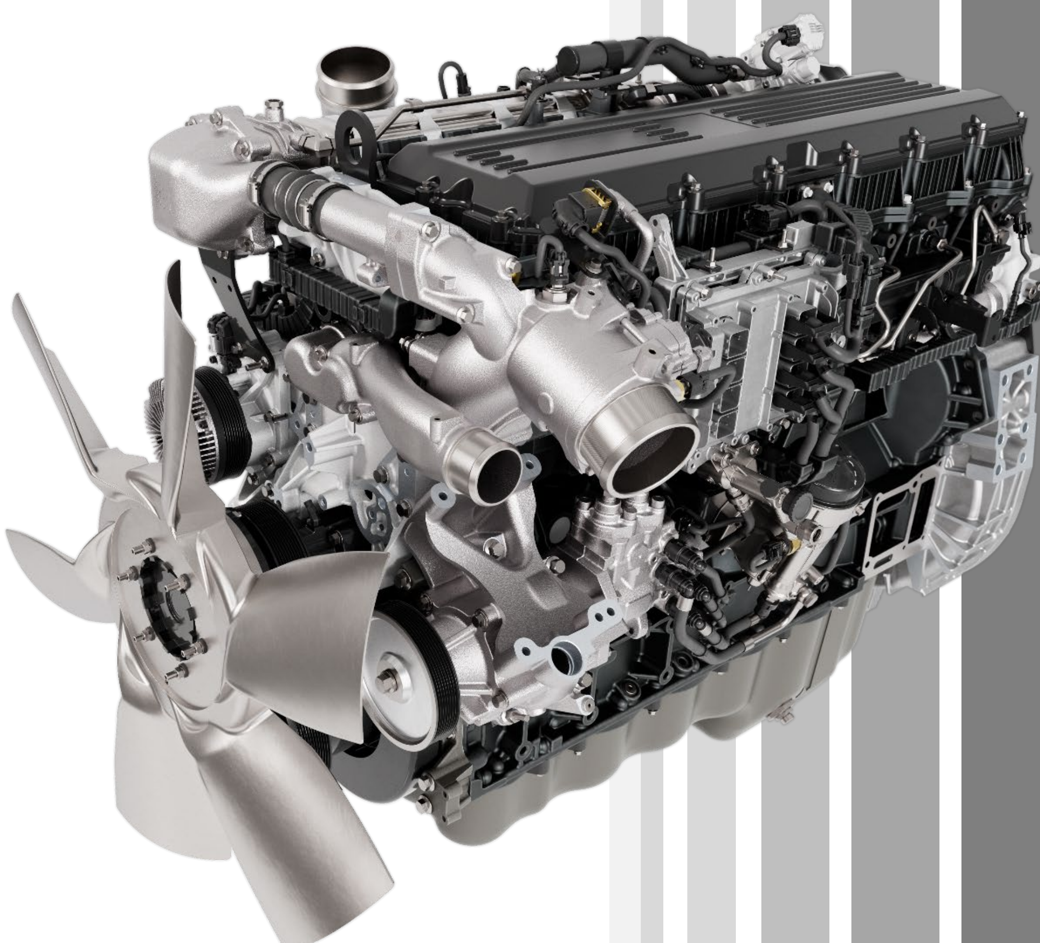
International ® A26 (2021 GHG) Engine Overview

Study Guide



Course Code: 9291

Table of Contents

This Page Intentionally Left Blank.

Course Introduction

NOTE

THE INFORMATION PROVIDED WITHIN THIS COURSE IS FOR TRAINING PURPOSES ONLY. ALWAYS CONSULT THE LATEST SERVICE, DIAGNOSTIC, AND TOOL INFORMATION, LOCATED ON THE INTERNATIONAL® SERVICE PORTAL℠, PRIOR TO PERFORMING SERVICE ON ENGINES, VEHICLES, AND EQUIPMENT.

Welcome to the Navistar® training course: International® A26 (2021 GHG) Engine Overview.

This course is intended to introduce the viewer to the 2021 International® A26 engine and its features.

Objectives

Upon completion of this course, the viewer will be able to:

- Identify the 2021 International® A26 engine
- Identify and describe the base engine components
- Describe the operation of the air management, cooling management, lubrication, fuel management, and electrical control systems
- Identify and describe the geartrain on the 2021 International A26 engine

Notes

Module 1: Engine Identification and Description

The 2021 International® A26 is an in-line, six cylinder diesel engine that is capable of producing 515 horsepower and 1,850 pound feet of torque. Horsepower and torque ratings are designated by the Engine Control Module, or ECM, calibration.

The engine has a dry weight of 2,392 pounds, and a compression ratio of 20.5:1.

There are several ways to identify the 2021 International® A26 engine. The easiest ways to do this are by viewing either the engine serial number or the emissions label.

The Engine Serial Number, or ESN, is engraved into the crankcase and is also included in the emissions label. While the ESN can be found elsewhere, these are the most common locations.

The ESN engraving is also located on the upper left side corner of the crankcase.

The emissions label is located on top of the valve cover. It typically includes the following: Model year; engine family, model and displacement; advertised brake horsepower and torque rating; emissions family and control system; valve lash specifications; and ESN.

Notes

Module 2: Base Engine

Let's take a look at the base engine components of the 2021 International® A26 engine, starting with the crankcase.

The one-piece crankcase uses replaceable wet cylinder liners, that are sealed by dual crevice seals.

