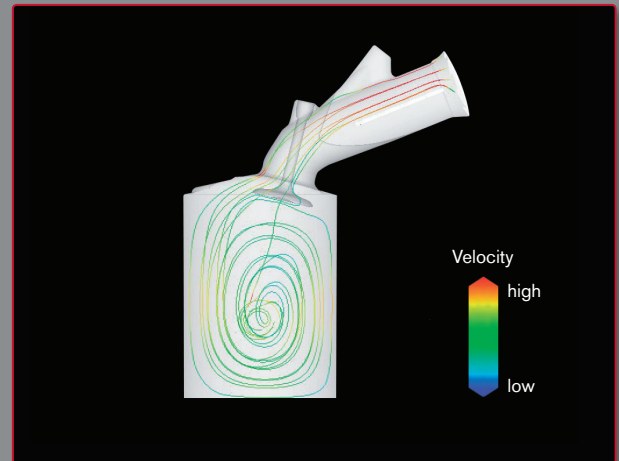


Improving combustion efficiency

To achieve more efficient combustion, we applied a variety of technologies to valves, fuel injectors, ignition systems and other areas.

Plastic intake manifold with integrated tumble control valve

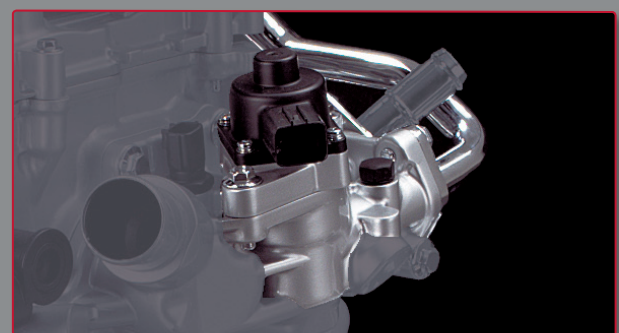
For rapid and efficient combustion, the air-fuel mixture must be in a state that is most conducive to ignition. The HR/MR engines incorporate an improved tumble control valve that generates optimal tumble (longitudinal vortex) of the air-fuel mixture to promote combustion stability. The cylinder interior and piston crowns are also shaped to promote tumble swirl. This design helps optimize air-fuel mixture consumption to enhance fuel economy even under typically unstable conditions such as while the engine is warming up.



Tumble flow in cylinder

Large capacity EGR system

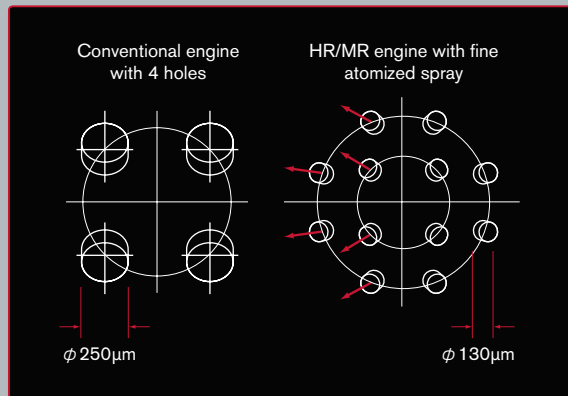
The EGR (Exhaust Gas Recirculation) system returns a portion of the exhaust gas to the intake side to reduce fuel consumption and minimize NOx emission. Reintroducing exhaust gas to the cylinders reduces pumping loss by allowing less energy to be used on the intake stroke to turn the engine. Owing to combustion efficiency improvements including the upgraded tumble control valve, the HR/MR engines can use more exhaust gas in EGR. This yields even better fuel economy with assured power delivery.



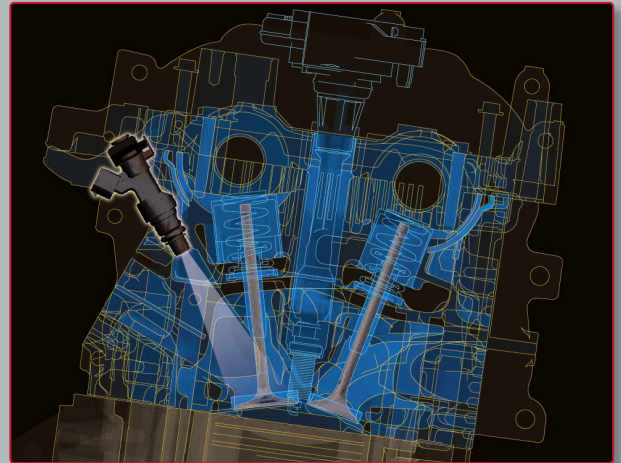
EGR system

Fine spray injectors

The finer the particle size of spray from the fuel injectors, the easier it is to attain complete combustion of the air-fuel mixture and therefore the less hydrocarbons (HC) are generated. The HR/MR engines replace the previous 4-hole injector nozzle plate (diameter: 250 μm) with a 12-hole version (diameter: 130 μm) in a multi-hole fine spray injector. Spray particle size is reduced by approximately 40%, and the spray range is greater, thereby raising combustion efficiency.



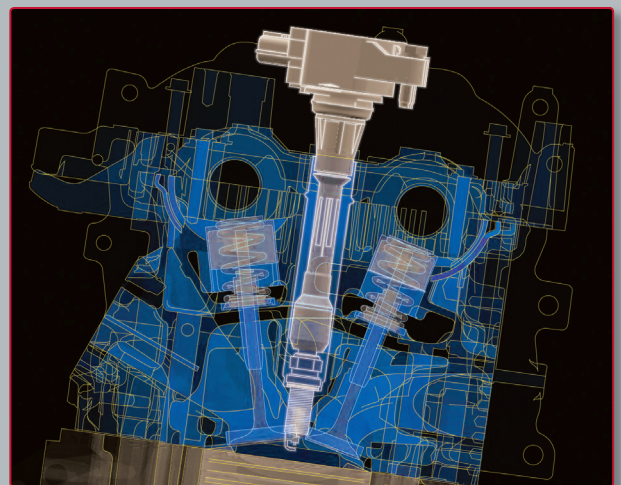
Nozzle plate (injector head)



Fuel injector

Long-discharge ignition coil

The large capacity EGR system returns a substantial volume of inactive exhaust gas to the air-fuel mixture in the cylinders, which lowers the ignitability of the mixture. To adjust for this situation, we lengthened the discharge time of the ignition coil, thereby improving ignition performance for efficient combustion even under unstable air-fuel mixture conditions.



Ignition coil with longer discharge time