

Automotive Fuel and Emissions Control Systems 4/E

Chapter 4 Diesel Engine Operation

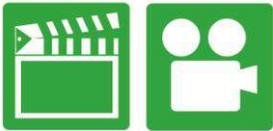
Opening Your Class

KEY ELEMENT	EXAMPLES
Introduce Content	This course or class covers operation and service of Automotive Fuel and Emissions Control Systems . It correlates material to task lists specified by ASE and NATEF.
Motivate Learners	Explain how the knowledge of how something works translates into the ability to use that knowledge to figure why the engine does not work correctly and how this saves diagnosis time, which translates into more money.
State the learning objectives for the chapter or course you are about to cover and explain this is what they should be able to do as a result of attending this session or class.	Explain the chapter learning objectives to the students. <ol style="list-style-type: none">1. List the characteristics of diesel engines.2. Describe the operation of fuel tanks, lift pumps, and injection pumps.3. Understand how the hydraulic electronic unit injection system works.4. Discuss the purpose and function of glow plugs, diesel fuel heaters, engine-driven vacuum pumps, diesel injector nozzles, and accelerator pedal position sensors.5. Explain the purpose and function of diesel engine turbochargers.6. Discuss the purpose and function of the exhaust gas recirculation system and diesel oxidation catalysts.7. Define diesel particulate matter, and discuss the function of diesel exhaust particulate filters.8. Describe selective catalytic reduction and diesel exhaust fluid (DEF).9. Explain compression testing, glow plug resistance balance test, injector pop testing, and diesel emission testing including diesel exhaust smoke diagnosis.
Establish the Mood or Climate	Provide a WELCOME , Avoid put downs and bad jokes.
Complete Essentials	Restrooms, breaks, registration, tests, etc.
Clarify and Establish Knowledge Base	Do a round robin of the class by going around the room and having each student give their backgrounds, years of experience, family, hobbies, career goals, or anything they want to share.

NOTE: This lesson plan is based on Fuel & Emission Control 4th Edition Chapter Images found on Jim's web site @ www.jameshalderman.com

LINK CHP 4: [Chapter Images](#)

ICONS



Chapter 4 Diesel Engine Operation

1. SLIDE 1 Ch04 DIESEL ENGINE OPERATION

DISCUSSION: Ask students to discuss advantages & disadvantages of diesel engines as opposed to gasoline engines. Ask students why a diesel block has to be constructed much heavier than a gasoline engine block.

Check for **ADDITIONAL VIDEOS & ANIMATIONS**
@ <http://www.jameshalderman.com/>
WEB SITE REGULARLY UPDATED

VIDEOS

Engine Operation (17 Links)

SAFETY Always be very careful when working on a Diesel engine that is running with air intake removed. Because most diesel **ENGINES DO NOT USE** a throttle plate, objects can very easily be sucked into engine, causing serious engine damage. **MOST OEMs offer intake covers.**

At the beginning of this class, you can download the crossword puzzle & Word Search from the links below to familiarize your class with the terms in this chapter & then discuss them

Crossword Puzzle ([Microsoft Word](#)) ([PDF](#))

Word Search Puzzle ([Microsoft Word](#)) ([PDF](#))

2. **SLIDE 2 EXPLAIN FIGURE 4-1** Diesel combustion occurs when fuel is injected into the hot, highly compressed air in the cylinder.

