1NZ-FE ENGINE

■ DESCRIPTION

The 1NZ-FE engine is a newly developed in-line 4-cylinder, 1.5-liter, 16-valve DOHC engine. This engine has adopted the VVT-i (Variable Valve Timing-intelligent) system and has been developed to realize high performance, quietness, fuel economy and clean emissions.
ENGINE — 1NZ-FE ENGINE

▶ Engine Specifications ◀

<table>
<thead>
<tr>
<th>Engine Specifications</th>
<th>1NZ-FE</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Engine Type</strong></td>
<td>1NZ-FE</td>
</tr>
<tr>
<td><strong>No. of Cyls. &amp; Arrangement</strong></td>
<td>4-Cylinder, In-line</td>
</tr>
<tr>
<td><strong>Valve Mechanism</strong></td>
<td>16-Valve DOHC, Chain Drive</td>
</tr>
<tr>
<td><strong>Combustion Chamber</strong></td>
<td>Pentroof Type</td>
</tr>
<tr>
<td><strong>Manifolds</strong></td>
<td>Cross-Flow</td>
</tr>
<tr>
<td><strong>Fuel System</strong></td>
<td>SFI</td>
</tr>
<tr>
<td><strong>Displacement cm³ (cu. in.)</strong></td>
<td>1497 (91.3)</td>
</tr>
<tr>
<td><strong>Bore × Stroke mm (in.)</strong></td>
<td>75.0 × 84.7 (2.95 × 3.33)</td>
</tr>
<tr>
<td><strong>Compression Ratio</strong></td>
<td>10.5 : 1</td>
</tr>
<tr>
<td><strong>Max. Output [SAE-NET]</strong></td>
<td>81 kW @ 6000 rpm</td>
</tr>
<tr>
<td></td>
<td>108 HP @ 6000 rpm</td>
</tr>
<tr>
<td><strong>Max. Torque [SAE-NET]</strong></td>
<td>142 N·m @ 4200 rpm</td>
</tr>
<tr>
<td></td>
<td>105 lb-ft @ 4200 rpm</td>
</tr>
<tr>
<td><strong>Valve Timing</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Intake</strong></td>
<td>Open –7° ~ 53° BTDC</td>
</tr>
<tr>
<td><strong>Close</strong></td>
<td>52° ~ –8° ABDC</td>
</tr>
<tr>
<td><strong>Exhaust</strong></td>
<td>Open 42° BBDC</td>
</tr>
<tr>
<td><strong>Close</strong></td>
<td>2° ATDC</td>
</tr>
<tr>
<td><strong>Fuel Octane Number</strong></td>
<td>RON 91</td>
</tr>
<tr>
<td><strong>Oil Grade</strong></td>
<td>5W–30</td>
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</tbody>
</table>

▶ Performance Curve ◀

![Performance Curve Graph](image)
FEATURES OF 1NZ-FE ENGINE

The 1NZ-FE engine has been able to achieve the following performance through the adoption of the items listed below.

(1) High performance and fuel economy
(2) Low noise and vibration
(3) Lightweight and compact design
(4) Good serviceability
(5) Clean emission

<table>
<thead>
<tr>
<th>Item</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
<th>(4)</th>
<th>(5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>The VVT-i system is used.</td>
<td></td>
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<tr>
<td>A long branch type stainless steel exhaust manifold is used.</td>
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<td></td>
<td>O</td>
<td></td>
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<tr>
<td>An offset crankshaft has been adopted.</td>
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<tr>
<td>A cylinder block made of alminum has been adopted.</td>
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<td></td>
<td></td>
<td></td>
<td>O</td>
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<tr>
<td>Intake manifold made of plastic has been adopted.</td>
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<td>O</td>
</tr>
<tr>
<td>Fuel returnless system has been adopted.</td>
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<tr>
<td>12-hole type fuel injectors have been adopted.</td>
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<tr>
<td>A rearward exhaust layout has been adopted to realize the early activation of the catalyst.</td>
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<tr>
<td>The coupling rigidity of the engine and the transaxle has been improved.</td>
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<td>O</td>
</tr>
<tr>
<td>An engine cover made of plastic has been adopted.</td>
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<tr>
<td>The DIS (Direct Ignition System) makes ignition timing adjustment unnecessary.</td>
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<tr>
<td>Quick connectors are used to connect the fuel hose with the fuel pipes.</td>
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<tr>
<td>The oil filter is installed diagonally downward.</td>
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<tr>
<td>A timing chain has been adopted.</td>
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<tr>
<td>The function to detect a leakage of evaporative emissions has been changed in the evaporative emission control system.</td>
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</table>
ENGINE PROPER

1. Cylinder Head

- The angle of the intake and exhaust valves is narrowed and set at 33.5° to permit a compact cylinder head.

