VCM® and Power2®

Shifting the fuel-NOx tradeoff with active air management

By Victoria Maier, PhD, Manager Global Media Relations & Editorial Services, ABB Turbo Systems AG

Recent dialogue around turbocharging has revolved around the question of what lies ahead, and for many, the answer has been to two-stage turbocharging, to increase pressure and therefore also power. Two-stage turbocharging represents a big step, and intuitively speaking, the most logical one. However, as with single-stage turbocharging, two-stage turbocharging compromises on volume flow and air pressure. The result to date has been an invariable tradeoff between either fuel efficiency or NOx emissions. According to this state of the art, a turbocharger's potential can never fully be exhausted.

Step one toward shifting the NOx-fuel tradeoff: Power2

At ABB Turbocharging, our recent forays into optimizing two-stage turbocharging have shown us that there is in fact a way to create a turbocharging solution that makes full use of the turbocharger's potential. The answer lies in combining our two-stage turbocharging solution, Power2®, with a new technology that we have dubbed Valve Control Management (VCM®), i.e. a variable valve train system. And it is a combination that works on either gas or diesel.

Three years ago, Power2 opened up new possibilities through two-stage turbocharging for increasing the performance of diesel and gas engines in every major aspect and application. It helped to reduce emissions and so enabled customers to meet increasingly stringent IMO regulations. Power2 made possible increases in mean effective pressures in gas and diesel engines by combining Miller timing, increased pressure and turbocharger efficiency.

Power2 also rendered an engine more powerful thanks to higher output density. Thanks to this development, customers could also save money on material costs, for example by choosing a smaller engine with fewer cylinders.

Time has brought new insights as well as constructive new developments to Power2. Now in its second generation, Power2 continues to ensure high efficiency at high-pressure ratios. Compared to the first generation, pressure ratios have now become higher and efficiency greater. Second-generation Power2 pressure ratios can climb to 12. Turbocharger efficiency is reaching 75%. Clearly, fuel consumption and power density are only going to get even better with time, both of which have clear implications for the environment as well.

Step two toward shifting the NOx-fuel tradeoff: VCM

Taken on its own, Valve Control Management already offers multiple benefits to a turbocharging solution. This technology constitutes a smart solution that responds adaptively to an engine's valve timing. Unlike other engine platforms with multiple control units, VCM's design has been streamlined into a single control element that makes the engine platform more straightforward and reliable.
VCM enhances customers' options for an engine's operating and application range. VCM also increase range of application for higher performance engines that are used on technology such as tugboats, pump drives, and compressor drives, in which either large operating ranges or fast load responses are major requirements. With VCM, a turbocharger can supply the air optimally for operation at different speed loads and ambient conditions. VCM facilitates transient behavior so that engines can accelerate more rapidly from one load point to the required load. A turbocharging solution equipped with VCM can take an engine that is idling to full load in half the time that it normally takes – in some cases even more quickly. VCM makes the most of every load point because it can optimize the turbocharger for every load. In short, it increases efficiency.

VCM also increases the durability and reliability of certain components in the engine and turbocharger by reducing thermal load. Specifically, since this technology can be used to optimize the configuration of the engine for every load point, it can also be used to reduce exhaust gas temperature. This technology also makes the air cleaner by reducing the particle emissions in exhaust gas.

Innovation is critical for reviving the market in the longer term because it is the only sustainable way to make a positive difference to customers' performance. So no matter now immediate the need for cash, our company's focus is and must be innovation with the potential to improve the

industry as we know it today.

The motivation to develop and refine a technology like VCM is thus clear, as Oliver Riemenschneider, head of ABB Turbocharging notes, “The first results from our collaborations with engine builders on power plant engines are very exciting. Since these engines are very similar to the engines found on many ships, we think that these results are a clear indicator that VCM will be highly relevant for and effective in the marine industry, also.”

Our findings right now indicate that VCM will generate savings in fuel and increase flexibility in operation, for example with respect to dual fuel. A technology like this speaks to the increasing trend to explore dual fuel options and create solutions for gas.

Step three toward shifting the NOx-fuel tradeoff: Combining the two technologies

Putting these two technologies together makes for a world-class solution. In combination, Power2 and VCM generate active air management that considerably improves the tradeoff between NOx emissions and fuel consumption. It shifts the entire tradeoff downward so that fuel efficiency can be increased without compromising on emissions. Without this combination, you either increase NOx and reduce fuel efficiency or you reduce fuel consumption but you increase NOx. Together, Power2 and VCM improve engine efficiency up to 10% on both gas and diesel engines. The more you run an engine with this solution, the more you save. Or you can reduce emissions up to 60%. Or you can choose some solution in between. So when Power2 and VCM work in conjunction, there really is a way to fully utilize the potential of high-pressure turbocharging for a range of different fuels, applications and engines in different environments.

Shifting the fuel-NOx tradeoff effectively and intelligently is by no means a theoretical exercise. Combining Valve Control Management and Power2 will have clear financial and operative implications for customers, both in the short and long terms.

For Riemenschneider, the meaning for customers is clear: “The market is going to revolve around the issue of fuel and fuel flexibility – gas and diesel – in the next few years. If you burn gas instead of diesel, you reduce NOx by 85%. For the same power output with gas, you have 18% less CO2. And gas is also cheaper for the same amount of energy – in the US, for example, about a third less. In Asia, it’s about 10 or 20% less, but this will change the more that is transported there. We now expect big ships to be converted by 2020 or so, because sulfur in exhaust is going to be regulated more stringently on these types of vessels very soon as well. So it’s NOx, it’s CO2, and it’s sulfur. And it’s money. Fuel and fuel flexibility are at the root of all those things.”