The cylinder liners are finished with a z-honed pattern. The improved liner surface does not retain as much oil, reduces frictional losses, and reduces oil consumption.

The cylinder head is mounted to the crankcase by 26 torque to yield single-use head bolts, and is sealed to the block by a single piece head gasket.

The Navistar Engine Brake by Jacobs® is optional for the International® A26 engine. The engine brake is a compression release system that provides additional vehicle braking performance.
The operator can control the engine brake for different operating conditions.

The Camshaft Position, or CMP, sensor is located at the left-rear of the cylinder head. It is a magnetic pickup type sensor.

The crankshaft has seven main bearings. Crankshaft endplay is controlled by thrust washers installed with the number six main bearing.

The connecting rods are precision forged with a cracked mating surface design. These cracked caps attach the connecting rods to the crankshaft journals.

CAUTION

TO PREVENT ENGINE DAMAGE, DO NOT ALLOW FRACTURED MATING SURFACES OF THE CONNECTING ROD OR CONNECTING ROD CAP TO CONTACT ANY SURFACE OTHER THAN ITS MATCHED FRACTURED SURFACE. CONTACTING ANY OTHER SURFACE COULD CAUSE MISALIGNMENT OF THE MATING SURFACE, RESULTING IN CONNECTING ROD BEARING AND ENGINE FAILURE.

The pistons have been redesigned to increase the engine compression ratio to 20.5:1. The unique bowl is specifically designed to pair with a new fuel injection pattern.

Each cylinder has an Anti-polish Ring, or APR, that is installed at the top of the cylinder liner. The APR removes carbon build-up from the top piston ring cylinder land. This prevents premature cylinder wear and increased oil consumption.

The front geartrain consists of the crankshaft front gear, oil pump gear, and an idler gear.

The rear geartrain consists of the crankshaft rear timing gear, air compressor idler gear, large idler gear, crankcase idler gear, and camshaft timing gears.

The crankshaft rear timing gear has a timing pin which aligns with both the crankshaft and flywheel. The gear and flywheel are secured together with ten one-time use 12-point straight-shank bolts.

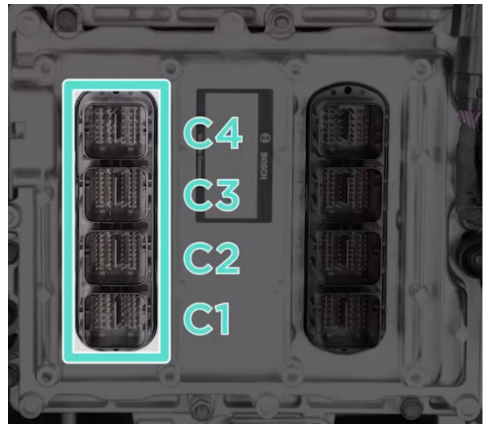
The Crankshaft Position, or CKP sensor, is located on the top of the flywheel housing. It is a magnetic pickup type sensor. It uses timing marks on the outer edge of the flywheel to determine the speed and position of the crankshaft

Notes

Module 3: Electrical Control

Now let's take a look at the major electrical control components on the 2021 International® A26 engine.

The electrical control system includes the Engine Control Module, or ECM; engine harness; injector harness; and various sensors and actuators.



The heart of the engine's electrical control system is the ECM. The ECM on the 2021 International® A26 engine uses eight connectors.

The left side connectors contain pins related to chassis components, and are identified as C1, C2, C3, and C4.

The right side connectors contain pins related to engine components. They are identified as E5, E6, E7, and E8.

Each ECM harness connector has unique keyed alignment features to ensure it's installed into the correct controller receptacle.

The connectors are removed by depressing the lever locking tab, then lifting the lever arm.
As the arm is rotated, the connector pushes away and separates from the receptacle.

When installing the connectors, align the keying features and evenly push onto the receptacle. When they are aligned, push the lever to draw the harness connector into the receptacle. Continue rotating until the locking tab is reengaged in the latched position.

NOTE

MATING FORCE SHOULD BE SMOOTH AND CONTINUOUS. IF NOT, REMOVE THE CONNECTOR, INSPECT, THEN REINSTALL. ALWAYS CONFIRM THAT THE LEVER IS FULLY RELEASED BEFORE ATTEMPTING TO DISCONNECT OR CONNECT THESE CONNECTORS TO AVOID DAMAGE TO THE CONNECTOR HOUSING OR TERMINALS

The preformed engine harness is routed along the sides and front of the engine. Within the harness, wiring and connections are encased in molded foam to protect circuits from damage due to abrasion, oil, heat, and debris.

The injector harness is secured and routed through the lower valve cover. It has two terminal connectors for each of the six injectors, as well as two connectors for each engine brake control solenoid, if equipped.

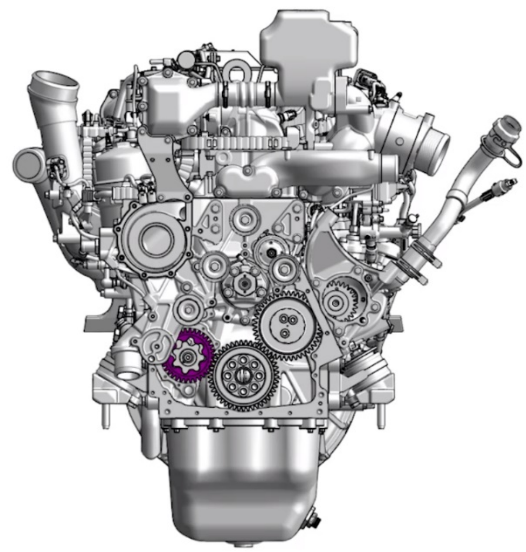
Notes

Module 4: Lubrication System

Overview

Now we will review the lubrication system on the 2021 International® A26 engine, including the system's major components and their operation.