- As a result of installing the injector in the intake port of the cylinder head, the contact of the fuel against the intake port wall has been minimized and fuel economy has been improved.

- A water jacket has been provided between the exhaust port and the spark plug boss in order to maintain the combustion chamber wall temperature uniform, thus improving the cooling performance of the combustion chamber and the area around the spark plug.
2. Cylinder Block

- A cylinder block made of aluminum alloy has been adopted to realize a significant amount of weight reduction.
- A water pump swirl chamber and an inlet passage to the pump are provided in the cylinder block.
- The rear portion of the cylinder block has been shaped conically to improve the coupling rigidity with the transaxle.
- Through the adoption of the offset crankshaft, the bore center has been shifted 12 mm towards the intake, in relation to the crankshaft center. Thus, the side force when the maximum pressure is applied has been reduced and fuel economy has been improved.
- Through the use of a thin-walled cast iron liner in the cylinder bore, a distance of 8 mm between the bores has been realized, resulting in a compact package.
- By discontinuing the use of the rear oil seal retainer and by pressing the rear oil seal into the cylinder block, a compact package has been realized.

![Diagram of Cylinder Block](image)

3. Piston

- The top of the piston has adopted a taper squish shape to improve combustion performance.
- Low-tension piston rings have been adopted to reduce friction and improve fuel economy and oil consumption performance.

![Diagram of Taper Squish Shape](image)
4. Connecting Rod

- The connecting rods are made of high-strength material for weight reduction.
- The connecting rod cap is held by plastic region tightening bolts.

5. Crankshaft

- The diameter and the width of the pins and journals have been reduced, and the pins for the No. 1 and No. 4 cylinders have been made highly rigid to realize a lightweight and low-friction performance.
- The crankshaft has 5 journals and 4 balance weights.
- A crankshaft position sensor rotor has been pressed into the crankshaft to realize an integrated configuration.
■ VALVE MECHANISM

1. General

- Each cylinder has 2 intake valves and 2 exhaust valves.
- The valves are directly opened and closed by 2 camshafts.
- The intake and exhaust camshafts are driven by a roller timing chain.
- The VVT-i system is used to improve fuel economy, engine performance and reduce exhaust emission.

2. Camshafts

- In conjunction with the adoption of the VVT-i system, an oil passage is provided in the intake camshaft in order to supply engine oil to the VVT-i system.
- A VVT-i controller has been installed on the front of the intake camshaft to vary the timing of the intake valves.
- The timing rotor is provided behind the intake camshaft to trigger the camshaft position sensor.
3. Intake and Exhaust Valve and Valve Lifter

- Valve lifters with shimless valve adjustment have been adopted for weight reduction. The adjustment of the valve clearance is accomplished by selecting and replacing the appropriate valve lifters.

- Narrower valve stems have been adopted to reduce the intake and exhaust resistance and for weight reduction.

<table>
<thead>
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<thead>
<tr>
<th>Item</th>
<th>Intake Valve</th>
<th>Exhaust Valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>Face Diameter</td>
<td>30.5 (1.2)</td>
<td>25.5 (1.0)</td>
</tr>
<tr>
<td>Stem Diameter</td>
<td>5.0 (0.20)</td>
<td>5.0 (0.20)</td>
</tr>
</tbody>
</table>

4. Timing Chain

- A roller timing chain with an 8.0-mm pitch has been adopted to make the engine more compact.

- A material which has excellent wear resistance has been selected for the timing chain to improve reliability.

- The timing chain is lubricated by engine oil from an oil jet.

- Chain tensioner, chain tension arm and chain guide are established to reduce the engine noise and friction loss.
5. Chain Tensioner

- The chain tensioner uses a spring and oil pressure to maintain proper chain tensioner at all times. The chain tensioner suppresses noise generated by the chain.
- A ratchet type half-back mechanism is used.

6. Timing Chain Cover

- A single-piece, aluminum diecast timing chain cover that entirely seals the front portion of the cylinder block and the cylinder head has been adopted.
- A service hole for the chain tensioner has been provided in the timing chain cover to improve serviceability.
LUBRICATION SYSTEM

- The lubrication circuit is fully pressurized and all oil passes through an oil filter.
- A trochoid gear type oil pump, which is driven directly by the crankshaft, has been provided in the front of the cylinder block.
- The oil filter has been installed diagonally downward from the side of the cylinder block to improve serviceability.
# COOLING SYSTEM

- The cooling system is a pressurized, forced-circulation type.
- A thermostat with a bypass valve is located on the water inlet housing to maintain suitable temperature distribution in the cooling system.
- The flow of the engine coolant makes a U-turn in the cylinder block to ensure a smooth flow of the engine coolant.
**INTAKE AND EXHAUST SYSTEM**

1. **Air Cleaner**

A new type of non-woven fabric element has been adopted and its shape has been optimized.

