VGT (VARIABLE GEOMETRY TURBOCHARGER)

► Overview

VGT is a certain type of turbocharger system that increases the intake air volume by using the exhaust air flow. The following chart shows the comparison values between a normal turbocharger and VGT regarding highest speed, drive-off performance and pass-ahead acceleration.

1. Enhanced highest speed: 4.1% of the highest speed increases compared to normal turbocharger.
2. Enhanced drive-off performance: The time taken to reach from 0 kph to 100 kph decreases 15.1% compared to normal turbocharger.
3. Enhance pass-ahead performance: This is evaluated by measuring the time taken to reach from 60 kph to 100 kph. The shorter it is the better performance.
Structure

Turbocharger assembly

<table>
<thead>
<tr>
<th>Part</th>
<th>Upper connection</th>
<th>Lower connection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tightening torque</td>
<td>25 ± 2.5 Nm</td>
<td>18 ± 1.8 Nm</td>
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</table>

Oil supply tube

<table>
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Support bar

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Tightening Torque

Turbocharger vacuum modulator

Upper connection: 10 ± 1.0 Nm
Lower connection: 10 ± 1.0 Nm
Components of VGT

- Turbocharger assembly
- Hollow bolt
- Seal ring
- Adaptor
- Turbocharger actuator
- Oil supply tube
- Gasket
- Oil return tube
- Gasket
Components

**Bearing housing and center housing:**
This encloses the bearing, seal, oil recirculation path and turbocharger shaft.

**Turbine housing:**
This is located on the exhaust manifold and encloses the turbine wheel.

**VGT actuator:**
This prevents the turbocharged pressure from increasing over the specified value.

**Compressor housing:**
This induces the fresh air to the compressor wheel and supplies the compressed air to the intercooler through the hose.

**Compressor wheel (Impeller):**
This is rotated by turbine wheel connected through turbocharger shaft, and compresses and draws the fresh air.

**Turbine wheel:**
This is rotated by exhaust gas and connected to the compressor wheel through turbocharger shaft.

**Unison ring**

**Turbocharger shaft:**
This is located within center housing and connects the turbine wheel to the compressor wheel.

**Floating bearing:**
Turbocharger rotates at very high speed (100,000 ~ 150,000 rpm). To prevent the turbocharger from being damaged, floating bearing is used for this system. This is lubricated by engine oil. If the engine stops when the turbocharger is still hot, the bearing may be stuck because the oil cannot be supplied. After high speed driving, run the engine at idle speed until the turbocharger cools down.
Components

In VGT system, the turbine and compressor are installed on a same shaft. And on the turbine shaft, 11 variable inlet vanes are installed to change the flow of exhaust gas. Also, the round unison ring is mounted behind vanes to activate all vanes concurrently. The turbine housing and compressor housing are installed to cover the turbine and compressor, and the vane control actuator is installed to activate the unison ring towards the turbine housing.

Unison ring

The unison ring is designed to be capable to rotate either clockwise or counterclockwise and to connect to the vane control actuator.

Variable turbine inlet vane

The variable turbine inlet vane is connected through the unison ring and vane arm, 11 vanes are rotated when the actuator is activated. 11 vanes are used as a passage for the exhaust gas led to the turbine inlet. According to their rotation, the flow passage area of exhaust gas varies. At low speed, the flow passage is narrowed and the flow speed of the exhaust gas increases, resulting in increasing the delivery energy of turbine. At high speed, the flow passage is widened and the much exhaust gas is generated, resulting in considerably increasing the delivery energy of turbine.

Vane control actuator

The vane control actuator is connected to the VGT solenoid valve duty-controlled by the engine computer (ECU) via the vacuum hose. Therefore, the duty rate of the solenoid valve is changed by ECU according to the operating conditions and accordingly the movement of the actuator is controlled.
Principles

How it works at low speed

Normal turbocharger can’t get the turbo effect because the amount of exhaust gas is not much and the flow speed is slow in a low speed zone, but VGT allows the flow passage of exhaust gas to narrow, resulting in increasing the flow speed of exhaust gas and running the turbine quickly and powerfully. Therefore, as VGT can inhale more air than normal turbocharger, it can give the benefit of the increased output even in a low speed zone.

Basic principle at low speed

At low speed, it utilizes the principle of venturi. For example, when air flows through the venturi tube, the flow speed is faster and the pressure is lower at the point “A”. In this case, if the inner diameter of venturi is more narrowed, the flow speed is so much faster (refer to the equation).
How it works at low speed

In a high speed zone, the amount of exhaust gas increases and it is accompanied with a great force. Therefore, if the inner diameter of venturi is more widened, the turbine in the turbocharger by the releasing force of abundant exhaust gas can deliver a more increased energy to the compressor. The output will increase in submission to the increase of intake air volume.
Controlling VGT system

The VGT control system checks the engine revolution, accelerator pedal value, atmospheric pressure, booster pressure, water temperature, intake air temperature, vehicle speed and clutch switch signal to determine the driving conditions of a vehicle.

The booster pressure map that is targeted on according to the engine revolution and fuel injection volume is determined inside of ECU. The ECU drives the vane control actuator to control the booster pressure, by controlling the solenoid valve to 300 Hz of frequency and the duty value. This helps to maintain the engine at its optimum condition.