The engine oil capacity is 42 quarts, including the filter. It uses CK-4 10W30 oil, depending on the application. Always refer to the engine Operation and Maintenance Manual, or OMM, found on International® Service Portal℠ for more information.



The oil level can be checked using the oil level gauge, or dipstick, located on the left side of the engine. When checking the oil level, ensure that the vehicle is on a flat, level surface.

The ADD mark indicates six quarts (5.8 liters) of oil should be added.

The optional Engine Oil Level, or EOL, sensor is installed on the lower left side of the crankcase. This sensor measures both oil level and temperature in the oil pan.

Oil is drawn from the oil pan through a pickup tube by the oil pump. A screen on the end of the pickup tube prevents large debris from entering the pump.

The gerotor-style oil pump is mounted behind the front cover and supplies the engine with pressurized oil. It is driven by the crankshaft gear.

Oil Flow through Module

From the oil pump, oil is delivered to the oil module assembly through a passage in the crankcase.

The oil module assembly includes:

- Oil Pressure Regulator
- Anti-drainback Valve
- Crankcase Oil Separator, or CCOS
- Oil Cooler and Oil Thermostat Regulated Bypass Valve
- Oil Filter and Oil Filter Bypass Valve
- Second Anti-drainback Valve
- Engine Oil Pressure, or EOP, sensor
- Engine Oil Temperature, or EOT, sensor

After entering the oil module assembly, oil first flows through a pressure regulator, which routes excess oil back to the oil pan. Oil then flows through an anti-drainback valve.

After passing the anti-drainback valve, a portion of the pressurized oil is routed to the CCOS. The remaining oil passes through an oil cooler that includes a thermostatic bypass valve.

The CCOS contains an internal element, driven by un-filtered oil pressure, causing it to rotate at high speeds.

The centrifugal element separates the oil mist from the crankcase gases. Oil drains to the crankcase, and the gases exit the breather tube.

The Crankcase Oil Separator Speed Sensor, or CCOSS, monitors the speed of the spinning element.

The remaining oil not flowing through the CCOS, is routed through an oil cooler that uses a thermostat regulated bypass valve. The valve aids in cold weather engine performance by bypassing the oil cooler when engine oil temperature is low.

Oil leaving the oil cooler flows to the canister style oil filter.

The oil filter element traps and stores debris from the oil passing through it.

An oil filter bypass valve is integrated into the oil filter cap.

From the oil filter, oil flows in three separate directions. Oil is routed to the crankcase, to the cylinder head, and to the Variable Geometry Turbocharger.

First we will look at oil flow to the crankcase.

Filtered oil flows through a second anti-drainback valve. This valve prevents oil from draining from the oil filter canister when the engine is not running. Oil then passes the Engine Oil Pressure sensor.

Oil exits the oil module assembly though a passage as it enters directly into the crankcase.

In the crankcase oil flows into the main oil passage.

These passages in the crankcase supply oil to:

- Crankshaft Main and Connecting Rod Bearings
- Piston Cooling Jets
- Cylinder Walls

After lubricating these components, the oil drains back to the oil pan.

At the front of the engine, oil is also supplied to:

- Accessory Drive Housing
- Idler Gear
- Oil Pump for lubrication

At the rear of the engine, oil is similarly supplied to:

- Crankcase Idler Gear
- Large Idler Gear
- Air Compressor Gear
- Air Compressor for lubrication

Oil Flow to Cylinder Head

Now let's look at the flow of oil from the oil filter module to the cylinder head.

The portion of oil flowing to the cylinder head exits the top of the module through the oil module flange. An Engine Oil Temperature, or EOT, sensor is installed in the flange.

Oil supplied to the cylinder head flows through passages to the valve train.

Oil is supplied to:

- the Camshaft Bearings
- Rocker Arms
- Engine Compression Brake Assemblies
- and Cylinder Head Idler Gear

Oil returning from the cylinder head is routed back through the oil module flange, where it flows through the oil filter module and back to the oil pan.

Oil Flow to VGT

Finally we will look at oil flow to the Variable Geometry Turbocharger, or VGT.

Oil is supplied to the VGT from the oil module through the turbocharger oil supply tube. The tube is connected to the module below the oil filter canister. It is a one-time use part. If disconnecting the oil supply tube for any repair, replace with a new tube.

After lubricating the VGT turbine shaft, return oil flows through the oil drain tube. The tube routes oil back to the crankcase where it drains to the oil pan.

Notes

Module 5: Coolant Management System

Overview

Let's take a look at the coolant management system on the 2021 International® A26 engine.