DISCUSSION: Ask the students why diesel engine does not have spark plugs. (ANS: Diesel relies on heat of compression to ignite fuel instead of spark)

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      	<p>3. SLIDE 3 EXPLAIN FIGURE 4-2 typical injector pump type of automotive diesel fuel-injection system</p> <p>4. SLIDE 4 EXPLAIN FIGURE 4-3 Cummins diesel engine as found in Dodge pickup truck. High-pressure pump (30,000 PSI) is used to supply diesel fuel to this common rail, which has tubes running to each injector. Note thick cylinder walls & heavy-duty construction.</p> <p><u>SAFETY</u> Diesel engine fuel systems operate under <u>extremely high pressure</u>. Severe injury can result if caution is not observed when opening fuel system. The high-pressure fuel can actually penetrate skin.</p> <p>5. SLIDE 5 EXPLAIN FIGURE 4-4 Rod/piston assembly from a 5.9 liter Cummins diesel engine used in a Dodge pickup truck.</p> <p><u>Show ANIMATION: Diesel 4-Stroke Cycle Diesel 4-Stroke Cycle (View) (Download)</u></p> <p>6. SLIDE 6 EXPLAIN FIGURE 4-5 indirect injection diesel engine uses a prechamber and a glow plug.</p> <p><u>DISCUSSION:</u> Ask the students why diesel fuel does not evaporate as easily as gasoline</p> <p><u>Show ANIMATION: IDI DIESEL OPERATION HPCR</u> www.myautomotivelab.com http://media.pearsoncmg.com/ph/chet/chet_myautomotivelab_2/animations/A1_Animation/Chapter11_Fig_11_10/index.htm</p>

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	<p>7. SLIDE 7 EXPLAIN FIGURE 4-6 direct injection diesel engine injects the fuel directly into the combustion chamber. Many designs do not use a glow plug.</p>
	<p>8. SLIDE 8 EXPLAIN Fuel Tank and Lift Pump & EXPLAIN FIGURE 4-7 A fuel temperature sensor is being tested using an ice bath.</p>
	<p>9. SLIDE 9 EXPLAIN Injection Pump & EXPLAIN FIGURE 4-8 A typical distributor-type diesel injection pump showing the pump, lines, and fuel filter.</p>
	<p>10. SLIDE 10 EXPLAIN FIGURE 4-9 A schematic of Stanadyne diesel fuel-injection pump assembly showing all of the related components.</p>
   <p>QUESTION</p>	<p><u>DEMONSTRATION:</u> Show typical fuel flow through a distributor type of fuel system. FIGURE 4-9</p> <p><u>DISCUSSION:</u> Ask the students why each fuel line of a distributor-type injection system must be the same length. (Answer: To ensure that injector timing is correct)</p>
	<p>11. SLIDE 11 EXPLAIN FIGURE 4-10 Overview of a computer-controlled high-pressure common rail V-8 diesel engine</p>
	<p><u>Diesel High Pressure Common Rail</u></p>
	<p>12. SLIDE 12 EXPLAIN FIGURE 4-11 HEUI injector from a Ford PowerStroke diesel engine. The O-ring grooves indicate the location of the O-rings that seal the fuel section of injector from coolant and from engine oil.</p>
	<p>DISCUSS TECH TIP</p>
	<p><u>HANDS-ON TASK:</u> Have the students search service information for bulletins relating to oil change intervals on Ford 7.7, 6.0, and 6.4 liter diesel engines</p>

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	<p>13. SLIDE 13 EXPLAIN electric solenoid attached to injector nozzle is computer controlled and opens to allow fuel to flow into injector pressure chamber EXPLAIN FIGURE 4-12 Typical computer-controlled diesel engine fuel injectors.</p>
	<p>DISCUSS TECH TIP</p>
	<p>14. SLIDE 14 EXPLAIN FIGURE 4-13 Duramax BOSCH COMMON RAIL injector showing all the internal parts.</p>
	<p><u>DEMONSTRATION:</u> Show examples of COMMON RAIL & OLDER diesel injectors. <u>FIGURE 4-13</u></p>
	<p><u>ANIMATION Fuel Injector, Electronic-Control, FIGURE 4-13</u></p>
	<p><u>HANDS-ON TASK:</u> Using service information, have the students research correct procedure for purging air from specific vehicle equipped with a diesel engine.</p>
	<p>15. SLIDE 15 EXPLAIN Glow Plugs EXPLAIN FIGURE 4-14 A glow plug assortment showing the various types and sizes of glow plugs used. Always use the specified glow plugs</p>
	<p>16. SLIDE 16 EXPLAIN FIGURE 4-15 A schematic of a typical glow plug circuit. Notice that the glow plug relay and intake air heater relay are both computer controlled</p>
	<p><u>DEMONSTRATION:</u> Show the students some examples of glow plugs and show them how to test them with an ohmmeter. <u>FIGURE 4-14</u></p>
	<p><u>HANDS-ON TASK:</u> Grade the students on their ability to test glow plugs and determine if they are functional <u>FIGURE 4-14 & 15</u></p>
	<p>17. SLIDE 17 EXPLAIN Diesel Fuel Heaters FIGURE 4-16 A wire-wound electric heater is used to warm the intake air on some diesel engines</p>

