Title: Turbocharger matching method for reducing residual concentration in a turbocharged gasoline engine

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Abstract: In a turbocharged engine, preserving the maximum amount of exhaust pulse energy for turbine operation will result in improved low end torque and engine transient response. However, the exhaust flow entering the turbine is highly unsteady, and the presence of the turbine as a restriction in the exhaust flow results in a higher pressure at the cylinder exhaust ports and consequently poor scavenging. This leads to an increase in the amount of residual gas in the combustion chamber, compared to the naturally-aspirated equivalent, thereby increasing the tendency for engine knock. If the level of residual gas can be reduced and controlled, it should enable the engine to operate at a higher compression ratio, improving its thermal efficiency. This paper presents a method of turbocharger matching for reducing residual gas content in a turbocharged engine. The turbine is first scaled to a larger size as a preliminary step towards reducing back pressure and thus the residual gas concentration in-cylinder. However a larger turbine causes a torque deficit at low engine speeds. So in a following step, pulse separation is used. In optimal pulse separation, the gas exchange process in one cylinder is completely unimpeded by pressure pulses emanating from other cylinders, thereby preserving the exhaust pulse energy entering the turbine. A pulse-divided exhaust manifold enables this by isolating the manifold runners emanating from certain cylinder groups, even as far as the junction with the turbine housing. This combination of appropriate turbine sizing and pulse-divided exhaust manifold design is applied to a Proton 1.6-litre CamPro CFE turbocharged gasoline engine model. The use of a pulse-divided exhaust manifold allows the turbine to be increased in size by 2.5 times (on a mass flow rate basis) while maintaining the same torque and power performance. As a consequence, lower back pressure and improved scavenging reduces the residual concentration by up to 43%, while the brake specific fuel consumption improves by approx. 1%, before any modification to the compression ratio is made.