

Efficient Dynamics and Minimal Emissions – BMW's concepts for SULEV-compliant Turbocharged Engines

Christoph Luttermann, Christoph Zülch

Abstract:

American emission regulations are the world's most demanding of SI engines. In particular, compliance with Californian "ZEV" regulations requires optimization of all engine and aftertreatment systems. The tightening emission constraints have resulted in a growing abundance of SULEV-compliant vehicles. Therefore, vehicles of a broad range of size/weight and performance classes must be made to comply with minimal emissions standards. Alongside of reducing HC and NO_x emissions is increasing fuel efficiency a primary goal. For this reason, downsizing engine concepts – mainly direct-injection and turbocharging – are applied, which realize a combination of high performance and high fuel efficiency.

Typically, turbocharging makes compliance with tightening emissions regulations substantially more difficult. Cumulative tailpipe emissions over drive-cycle are dominated by emissions during the first 30 seconds of engine use, during which time the conversion of pollutants in the catalyst has not yet reached the steady state efficiency. The process initiates when a minimum catalyst temperature is reached using the enthalpy of the engine exhaust. The exhaust enthalpy also heats the turbocharger-casing, and catalyst light-off therefore requires more time with a turbocharged engine than with a naturally aspirated one. Additional steps must be taken to fulfil emissions requirements.

Within a concept study, a variety of options for reducing emissions from turbocharged engines is investigated using a combination of advanced development practices. A fundamental understanding of the strongly cross-linked processes by which pollutant emissions are born and converted is achieved via a range of dynamometer and vehicle experiments coordinated with extensive computation. In addition to complying with stringent emissions regulations, it is essential that this concept consider economic aspects as well as maintain the efficient dynamics a BMW customer expects.