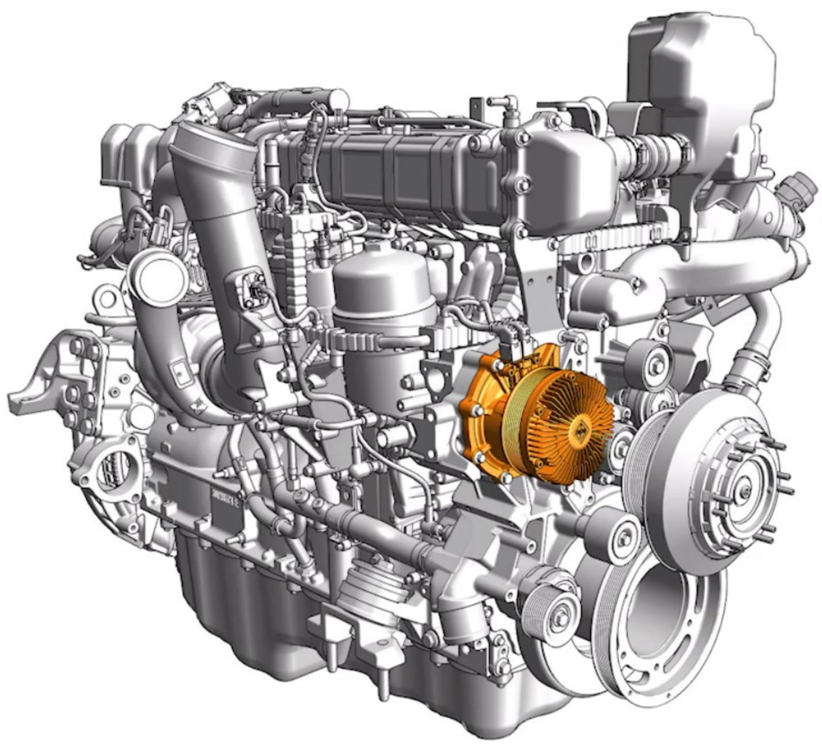
The system is designed to keep the engine at an optimum operating temperature for both performance and emission control, and contains a large number of components.

These include:

- Coolant Distribution Housing, Coolant Pump, Coolant Pump Speed Sensor (CPSS), and Engine Coolant Pressure (ECP) sensor
- Engine Oil Cooler and Air Compressor
- Rear Coolant Manifold and Orifice Plate
- EGR Cooler, EGR Valve, VGT Actuator, and Deaeration Tank
- EGR Coolant Return Manifold and Engine Coolant Temperature sensor
- Thermostat Housing and Thermostats
- Radiator and Cooling Fan
- Aftertreatment DEF System
- Cab Heater Core and H-valve

Base Engine

Starting at the heart of the system, the coolant distribution housing contains the coolant pump, and routes coolant to the crankcase and cylinder head.



The electronically controlled coolant pump circulates coolant through the system.

Located on the pump are two electrical connections. The pump clutch is actuated by the Coolant Pump Control, or CPC, solenoid.

The Coolant Pump Speed Sensor, or CPSS, measures the speed at which the pump shaft rotates.

An Engine Coolant Pressure, or ECP, sensor is mounted in the rear of the coolant distribution housing, and is located on the lower right side of the engine.

The ECP sensor measures the system pressure at the housing inlet.

From the coolant pump, coolant flows through passages to the crankcase and cylinder head. Coolant flows through the engine from front to rear in parallel paths.

A portion of coolant flowing through the crankcase is routed to the oil cooler, located within the oil module assembly.

Coolant exiting the oil cooler is returned through internal crankcase passages to the distribution housing.

Some coolant from the crankcase is also directed to the air compressor. Coolant supply and return are both routed to the compressor through hose connections on the left side of the crankcase.

The primary flow of coolant exiting the crankcase and engine cylinder head is routed together through the externally mounted rear coolant manifold, at the back of the engine.

Before leaving the crankcase and entering the manifold, coolant first flows through an orifice plate. This restriction improves coolant flow through the cylinder head.

From the manifold, coolant enters the Exhaust Gas Recirculation, or EGR, cooler.

Here, the coolant passes through tubes that travel parallel to the exhaust flow, absorbing the heat of the exhaust gasses passing through the cooler.

From the EGR cooler, coolant is directed to additional engine components (EGR Valve, VGT Actuator, Deaeration Hose and Tank).

One connection on the cooler directs coolant to the EGR valve through the EGR valve coolant supply tube. After coolant passes through the valve, it is routed through the coolant return tube, to the heater return tube.

The heater return tube is mounted on the right side of the engine. This tube has multiple ports and returns flow from various components back to the distribution housing inlet.

Another connection on the cooler supplies coolant to the VGT actuator through a supply line that runs along the cooler assembly. After passing through the actuator, return coolant is routed through the VGT coolant return tube, to the heater return tube.

A deaeration port on top of the cooler vents coolant and trapped air through a hose to the deaeration tank.

The deaeration tank is mounted to the cooling package. It is used to eliminate trapped air, and serves as a reservoir for the system. The Engine Coolant Level, or ECL, sensor is also located in the deareation tank.

A return hose from the tank routes coolant back to the distribution housing where it is recirculated through the engine.

The primary flow of coolant exits the EGR cooler through the EGR coolant return manifold and flows to the thermostat housing.

The Engine Coolant Temperature, or ECT, sensor is located in the EGR coolant return manifold.
The ECT sensor measures the temperature of the coolant as it exits the EGR cooler, before it enters the thermostat housing.

Located in the thermostat housing are two thermostats.

NOTE

Thermostats must be clocked with the aeration holes located at the 12 o'clock position.

Regardless of coolant temperature, a small amount of coolant and any trapped air will still flow through the aeration holes of each thermostat.

If the coolant is below normal operating temperature, the thermostats will be closed and coolant is then routed back to the coolant pump to be recirculated through the engine.

Flow to Radiator

As coolant reaches operating temperature, the thermostats begin to open. When they open, coolant is routed through the coolant outlet manifold to the radiator.

