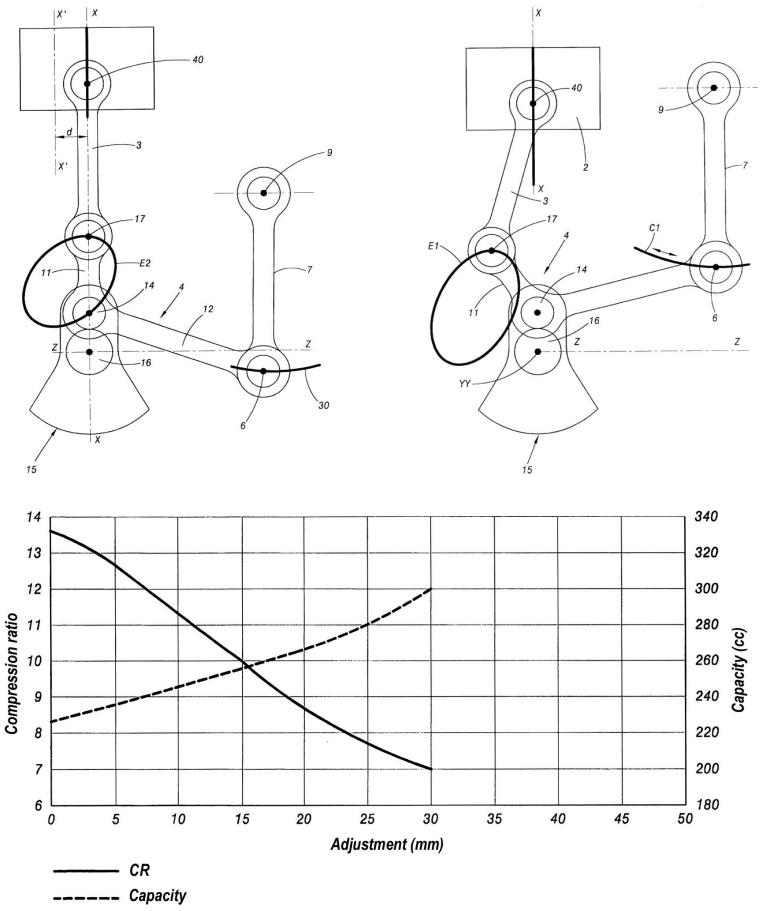
It does not enable the control of cubic capacity

Different carmakers have tried to develop VCR engines with a variable cubic capacity. This type of engine does not provide a real advantage and, in certain cases, can even have different disadvantages.



Various VCR concepts and applications exist that aim to make compression ratio and capacity vary simultaneously

Engines with variable cubic capacity are in reality variable-stroke engines. The aim is to minimize pumping losses by having the piston intake the necessary load at atmospheric pressure. In other words, at half-load, instead of intaking the whole volume of the cylinder at half the atmospheric pressure, which generates pumping losses, it only intakes during half the cylinder stroke but at atmospheric pressure. The mass introduced into the cylinder is the same in both cases, but in the case of the reduced stroke, the pumping losses due to the butterfly throttle valve are eliminated.

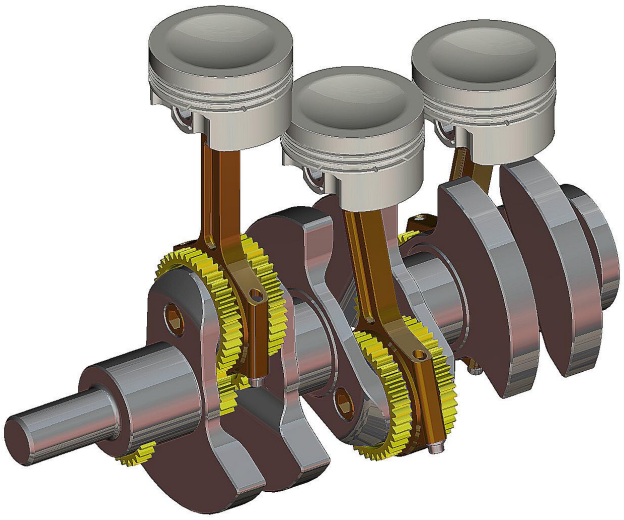
The theory is appealing but in practice there are many difficulties.

The first difficulty is a technological one, since one would have to be capable of building a variable-stroke VCR engine. In this type of engine, the stroke and the compression ratio are generally linked, which avoids having one actuator to control the compression ratio and another for the cubic capacity. This means that we exclude different cubic capacity/compression ratio combinations. For example, the combination of high cubic capacity with a high compression ratio is impossible. This handicap is manageable since it only accounts for 1 or 2% of efficiency losses in NEDC, if the engine has a well-selected relationship between the cubic capacity and the compression ratio.

