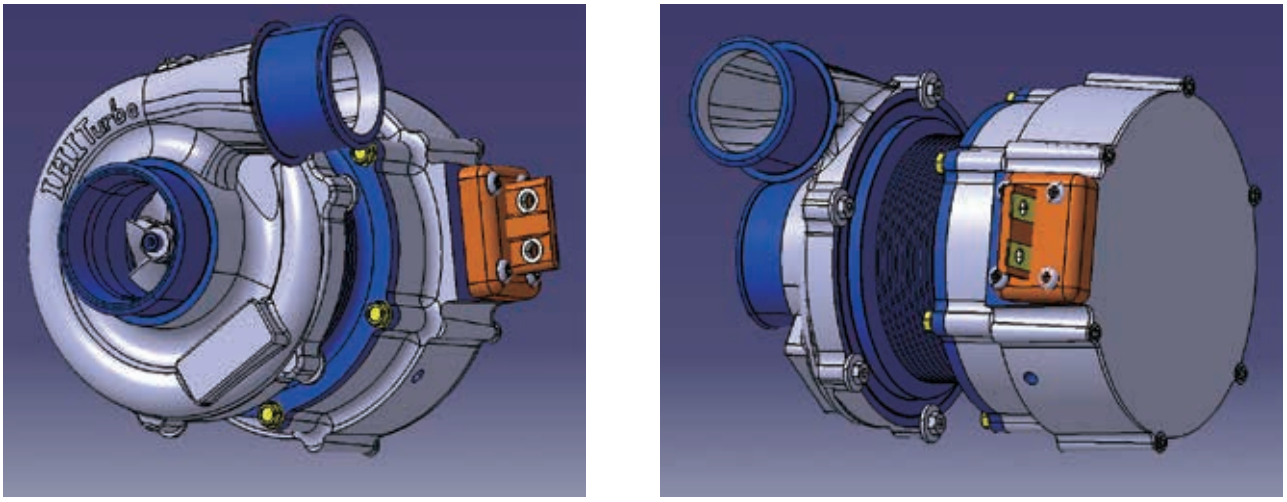
Next-Generation Turbocharger Enhanced with Electric Power

Electric power utilized for best acceleration of turbochargers

Recent progress in efficiency of car engines requires most advanced charging systems providing best response time, highest pressure ratio and best efficiency while the available exhaust gas energy to propel the turbocharger is simultaneously reduced. Thus, IHI Turbo is developing products that apply electric motor technology to turbochargers allowing overcoming this conflict.



Electric compressor

Currently in the scope of the general downsizing (or recently right sizing) trend of passenger car engines in Europe the third generation of turbocharged engines is under development. Turbocharging is employed to achieve both high fuel efficiency and powerful engine performance while maintaining best drivability. Especially European engine manufacturers need to develop advanced technologies as enabler to meet stricter fuel efficiency regulations that will be introduced by 2020 in respective European countries.

One effective technology to meet the stricter fuel efficiency regulations is a hybrid system, which uses both a conventional combustion engine and an electric motor. However, manufacturers cannot take advantage of hybrid systems in the World wide harmonized Light vehicles Test Procedure (WLTP) that is expected to be the future international standard test cycle. In contrast to the existing test cycle WLTP requires high fuel efficiency and powerful driving performance in a wide operating range from low-speed travel in heavy traffic on urban streets to high-speed travel on highways. The WLTP mode evaluation will be more representative for actual customer operation, but is a challenge for engineers who need to develop suitable technologies. Simple evolution of existing technologies might not be sufficient, but new advanced technologies need to be progressed. IHI is investing in upfront development programs with the target to be prepared for new technology trends identified by close customer contact.

This article introduces two new products on electric boosting technologies developed to serve next-generation engines.

Market environment for electric power use

To meet future fuel consumption regulations, European automobile manufacturers have developed Plug-in Hybrid Electric Vehicles (PHEVs) similar to the ones already introduced into the Japanese market. PHEVs can travel a certain distance as an electric vehicle, whereas the combustion engine charges the battery. Because PHEVs are assumed to be an effective means to improve average fuel consumption they are expected to be widely used in the future. In parallel with such changes of engine concepts the automobile markets are generally in change and will allow utilization of electric power for higher acceleration of turbochargers including the combination of PHEVs with turbo-engines (engines equipped with a turbocharger).

Electrically assisted turbocharger

Electrically assisted turbochargers are turbochargers with a motor positioned between the compressor and turbine. Equipped with an exhaust gas driven turbine and an electric motor, electrically assisted turbochargers can supplement available exhaust gas power with electric power thereby allowing faster response and higher boost pressure. Electrically assisted turbochargers can be called hybrid turbocharging systems as they can regenerate electric power from the exhaust gas during operation when excessive energy is available. As electrically assisted turbochargers have to be used under the same conditions as standard turbochargers, specifications such as maximum rotation speed, maximum gas temperature and endurance reliability have to be equivalent to those of standard turbochargers.

As the electric power supply from on-vehicle 12-Volt batteries is hardly sufficient to increase turbocharger rotation speed with short response time, the use of 48-Volt batteries is considered to be effective and its introduction in European engine markets is expected.

Electrically assisted turbocharger

The electrically assisted turbocharger allows the enhancement of conventional turbocharging systems with increased acceleration in a wide range of operating conditions. Moreover, it allows energy recuperation and enables future engine concepts with best fuel consumption.

Electric compressor

In this device, an electric motor propels the compressor. Electric compressors can be used in combination with a conventional turbocharger enabling the turbocharging system with improved response time and allowing operation in charging pressure range unachievable with conventional single stage turbochargers. Conventional two-stage charging systems that consist of two standard turbochargers adjusted in size respecting the engine requirements will be inferior with required design space and required piping systems as well as response time. Due to the expected electrification of engine concepts, electric compressors will also be an alternative to replace mechanical superchargers with the benefit of again design space but also weight.

IHI has developed an electric compressor device with a highly efficient motor capable of continuous operation but also allowing best acceleration and therefore response time due to light-weight rotor design.

As explained above, this article briefly introduces two types of new turbochargers based on electric boosting technologies that can be applied to highly efficient future engine systems.

With the new product lineup composed of electrically assisted turbocharger, and electric compressor device IHI turbo supplements its conventional turbocharger product program to meet increasingly diversified customer needs and contributes to future engine development.

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