As coolant flows through the radiator, heat is removed by passing air.

A six-blade engine fan is belt driven; and is controlled by the fan clutch. The engine fan pulls air through the radiator fins.

A deaeration port on the radiator vents coolant and trapped air to the deareation tank.

After flowing through the radiator, coolant is routed back to the coolant distribution housing)

Aftertreatment DEF System

In addition to the engine, coolant is also routed to other components on the vehicle.

These include parts of the aftertreatment Diesel Exhaust Fluid, or DEF, system,
and the cab heater core.

The aftertreatment DEF system is supplied coolant from the rear coolant manifold.

A connection on the manifold routes coolant through hoses:
- DEF Tank Heater Valve, or DEFTHV
- DEF Head Unit
- DEF Supply Module, or DEFSM

The aftertreatment return flow is routed along the right side of the engine where it connects to the DEF coolant return tube, and then to the heater return tube.

Cab Heater Core

The cab heater core is supplied coolant from the EGR cooler.

A connection on the cooler inlet routes coolant through a hose to the right side of the engine.

The heater core return flow is routed back through the heater return tube.

Notes

Module 6: Air Management System

Overview

Managing the supply of intake air to the engine is critical for engine performance and can impact starting, power, emissions, and fuel economy.

The air management system on the 2021 International® A26 Engine combines components of the intake, exhaust, and Exhaust Gas Recirculation, or EGR, systems to achieve this.

These include the:
- Air Filter
- Variable Geometry Turbocharger, or VGT
- Engine Throttle Valve, or ETV
- EGR Valve
- EGR Cooler
- Integral Intake Manifold
- Engine Control Module, or ECM
- Variety of sensors and actuators

The Exhaust Gas Recirculation system is essential for controlling engine emissions. Oxides of Nitrogen, or NOx, is a form of pollution produced from the reaction of nitrogen and oxygen in the air during combustion, especially at high temperatures.

To lower the NOx emissions, the engine uses an EGR system that recirculates a portion of exhaust flow through a cooler and reintroduces cooled inert gas back into the air intake.

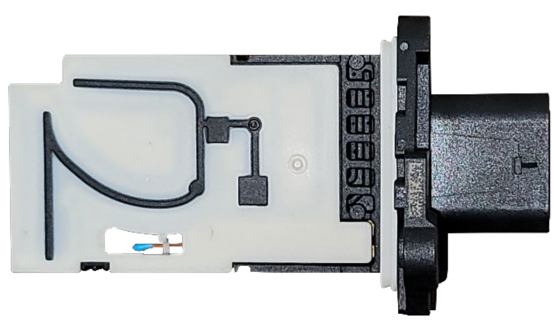
During combustion, the inert exhaust gas helps to decrease peak combustion temperatures, therefore lowering NOx formation.

EGR flow is controlled by the ECM according to multiple inputs, including:
- Engine Load (Coolant, Intake Manifold, and EGR Temperatures)
- Charge-Air Pressure
- and Oxygen Level

Now, let's take a look at how air is moved through the engine and its components.

Fresh Air Flow

Air enters the engine through the air filter housing and is routed through ducts to the Variable Geometry Turbocharger, or VGT, mounted to the exhaust manifold on the right side of the engine.



Air flowing through the turbocharger inlet duct passes the combination Mass Air Flow and Intake Air Temperature, or MAF/IAT, sensor. It monitors the volume and temperature of air entering the engine.

From here, air enters the VGT, which increases the pressure, temperature, and density of the intake air.

Adjustable vanes within the VGT allow the ECM to control the volume and angle of exhaust flow to the turbine wheel blades, which drives the intake compressor.

To control charge air pressure to the engine intake, the angle of the vanes is adjusted by the VGT actuator, which is mounted on top of the VGT assembly.

The actuator communicates with the ECM on the 250K Engine Private datalink.

Hot, compressed intake charge air exiting the VGT passes the Turbocharger Outlet Temperature, or TCOT, sensor, mounted in the VGT compressor housing outlet.

From the VGT outlet, charge air is routed to the air-to-air Charge Air Cooler, or CAC, mounted in front of the radiator.

The CAC exchanges heat from the charge air passing through it to the ambient air passing across the outer fins. The CAC is part of the cooling package.

From the CAC, cooled charge air is routed to the Engine Throttle Valve, or ETV, located on the left side of the engine.

The ETV has a variable position actuator with an internal position sensor that controls a throttle plate.

The ECM-controlled valve regulates the amount of charge air entering the engine to aid in both EGR flow, and the regeneration process.

Mounted in the charge air cooler adapter at the ETV intake, is the Charge Air Cooler Outlet Temperature, or CACOT, sensor. This sensor measures the temperature of the charge air entering the ETV from the CAC.

Mixed Air Flow

The ETV is mounted to the EGR mixing duct.

The EGR mixing duct is where a portion of exhaust gas from the EGR cooler is mixed with charge air from the ETV, before entering the intake manifold.

The EGR mixing duct contains the EGR Temperature sensor, Intake Manifold Pressure sensor, and Cold Start Fuel Ignitor.

The EGR Temperature, or EGRT, sensor is installed in the inlet of the mixing duct. It measures the temperature of the exhaust gas exiting the EGR cooler.

The Intake Manifold Pressure, or IMP, sensor measures the pressure of the air entering the intake manifold.

The optional Cold Start Fuel Ignitor, or CSFI, injects and vaporizes fuel in the air intake which is drawn into the engine to provide easier starting in cold-climates.

