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6AR-FSE ENGINE CONTROL SFI SYSTEM CONTROL DIRECT INJECTION 4-STROKE GASOLINE ENGINE SUPERIOR VERSION SEQUENTIAL MULTIPORT FUEL INJECTION (D-4S SFI)

FUNCTION

a. The D-4S system is a fuel injection system which combines direct injection injectors and port injection injectors.

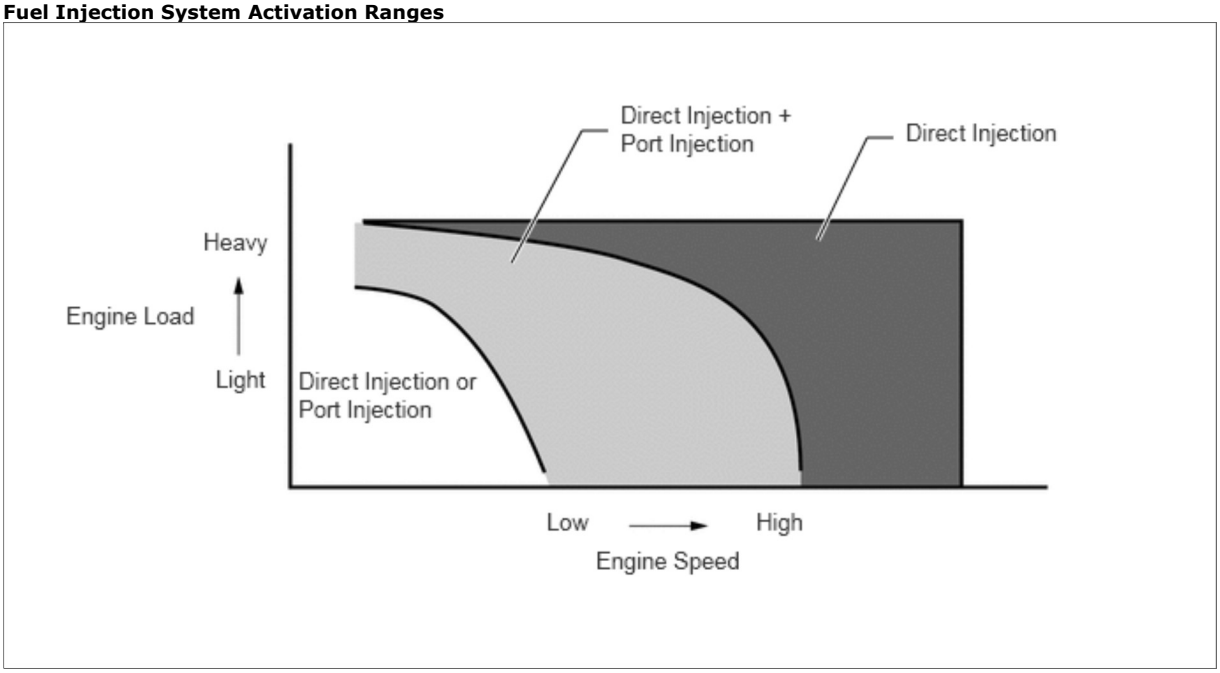
b. The mass air flow meter sub-assembly detects intake air volume to control fuel injection volume.

c. Based on signals from each sensor, the ECM controls the injection volume and timing of each type of fuel injector assembly (direct and port injection types) in accordance with engine load and engine speed in order to optimize combustion conditions.

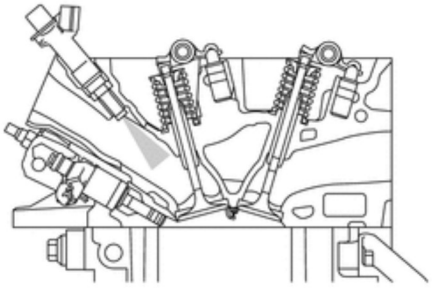
d. To promote warm-up of the catalyst after a cold engine start, this system uses a stratified air fuel mixture. This creates an area near the spark plug that is richer than the rest of the air fuel mixture. This also allows a greater amount of ignition timing retard to be used, raising the exhaust gas temperature. The increased exhaust gas temperatures promote rapid warm-up of the catalysts, significantly reducing exhaust emissions.

e. When the engine is idling after warm-up, the fuel injector assembly (for port injection) is used to inject fuel, ensuring quietness.

