Turbocharger with variable turbine geometry (VTG)

In its role as a pioneer of turbo technology, Porsche introduced the world's first VTG charger for petrol engines to series production.

In 2006, the 911 Turbo entered a new generation with an incredible power boost: the boxer engine delivered 353 kilowatts (480 horsepower), a full 44 kilowatts (60 horsepower) more than the engine in the predecessor model, while featuring an identical cubic capacity of exactly 3.6 litres. The uptick in performance stemmed from the two turbines with variable geometry (VTG), which were integrated into the exhaust tract of the cylinder blocks as part of their debut appearance in a Porsche. Only this technology enables optimum use of the entire exhaust stream at all speeds for the purpose of turbocharging.

A turbocharger with variable turbine geometry combines the benefits provided by small and large turbochargers alike. Thanks to their narrow flow cross sections, small turbochargers respond even to small amounts of exhaust gas. The disadvantage of this is that, in the case of increasing speeds with a higher air throughput, the flow resistance also rises. This leads to the formation of high levels of counter pressure, meaning that a portion of the exhaust gas has to be diverted around the charger via a wastegate or bypass valve. The opposite is the case with large turbochargers: although these demonstrate poor responsiveness due to their larger cross sections and higher turbine masses, the level of counter pressure is lower in the context of higher air throughput.

The variable turbine geometry makes it possible to simulate the cross sections of the respective optimum charger size via guide vanes positioned in the exhaust stream. At lower speeds, the vanes close in order to form the small air gaps that are found in a small turbocharger. The guide vanes remain in this position until the desired charging pressure is reached. If the exhaust flow continues to rise as the speed increases, the VTG guide vanes increase the throughflow and thereby regulate the charging pressure. In addition, the variable geometry of the charger is calculated to ensure that it is able to handle even the maximum exhaust mass that can occur. This in turn eliminates the need for a bypass valve.

The 911 Turbo is the world's first production car with a petrol engine to feature a turbocharger with variable geometry. VTG chargers have long been a common feature in cars with diesel engines. However, the exhaust gas temperature at the turbine inlet on diesel engines is between 700 and 800 degrees Celsius, compared with 1,000 degrees Celsius for the exhaust gas in Porsche turbo engines. Only with the development of high-alloy nickel-based materials with extreme resistance to high temperatures will it be possible to manufacture VTG chargers that are suitable for series production, in addition to featuring the necessary fatigue strength and service life.