From the EGR mixing duct, EGR gases and charge air are routed to the intake manifold, which is integrated into the cylinder head.

The Intake Manifold Temperature, or IMT, sensor measures the air temperature in the intake manifold, before it enters the combustion chamber.

Exhaust Air Flow

After combustion, exhaust gases exiting the cylinder head pass through a three-piece exhaust manifold mounted to the right side of the engine. The manifold routes exhaust to both the VGT, and the EGR valve.

The Exhaust Back Pressure, or EBP, sensor is threaded into a tube mounted to the center section of the exhaust manifold.

The sensor measures the backpressure in the manifold before the VGT and EGR valve.

The Engine Exhaust Temperature, or EET, sensor is also threaded into the center section of the manifold.

A portion of exhaust is routed to the EGR cooler from the exhaust manifold. Flow to the EGR cooler is controlled by the EGR valve located on the right-rear side of the cylinder head.

The valve is a single butterfly-type valve that is controlled by the ECM and is mounted behind the EGR cooler, in between the front and rear bellows pipes.

When commanded, the EGR valve opens and allows exhaust gases to enter the EGR cooler.

Located on the bottom of the EGR valve is a vent hole. Exhaust passing through the vent is routed through a tube to the crankcase.

The single stage EGR cooler is mounted above the exhaust manifold and uses engine coolant to remove heat from exhaust gases that pass through it.

Located at the outlet of the EGR cooler are reed valves. The valves ensure exhaust flows in one direction. Due to cylinder firing sequence, exhaust flow comes in a series of strong pulses. The valves open every time exhaust pressure exceeds intake charge air pressure. When charge air pressure is greater than exhaust, the valves close, improving cylinder intake efficiency.

From the EGR reed valve housing, exhaust flows across the front of the engine to the EGR resonator, which is mounted to the EGR mixing duct. The resonator absorbs exhaust fluctuations, reduces noise, and improves flow to the intake system.

The primary flow of exhaust leaving the exhaust manifold enters the VGT, which is mounted directly to the center section of the exhaust manifold. Exhaust flow is used to drive the turbocharger.

Exhaust exiting the VGT passes through the turbocharger exhaust outlet pipe. Mounted in the pipe is the NOx In sensor, which monitors the amount of NOx leaving the engine and entering the aftertreatment system. The aftertreatment system will be discussed in module 8.

Notes

Module 7: Fuel Management System

Overview

The 2021 International® A26 engine features a high-pressure common-rail fuel system controlled by the Engine Control Module.

The components found in this system include the:

- Fuel Tank
- Primary and Secondary Fuel Filters
- Hand Priming Pump
- Fuel Pump Assembly which includes both Low and High-pressure Fuel Pumps
- Common Fuel Rail
- High-pressure Fuel Lines and Feed Pipes
- Fuel Injectors
- Engine Control Module, or ECM
- Variety of sensors and other electronically controlled components
- Optional Cold Start Fuel Ignitor, or CSFI

Let's review the fuel system operation

WARNING

TO PREVENT PROPERTY DAMAGE, PERSONAL INJURY, AND/OR DEATH,
NEVER LOOSEN A HIGH-PRESSURE FUEL LINE OR OTHER COMMON RAIL COMPONENT WHILE THE ENGINE IS RUNNING, OR WHEN THE ENGINE IS OFF WITHOUT FIRST CHECKING THAT RAIL PRESSURE IS AT A SAFE PRESSURE USING AN ELECTRONIC SERVICE TOOL, OR EST.
COMMON RAIL LINES AND COMPONENTS CONTAIN FUEL UNDER EXTREMELY HIGH PRESSURES.
HIGH PRESSURE FUEL MAY PENETRATE THE SKIN AND CAUSE INJURY OR DEATH.

Fuel Suction

As fuel is drawn from the fuel tanks, it passes through the remotely mounted primary fuel filter module.

The module consists of a serviceable fuel filter, Water-in-Fuel, or WIF, sensor, and an optional 12 volt fuel pre-heater.

The filter traps and stores any debris from the fuel tank before it enters the system.

It also separates any water that is in the fuel. A valve on the module can be opened to drain water that has been stored in the filter.

The primary fuel filter module is commonly mounted to the frame rail, but the location may vary depending on platform and installed options. Refer to International® Service Portal℠ for more information.

From the primary fuel filter, fuel is routed through the primer pump on the left side of the engine.

The hand-operated pump is mounted to the ECM mounting bracket for unobstructed access; and is used to prime the fuel system, when required.

Low Pressure Fuel

Fuel is then routed to the low-pressure fuel pump, which is joined to the rear of the high-pressure fuel pump assembly.

The low-pressure fuel pump is driven by the high-pressure fuel pump and is internally regulated.

It has an output pressure of approximately 85 psi, and supplies fuel to the high-pressure fuel pump.

Fuel exiting the low-pressure fuel pump is routed to the secondary fuel module assembly.

A filter within the fuel module traps and stores finer particles, preventing them from entering the high-pressure fuel pump. The serviceable filter element is accessed by removing the cap.

Fuel exiting the module is routed to the high-pressure fuel pump supply inlet.

The high-pressure fuel pump supply line contains an in-line orifice that is incorporated into the banjo-style fitting connected to the module. This orifice reduces the pressure of fuel being supplied to the high-pressure fuel pump.

High Pressure Fuel

The high-pressure fuel pump is mounted to the left side of the engine and is driven off the front gear train. It is a two-cylinder inline plunger style pump that is specifically timed to the accessory drive gear and driven by the front crankshaft gear.