2. **Intake Manifold**

- The intake manifold has been made of plastic to reduce the weight and the amount of heat transferred from the cylinder head. As a result, it has become possible to reduce the intake temperature and improve the intake volumetric efficiency.

- The branches have been lengthened to optimize the shape of the intake manifold. As a result, the engine’s low- to mid-speed range torque and the maximum output have been improved.

- A torque-up resonator has been provided inside the intake manifold to improve the engine’s mid-speed range torque.

3. **Exhaust Manifold**

- A ball joint has been adopted for coupling the exhaust manifold to the front pipe in order to improve reliability.

- The branches have been lengthened to improve the low- to mid-speed range torque.

- A stainless steel exhaust manifold is used for weight reduction.
4. Muffler

- By adopting a rearward exhaust layout and a double-wall construction for the pipe to the catalytic converter, the warm-up performance of the TWC has been improved.

- A ball joint has been adopted for coupling the exhaust manifold to the exhaust pipe and the exhaust pipe to the main muffler to achieve a simple configuration and improved reliability.

- A 2-way exhaust control system has been adopted to improve engine performance and to ensure an even quieter operation.

![Diagram of muffler system](image)

2-Way Exhaust Control System

- A 2-way exhaust control system is used. This system reduces the back pressure by opening and closing a variable valve that is enclosed in the main muffler, thus varying the exhaust gas passage.

- The valve opens steplessly in accordance with the operating condition of the engine, thus enabling a quieter operation at lower engine speeds, and reducing back pressure at higher engine speeds.

1) Construction

The control valve is enclosed in the main muffler. When the exhaust gas pressure overcomes the spring pressure, the control valve opens steplessly in accordance with the exhaust gas pressure.

2) Operation

a. When Control Valve is Closed (low engine speed)

Since the pressure in the main muffler is low, the control valve is closed. Hence exhaust gas does not pass the bypass passage, and exhaust noise is decreased by the main muffler.

b. When Control Valve is Open (middle to high engine speed)

The control valve opens more as the engine speed and the back pressure in the muffler increase. This allows a large volume of exhaust gas to pass the bypass passage, thereby substantially decreasing the back pressure.
Three-Way Catalytic Converter

The thickness of the ceramic walls in the TWC (Three-Way Catalytic Converter) has been made thinner than in the previous model. By decreasing the thermal capacity in this manner, it becomes easier to heat the catalyst and the catalyst’s exhaust cleansing performance is improved.

■ CHARGING SYSTEM

- Alternator S terminal is discontinued
- M terminal (Duty signal) is newly made for electric load sensing. M terminal sends generating condition to PTC heater control and IAC.
FUEL SYSTEM

1. Injector

A compact 12-hole type injector has been newly adopted to improve the atomization of fuel.

2. Fuel Returnless System

The new ECHO has adopted a fuel returnless system to reduce evaporative emissions. With the pressure regulator and the fuel filter-integrated fuel pump housed inside the fuel tank, this system eliminates the return of fuel from the engine area. This helps prevent the internal temperature of the fuel tank from rising, and reduces evaporative emissions.

3. Quick Connector

Quick connector has been adopted to connect the fuel pipe with the fuel hose to improve serviceability.
4. ORVR System

The ORVR (On-Board Refueling Vapor Recovery) is a system that uses a charcoal canister, which is provided onboard, to recover the fuel vapor that is generated during refueling. This reduces the discharge of fuel vapor into the atmosphere.

**Operation**

When the fuel tank cap is removed, atmosphere applies to the fuel tank over fill check valve’s chamber A. Refueling causes the internal pressure of the fuel tank to increase, the vapor flows to the charcoal canister while maintaining valve B pressed, thus allowing the vapor to become absorbed by the charcoal canister. When the tank is full, valve C closes, thus shutting off the passage to the charcoal canister.
IGNITION SYSTEM

1. General

A DIS (Direct Ignition System) has been adopted in the 1NZ-FE engine. The DIS improves the ignition timing accuracy, reduces high-voltage loss, and enhances the overall reliability of the ignition system by eliminating the distributor.

The DIS in 1NZ-FE engine is an independent ignition system which has one ignition coil for each cylinder.

2. Ignition Coil

The DIS provides 4 ignition coils, one for each cylinder. The spark plug caps, which provide contact to the spark plugs, are integrated with an ignition coil. Also, an igniter is enclosed to simplify the system.