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Emissions – A new Challenge for Turbocharging

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Abstract: The main focus of attention in engine development today is on satisfying coming emissions requirements and regulations. This has largely replaced the traditional development drivers, such as power density, efficiency and cost, all of which experienced considerable improvement throughout the 1990s. The new main focus naturally also has a considerable influence on the development activities of the turbocharger manufacturers.

Development work in the past decade has led to the power density stagnating somewhat, since the available pressure ratios have been absorbed by early inlet valve closure. The well known trade-off between engine efficiency and lower emissions can lead to a penalty in engine efficiency where low NOx emission regulations are already in force, due to the fact that the injection timing is often retarded.

It is expected that there will be pressure in the near future to lower emissions still further. The big question is: Will this lead to a further stagnation in power density or will development work aimed at high boost pressure levels act as an impulse and drive a new wave of engine development?

Very high boost pressure levels open the door to a reduction in cycle temperature by different means, an especially interesting one being advanced Miller timing. The lower process temperature not only allows a reduction in the NOx emissions of an engine, but also an improvement in the efficiency and power density of the plant. Intelligent charge air management is also called for here in order to ensure an adequate supply of air at every engine load and allow for better control of the smoke and particulate emissions.

ABB Turbo Systems Ltd has been very active in this field with various research projects in cooperation with engine builders, universities and other institutions. These activities have shown the considerable potential of high boost pressure turbocharging (1- or multistage) in connection with engine concepts such as the Miller process, EGR, common rail or variable injection pressure, long stroke,. . .

As always, one single turbocharging solution cannot meet every challenge. The paper therefore presents different concepts for the future realisation of high boost pressure levels, each with its pros and cons for the diverse engine configurations and applications. However, the criteria applied to judge the suitability of a solution is the same in each case: low emissions (NOx and particulates), enhanced operation capability, load response, and reliability – all issues with major benefits for the environment, the engine builder, the enduser, and last but not least, for the manufacturer himself.