The pump is capable of increasing the fuel pressure up to 36,000 psi (2,500 bar).

The Engine Fuel Actuator 1, or EFA1, valve located on the back of the pump regulates fuel volume entering the high-pressure pumping chambers. Excess fuel not entering the chambers is used to lubricate and cool the pump before being routed back to the fuel tank.

After the fuel is pressurized, it exits through two high-pressure fuel supply lines on top of the pump.

The lines connect to the fuel rail, which acts as a high-pressure fuel reservoir and distributes fuel equally to the six fuel injectors through individual high-pressure fuel injector lines.

Located on the front of the fuel rail is the Fuel Rail Pressure 1 and Fuel Rail Pressure 2, or FRP1/FRP2 sensor.

Found on the rear of the fuel rail is the Engine Fuel Actuator 2, or EFA2, valve which controls fuel pressure. Excess fuel from EFA2 is also returned to the fuel tank.

The injectors are installed in the cylinder head and are held in place by hold-down clamps.
Fuel from the fuel rail injector lines is supplied to each injector by a high-pressure connector feed pipe that runs through the cylinder head to the injector body, and is screwed into the cylinder head.

The high-pressure fuel lines and the connector feed pipes are one-time use only.

The ECM regulates fuel delivery to each cylinder by controlling the time each injector is open.

Fuel Return

Excess fuel that is not injected into the combustion chamber is routed through passages in the cylinder head to a port located at the rear of the head.

Here it is routed through lines to the tank, along with return flow from EFA2, the high-pressure fuel pump, and the secondary fuel filter.

Cold Start Fuel System

The optional Cold Start System, is also located on the left side of the engine. It includes the Cold Start Enable Device, or CSED, fuel solenoid; the Cold Start Fuel Ignitor, or CSFI mounted in the EGR mixing duct; and a CSFI relay controlled by the ECM.

Low-pressure fuel is supplied from the secondary fuel filter to the CSED, which opens under certain conditions, supplying fuel to the ignitor during engine cranking for starting in cold climates.

Notes

Module 8: Aftertreatment System

Overview

In our final module, let's review the exhaust aftertreatment system.

The primary function of the aftertreatment system is to meet emission requirements by reducing harmful pollutants created during combustion.

These include hydrocarbons, or incompletely burned fuel; particulate matter, or soot; and nitrogen oxides, or NOx, a harmful chemical combination of oxygen and nitrogen formed during combustion at high temperatures.

These are filtered and broken down in the system through a series of catalysts which oxidizes, or converts, them into nitrogen, water, and carbon dioxide, or CO2.

The system incorporates a single canister aftertreatment assembly and the Diesel Exhaust Fluid, or DEF, system controlled by the ECM.

Exhaust gases that leave the engine exit through the VGT outlet pipe and then enter the aftertreatment system.

Located in the VGT outlet pipe is the NOx In sensor.

This sensor monitors the level of NOx in the exhaust stream leaving the engine and entering the aftertreatment system. It is used to help control engine EGR.

There is a second NOx sensor located in the aftertreatment outlet. The ECM uses the NOx In and NOx Out sensor readings to compare and calculate the SCR efficiency and adjust DEF injection.

Single Cannister Assembly

Downstream of the NOx In sensor is the single canister aftertreatment assembly.

It has four main sections, and includes the Diesel Oxidation Catalyst; Diesel Particulate Filter; decomposition mixer; and the Selective Catalyst Reduction, or SCR, section that contains the SCR catalyst and the Ammonia Slip Catalyst.

NOTE

AFTERTREATMENT ASSEMBLIES FOR THE 2021 INTERNATIONAL® A26 ENGINE ARE VEHICLE AND FEATURE SPECIFIC. ALTHOUGH PARTS MAY APPEAR TO BE THE SAME, THERE MAY BE MULTIPLE VARIATIONS OF THE SAME PART. WHEN SERVICING, ENSURE ONLY PARTS SPECIFIC FOR THE APPLICATION ARE BEING USED.

The sections of the canister can be serviced individually. They are separated by one-time use gaskets that must be replaced if disassembled.

The first section in the canister is the Diesel Oxidation Catalyst, or DOC.

Engine exhaust flows through the DOC which contains a ceramic substrate with a catalyst wash coat. The DOC converts oxygen, carbon monoxide, and unburned fuel into CO_2 and water. These reactions generate the heat needed for DPF and SCR operation.

The ECM uses two temperature sensors to monitor the DOC. They are the DOC Inlet Temperature, or DOCIT, sensor located at the DOC inlet, and the DPF Inlet Temperature, or DPFIT, sensor located at the DPF inlet.

The second section in the canister is the Diesel Particulate Filter, or DPF. The DPF is a wall flow device consisting of a ceramic substrate with a catalyst wash coat.

It has a honeycomb structure with alternate channels plugged at opposite ends that traps and temporarily stores particulate matter, or soot, that enters the filter. This allows for the oxidation of the stored particulates once soot load reaches a specific level.

The soot is converted to CO_2 and ash when the DPF temperature is above approximately 550 degrees Fahrenheit.

To measure the buildup of soot in the DPF, a combination DPF Differential Pressure and DPF Outlet Pressure, or DPFDP-DPFOP, sensor module is used.

Two sensing hoses from the module lead to probes on either side of the DPF. One is located at the inlet of the DPF, and the other is located at the inlet of the decomposition mixer.

