrating the simulation model. Then, an accurate and reliable GT-Power model in steady and transient engine operation was developed. On this basis, the transient processes of four types of engines: EGT engine, SET engine, SAT engine and ECT engine were investigated by simulation and comparative analysis. The results show that SET, SAT and ECT can reduce the response time and fuel consumption in acceleration process. The response time of various turbocharging approaches follows the descending sequence of EGT, SAT, ECT and SET. At the speed of 2000 r/min (from idling to full load), compared with EGT engine, the specific fuel consumption (SFC) of SET engine is decreased by 23.3%, while it can be reduced by 38.2% and 36.3% in SAT engine and ECT engine, respectively. Finally, to reveal the improvement potentials of SAT and ECT, both of them were re-matched with a larger turbine without wastegate. The results indicate that the torque and thermal efficiency of SAT and ECT engines can be further improved, while the acceleration equilibrium time is increased.

**Keywords: Gasoline engine; Turbocharger; Transient Response; Exhaust gas energy recovery; Thermal efficiency**

## 1. Introduction

It is usually admitted that exhaust gas turbocharging (EGT) is a useful technology to improve engine power and fuel economy. As a matter of fact, it is also a promising technique of engine waste heat recovery (WHR) [1,2], since the turbine uses engine exhaust gas energy to drive the compressor. Compared with the naturally aspirated (NA) engine, EGT engine has many advantages, such as higher specific power, smaller displacement and larger torque. As a result, EGT has been widely applied in automotive gasoline engines in recent years [3-5]. However, there are still some barriers in EGT gasoline engine, especially the poor torque and response performances during acceleration process of the automobile [6]. It is commonly accepted that the torque of NA gasoline engine increases with the opening of throttle. Nevertheless, in the turbocharged gasoline engine, torque and other engine variables not only depend on the throttle opening, but also on the

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