Fuel Injection System Activation Ranges

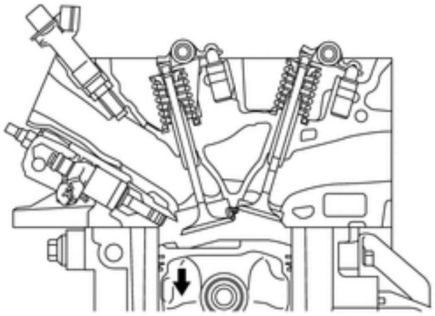


f. Stratified Combustion: To achieve stratified combustion, immediately after a cold engine start, fuel is injected into the intake port from the fuel injector assembly (for port injection) during the exhaust stroke. Fuel is also injected from the fuel injector assembly (for direct injection) near the end of the compression stroke. This results in an air fuel mixture that is stratified, and the area near the spark plug is richer than the rest of the air fuel mixture. This allows a retarded ignition timing to be used, raising the exhaust gas temperature. The increased exhaust gas temperatures promote rapid warm up of the catalysts, and significantly improve exhaust emission performance.



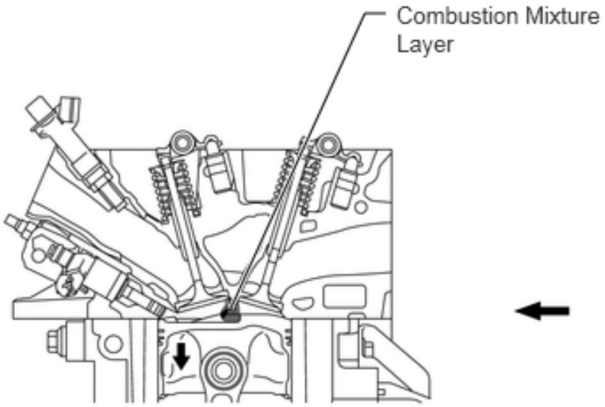
Expansion to Intake Stroke

Fuel is injected into the intake port from the fuel injector assembly (for port injection) before the intake valves open.



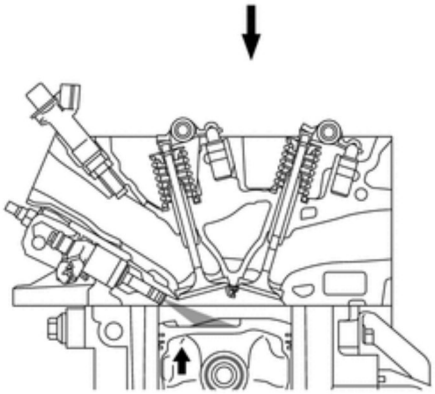
Intake Stroke

The intake valves open and a homogeneous air fuel mixture is drawn into the combustion chamber.



Ignition to Combustion Stroke

Injected fuel is directed along the piston contour to the area near the spark plug. This produces a combustible area of rich air fuel mixture that allows for easy ignition. This allows combustion of a lean air fuel mixture to occur.

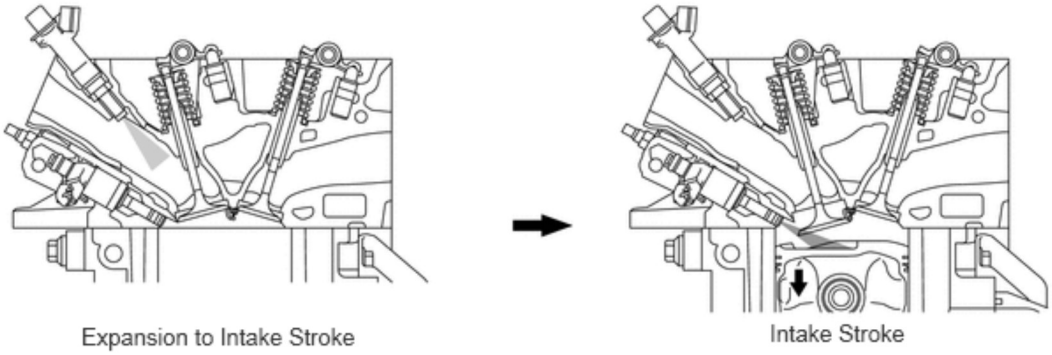


Compression Stroke

Fuel is injected into the combustion chamber from the fuel injector assembly (for direct injection) near the end of compression stroke.