Also found at the inlet of the decomposition mixer is the DPF Outlet Temperature, or DPFOT, sensor.

DPF Regeneration

The process of reducing the soot to ash is called DPF regeneration, or more commonly referred to as a regen.

A passive regeneration occurs when the exhaust system reaches the temperature required to reduce the soot in the DPF to ash.

It takes place without additional fuel being introduced into the exhaust system and without any action by the operator.

It typically happens during highway operation or driving with heavy loads that causes DPF temperatures to be above approximately 600 degrees Fahrenheit.

If the DPF differential pressure indicates excessive soot has accumulated in the DPF but the exhaust temperature is below 600 degrees Fahrenheit, an active regeneration is required. The ECM will inject additional fuel into the combustion chamber at the end of the exhaust stroke, heating the DOC and DPF.

During active regeneration the ECM will maintain DPF temperatures between approximately 900 and 1200 degrees Fahrenheit for 20 to 40 minutes. If the exhaust flow or temperature drop below threshold, active regeneration stops.

No driver input is needed for active regeneration to occur.

A stationary, or parked, regeneration is required if DPF differential pressure is above the threshold and the vehicle has not been able to reduce soot during normal vehicle operation.
The vehicle will need to be parked and a stationary DPF regeneration must be commanded by the operator.

The third section in the canister is the decomposition mixer. Here DEF is injected into the exhaust stream by the DEF Doser Valve, or DEFDV, when commanded by the ECM. An internal chamber in the mixer ensures the DEF is evenly vaporized with exhaust gases.

DEF is approximately 68 percent water and 32 percent urea. Once the DEF is mixed into the exhaust, the water evaporates, and the urea is converted to ammonia and CO2, which travels to the SCR.

The fourth section in the canister is the Selective Catalyst Reduction, or SCR, assembly. The SCR contains two catalysts.

The first is the SCR catalyst, which contains a ceramic substrate with a catalyst wash coat which helps convert NOx and ammonia into nitrogen and water vapor.

The second is the Ammonia Slip Catalyst, or ASC, which is the last catalyst in the aftertreatment system.

The ASC converts any remaining ammonia that may pass through the SCR catalyst into nitrogen and water.

At the aftertreatment outlet there are three sensors. These are the SCR Outlet Temperature, or SCROT, sensor; the NOx Out sensor; and the Particulate Matter, or PM, sensor. They are used to protect the system, and measure its efficiency.

When the SCR outlet temperature sensor reading is too high, the ECM will lower the temperature by reducing fuel during regeneration, or introduce more EGR gas into the engine to protect the SCR.

The PM sensor inputs are used by the ECM to help determine DPF soot accumulation and DPF health.

DEF Storage Tank

The DEF system injects DEF fluid into the decomposition mixer.

This system includes the:

- Storage Tank
- Head Unit
- DEF Supply Module, or DEFSM
- DEF Tank Heater Valve, or DEFTHV
- Suction, Pressure, and Backflow Lines
- DEF Doser Valve

> **NOTE**
>
> **THE SIZE AND LOCATION OF THE DEF STORAGE TANK WILL DEPEND ON THE FACTORY INSTALLED FEATURES. REFER TO INTERNATIONAL® SERVICE PORTAL℠ FOR MORE INFORMATION ON FACTORY INSTALLED OPTIONS AND FEATURE CODES.**

Diesel exhaust fluid is stored in the DEF tank on the frame of the vehicle.

The DEF head unit is located in the DEF tank.

It consists of:

- Smart Sensor Module
- Coolant Heating Loop
- DEF Suction Tube and Inlet Screen
- Backflow Tube
- Vent

The Smart Sensor Module contains:

- DEF Tank Level Sensor
- DEF Tank Temperature Sensors
- Urea Quality Sensor, or UQS

The UQS is commonly referred to as the QLS, or Quality Level Sensor.

All of these sensors communicate with the ECM on the 250K Engine Private datalink.

If the DEF tank level is too low, the ECM will set a fault and engine power may be limited.

The UQS measures DEF urea concentration. If DEF urea concentration is low, the ECM will set a fault and engine power may be limited.

To prevent DEF fluid from freezing, when the tank temperature is approximately 23 degrees Fahrenheit or below, the ECM will command the tank heater valve, located on top of the tank, to open. This allows warm engine coolant to flow through the DEF tank heating loop, and DEFSM.

DEF Flow

The DEFSM is mounted to the rear of the DEF storage tank. It contains an electric pump that draws DEF from the tank, through the DEF head unit and suction line.

The DEFSM filters, pressurizes, and sends DEF through the pressure line to the DEF Doser Valve, or DEFDV.

A serviceable filter cartridge is located within the module and can be accessed by removing the filter cap.

During normal operation the DEF filter cartridge should be changed approximately every 300,000 miles. Refer to International® Service Portal℠ for more information.

The DEFDV is a solenoid valve assembly that is located on the decomposition mixer. The valve injects DEF into the exhaust stream passing through the mixer. It broadcasts DEF system pressure and DEF Absolute Pressure, or DEFAP, to the ECM.

The DEFDV uses two gaskets: a one-time use injector tip gasket seals the DEF Doser valve to the decomposition mixer, and a one-time use thermal isolator that protects the DEF Doser valve from the heat of the exhaust.

The assembly is cooled by DEF that is constantly circulating through it when the engine is running.

Notes

Conclusion

This concludes the Navistar® training course: International® A26 (2021 GHG) Engine Overview

Thank you for your participation.

Notes