Take a note that the booster pressure sensor is adopted, which is designed to perform the feedback control for matching the booster pressure targeted by ECU by measuring the booster pressure actually. The feedback control allows more accurate controlling.

8 Conditions for inhibiting VGT operation

1. If the engine speed is less than 700 rpm
2. If the coolant temperature is below approx. 0?
3. If any part related to the EGR is defective
4. If the VGT actuator is defective
5. If the booster pressure sensor is defective
6. If the mass flow sensor is defective
7. If the throttle flap is defective
8. If the accelerator pedal sensor is defective

If any of above conditions is met, ECU will not control the VGT system.
Notes and Check for VGT

Notes When Handling VGT

1. The turbocharger is sensitive to excessive vibration coming from external impact. When exposed to excessive impact or vibration, the inside mechanism may be damaged even though the outside is intact.

2. The turbocharger should be kept horizontally. If there is much engine oil in the turbocharger and it is kept vertically with the turbine housing downward, the engine oil may be provided to variable mechanism assembled towards the turbine housing, which may lead to a malfunction of the variable mechanism.

3. Never re-adjust the adjusting screw marked with yellow paint or the axial end of actuator. Renew them if you found looseness of the screw or actuator axle, because they are shipped after precisely adjusting from the factory.

4. Do not move or assemble the actuator axle by grasping it in hands. The actuator axle may be deformed, which affects the precisely adjusted value.
5. After installing to the engine, replenish a small amount of clean engine oil to the inlet before connecting the oil inlet pipe of the turbocharger.

6. Do not let any metal debris enter when installing to the engine.

7. The engine oil may be provided to the compressor housing if you rapidly operate the turbocharger with excessive revolutions immediately after installing to the engine.
   1) Do not raise the engine rpm rapidly after starting the engine.
   2) Do not raise the engine rpm rapidly after renewing the engine oil and filter element.
   3) Do not stop the turbocharger rapidly after operating at high engine speed.

Check and Service

The turbocharger is rarely out of order or damaged unless the engine is operated in abnormal conditions. Therefore, it is not necessary to additionally check the turbocharger according to mileage or operation hours. It is sufficient to simply maintain or service the engine thoroughly.

The following symptoms occur if there is a fault in the turbocharger:
1. reduced engine output
2. noisy engine operation
3. excessive engine oil consumption
4. excessive exhaust gas emitting

The symptoms may be due to a fault of the engine, not the turbocharger. In most cases, you can check the cause of the fault visually before removing the turbocharger from the engine.

Check Procedures

1. Firstly, check conditions of the engine because the fault may be due to the engine, not the turbocharger.
2. Then, check conditions of the turbocharger as follows:
   1) whether the compressor is damaged by metal debris or foreign materials.
   2) whether the turbine is damaged by metal debris or foreign materials.
   3) whether there is no contact between the wheel and the housing (check the bearing for damage).
   4) whether there is damages or influences by hot temperature.

Diagnosis and Servicing

1. Operation conditions of actuator’s diaphragm: It is impossible to control the turbocharger when the operation is poor.
2. Leaking of the turbocharger housing: More engine oil is consumed when leaking.
3. Damage on the turbocharger bearing: Noise can be heard during the turbocharger is operating (The whole turbocharger may be damaged when the bearing is damaged).
## Removal and Installation

Basically, the turbocharger should be serviced at Ssangyong Authorized Service Center. When eliminating the carbon deposit from the turbine wheel during the service procedure, use only soft brush or solvent other than sand paper or metallic tools.

### Cautions When Removing/Installing

1. Use only the turbocharger with same specifications.
2. Replace the gasket and sealing with new ones once removed.
3. Tighten the fasteners with specified tightening torque.
4. Change the engine oil before starting the engine.
5. If suspected, check the oil supply pressure.
6. Check if the turbine nozzle actuator operates properly.
Turbo Charger Assembly
- Removal and Installation

1. Remove the drain plug and drain the engine oil from the oil pan.

   **Installation Notice**
   
   | Tightening torque | 25 ± 2.5 Nm |

2. Remove the vacuum hose and inlet hose from the turbo charger.

   **Installation Notice**
   
   | Tightening torque | 6 ~ 7 Nm |

3. Remove the bolts and nuts at the exhaust manifold in turbo charger.

   **Installation Notice**
   
   | Tightening torque | 25 ± 2.5 Nm |
4. Remove the lower and upper bolts at turbo charger oil supply pipe.

**Installation Notice**

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5. Remove the lower bolts at turbo charger oil return pipe.

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- Replace the steel gasket with new one.
6. Remove the lower bolt at turbo charger bracket.
7. Remove the turbo charger bracket bolts.

**Installation Notice**

| Tightening torque | 32 ± 3.2 Nm |

- *Use only 12 1/2" wrench.*

8. Remove the bolts and nuts at the turbo charger and the exhaust manifold.

**Installation Notice**

| Tightening torque | 25 ± 2.5 Nm |

- Use only 12 1/2" wrench.
9. Remove the turbo charger assembly.
10. Install in the reverse order of removal.

**NOTICE**
- Replace the steel gasket with new one.
- To prevent gas leaks, tighten the fasteners with the specified tightening torques.