This illustrations shown are examples only.

g. Homogeneous Combustion: To optimize combustion conditions, the ECM controls injection volume and timing of the fuel injector assemblies (for port injection) which inject fuel into the intake ports during the expansion, exhaust, and intake strokes. The ECM also controls the injection volume and timing of the fuel injector assemblies (for direct injection) which inject fuel during the first half of the intake stroke. The homogeneous air fuel mixture is created by either combined or individual use of the 2 different types of injectors. This allows utilization of the evaporation heat of the injected fuel to cool the compressed air, and it also allows an increase of charging efficiency and power output.



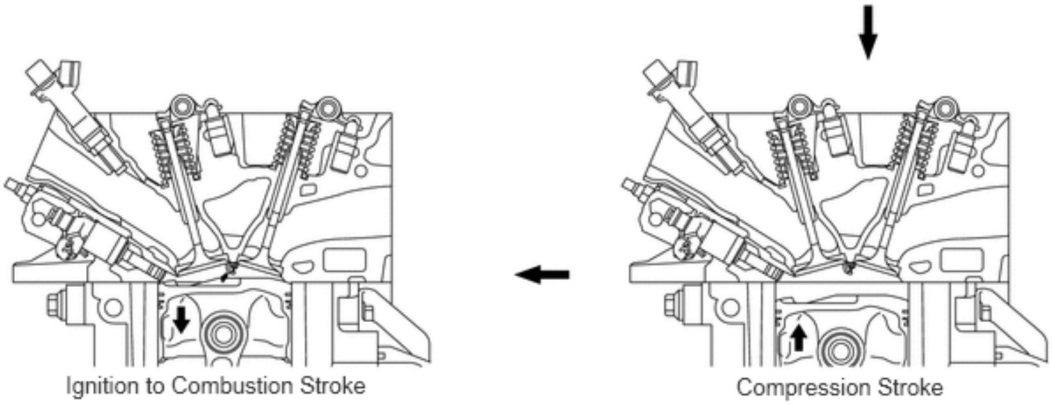
Expansion to Intake Stroke

Fuel is injected into the intake port from the fuel injector assembly (for port injection) before the intake valves open.

Intake Stroke

The intake valves open to allow the homogeneous air fuel mixture into the combustion chamber, and fuel is injected into the combustion chamber from the fuel injector assembly (for direct injection) during the first half of the intake stroke.

The injected fuel and air are evenly mixed by intake air force.



Ignition to Combustion Stroke

The spark plug ignites the homogeneous air fuel mixture.

Compression Stroke

The homogeneous air fuel mixture is compressed.

This illustrations shown are examples only.

h. Air Fuel Ratio Control

i. Fuel injection volume is determined based on the engine speed and the intake air volume. In addition, feedback control is performed for the air fuel ratio after engine start based on the signal from the air fuel ratio sensor.

Control	Combustion State	Air Fuel Ratio	Injection Timing*	Precondition
Lean air fuel ratio control	Stratified Combustion	15 to 17 : 1	Compression Stroke	Immediately after cold engine start
Stoichiometric air fuel ratio control	Homogeneous Combustion	14 to 15 : 1	Intake Stroke	Low to mid-load driving

Air fuel ratio feedback control prohibition	Homogeneous Combustion	-	Intake Stroke	High-load driving
				Cold engine

*: Of the fuel injector assembly (for direct injection). The fuel injector assembly (for port injection) performs respective control to inject fuel from the expansion stroke to the intake stroke in accordance with the engine running conditions.

i. Fuel Cut
   i. When the engine speed exceeds the specified value, fuel injection is stopped to prevent over-revving.

Engine Speed for Fuel-cut at High Revs

Engine speed (rpm)	6800 or more