The second problem stems from the truncated expansion: if it makes sense to reduce the admission-compression stroke, it also makes sense to use the entire stroke to expand the gas. This problem has been solved in certain technologies (GoMecsys).

The most important problem is the turbulence and the development of combustion. In order for the flame to propagate quickly enough in the combustion chamber volume, it needs fine-scale turbulence. This turbulence is mostly created from macroscopic gas movements, called “tumble”. This tumble is an aerodynamic effect that gives the gas a horizontal rotation movement within the cylinder. Tumble is generated by the relative position and orientation of the inlet duct with respect to the cylinder. When the gases are animated by this rotational movement and compressed by the piston, tumble turns into fine-scale turbulence, thereby creating the right conditions for the quick propagation of the flame in the volume.

In a variable-stroke engine, tumble is variable at the same speed: it depends on the stroke. At low stroke, it is no longer possible to guarantee a turbulence rate that is sufficient to

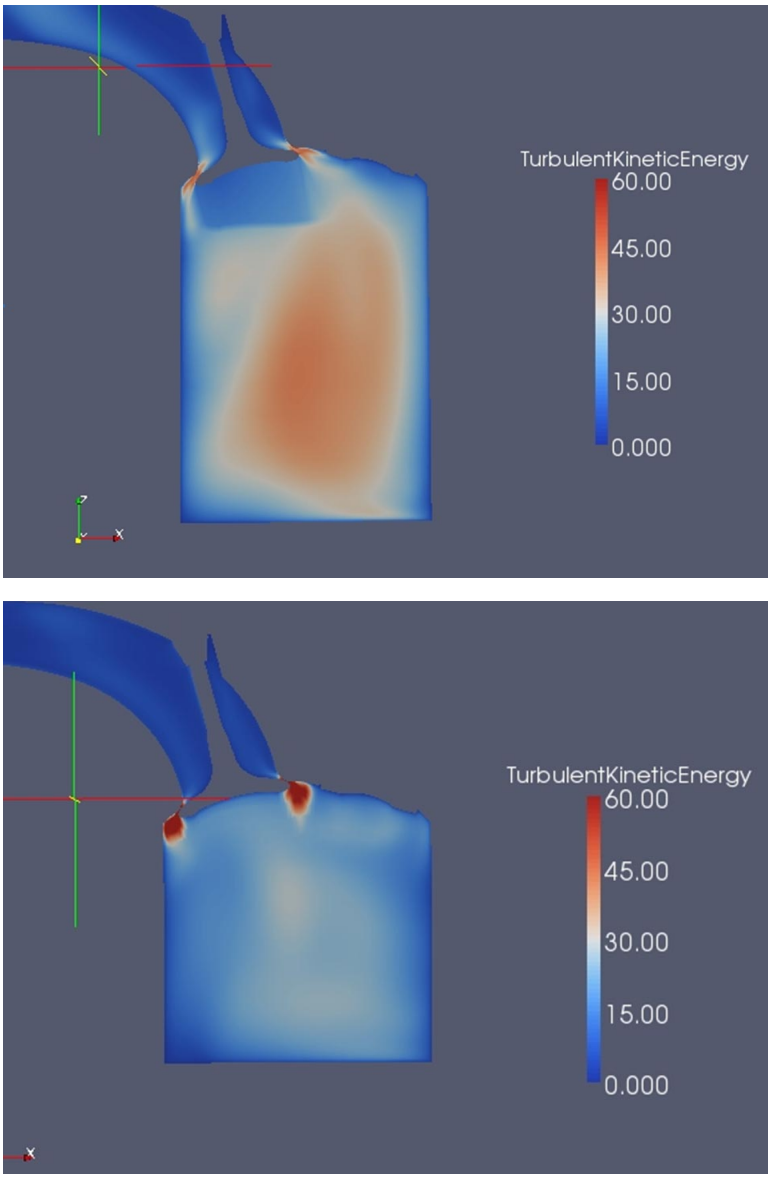


The GoMecsys concept enables the differentiation of the intake-compression stroke from the expansion-exhaust stroke

"burn" the load in a short time. To do this, one would need an engine with a variable tumble rate, which is difficult in practice (tumble flaps). Since combustion is slow when the engine is used at low stroke, one must increase ignition advance, which makes the engine more knock-sensitive. You therefore need a lower compression ratio, which reduces efficiency. It's the squaring of the circle and any expected gain is lost.

Essentially because of the last phenomenon, a variable-stroke VCR engine provides almost no additional efficiency compared with a fixed-stroke VCR engine, and especially if the latter is equipped with VVA.

To simultaneously benefit from all of the advantages without any restrictions, it is preferable to develop a fixed-stroke VCR engine with "intelligent" valves, which is the whole objective of MCE-5 VCRi.



Varying the piston stroke causes variations in internal turbulence with negative consequences on engine thermal efficiency