

Internal Combustion Engine Technology



Pre-Chamber Combustion

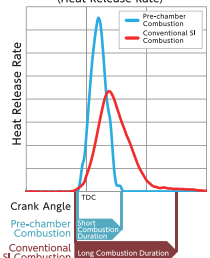
Advantages Reduction in CO₂ emissions through increased efficiency (output)

"improvement of knock limit, improvement of lean limit, and improvement of constant volume combustion due to rapid combustion"

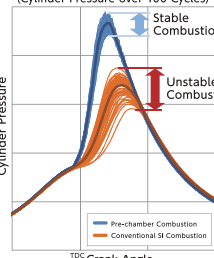
Rapid combustion with pre-chamber can enable increased efficiency through improvements in knock limit, lean limit, and constant volume combustion by shortening the combustion duration and reducing combustion variations.

Comparison of Combustion Characteristics with Pre-chamber Adoption

Comparison of Combustion Duration (Heat Release Rate)



Comparison of Combustion Variability (Cylinder Pressure over 100 Cycles)



Pre-chamber Installation (Cutaway Model)

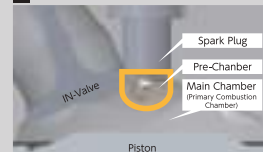
Overview of Rapid Combustion by Pre-Chamber

1 Conventional SI Combustion



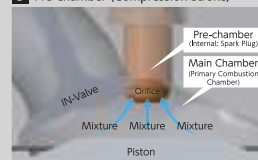
Conventional combustion chambers feature spark plugs protruding directly into the combustion chamber.

2 Combustion Chamber with Pre-chamber



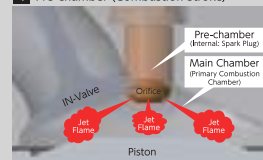
A combustion chamber equipped with a pre-chamber features a structure where the tip of the spark plug of the conventional combustion chamber is covered by a relatively small-volume partition.

3 Pre-chamber (Compression Stroke)



Supply of the mixture to the pre-chamber is done through an orifice located at the tip of the pre-chamber during the compression stroke.

4 Pre-chamber (Combustion Stroke)



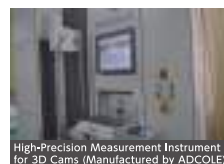
When igniting the mixture in the pre-chamber, jet flames are ejected from the orifice at the tip of the pre-chamber, rapidly igniting the mixture in the main chamber.

3D Camshaft (Radial Valve)

Advantages Reduction in CO₂ emissions through increased efficiency (output)

"Enlarged valve diameter, Spherical combustion chamber (improvement of S/V ratio)"

Traditionally, when using a cam grinding machine for oscillating follower camshafts, it was difficult to create cam profiles that accommodate radial valves. In contrast, the HKS cam grinding machine (manufactured by EMAG) is capable of 5-axis grinding, enabling the creation of 3D cam profiles that accommodate radial valves, which cannot be reproduced by conventional cam grinding machines.



3D Cam vs 2D cam

3D Cam Profile Design

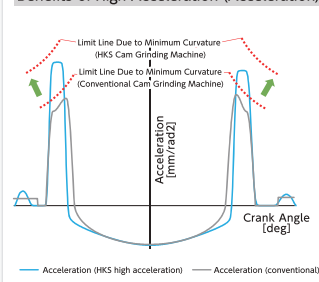
High Acceleration Cam Profile

Advantages Reduction in CO₂ emissions through increased efficiency (output)

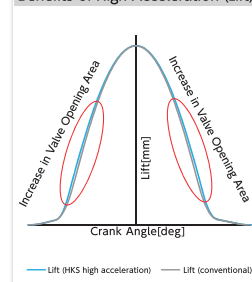
"Increase in Valve Opening Area, High Lift"

With oscillating follower camshafts, there were limitations on negative minimum curvature when using conventional cam grinding machines (with conventional grinding wheels). In contrast, the HKS cam grinding machine (manufactured by EMAG) can produce profiles with smaller curvatures (ultra-small R) by using special grinding wheels, enabling the realization of high-acceleration profiles.

Benefits of High Acceleration (Acceleration)



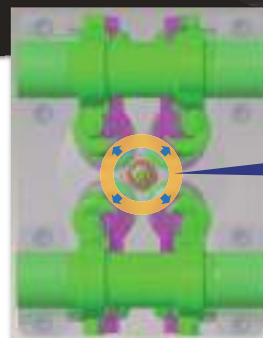
Benefits of High Acceleration (Lift)



Pre-Chamber + Radial Valve

Advantages Improved Pre-chamber Unit Installation Capability

By arranging the valves radially, it is possible to increase the volume in the central portion of the cylinder head bore, thereby improving the installation capability of the pre-chamber unit.



Example of Improved Installation Capability by Adopting Radial Valves

Expansion of Pre-chamber Installation Area by Adopting Radial Valves

Layout of Radial Valve Adoption
Conventional Valve Layout