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DISCUSSION: Ask students why diesel engine doesn't generate enough vacuum to operate a vacuum-controlled device. (ANS: to generate vacuum in an engine, you need a restriction to incoming air such as a throttle plate. Since MOST diesels do not have throttle plate, there is no restriction to incoming air and very little vacuum is created OR is there a way to retain vacuum)

DISCUSS FREQUENTLY ASKED QUESTION

18. **SLIDES 18 EXPLAIN Accelerator Pedal Position Sensor & EXPLAIN Figure 4-17** typical accelerator pedal position (APP) sensor uses three different sensors in one package with each creating a different voltage as the accelerator is moved.
19. **SLIDE 19 EXPLAIN Diesel Engine Turbochargers & EXPLAIN FIGURE 4-18** Cummins diesel turbocharger is used to increase power & torque
20. **SLIDE 20 EXPLAIN FIGURE 4-19** An air charge cooler is used to cool the compressed air.
21. **SLIDE 21 EXPLAIN Figure 4-20** variable vane turbocharger allows the boost to be controlled without the need of a wastegate

ANIMATION: Turbocharger Operation

ANIMATION: Variable Vane Turbocharger

Turbocharger Blow-Off Valve

ANIMATION: Turbocharger Wastegate

DEMONSTRATION: Given a diesel engine equipped with an EGR system, point out the various components that make up the EGR system.

ICONS

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22. **SLIDE 22 EXPLAIN Exhaust Gas Recirculation & EXPLAIN Figure 4-21** cutaway showing the exhaust cooler. The cooler the exhaust is, the more effective it is in controlling NOx emissions

DISCUSSION: Ask the students how recirculating hot exhaust gases helps cool the combustion.

DISCUSS FREQUENTLY ASKED QUESTION

23. **SLIDE 23 EXPLAIN Figure 4-22** Relative size of particulate matter to a human hair

DEMONSTRATION: On a newer vehicle equipped with a DOC and a DPF, point out the components on the vehicle

24. **SLIDE 24 EXPLAIN FIGURE 4.23** Chemical reaction within the DOC
25. **SLIDE 25 EXPLAIN FIGURE 4-24** Aftertreatment of diesel exhaust is handled by the DOC and DPF
26. **SLIDE 26 EXPLAIN FIGURE 4-25** The soot is trapped in the passages of the DPF. The exhaust has to flow through the sides of the trap and exit
27. **SLIDE 27 EXPLAIN FIGURE 4-26** EGT 1 and EGT 2 are used by the PCM to help control after treatment
28. **SLIDE 28 EXPLAIN FIGURE 4-27** Regeneration burns the soot and renews the DPF

SAFETY Usually regeneration of particulate filter occurs when vehicle is driven. At times a vehicle may require regeneration in the shop. Make sure that the vehicle is parked outside away from any other vehicles before starting regeneration process.

DISCUSS FREQUENTLY ASKED QUESTION

29. **SLIDE 29 EXPLAIN FIGURE 4-28** The post injection pulse occurs to create the heat needed for regeneration.

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        	<p>EXPLAIN WARNING</p> <p>DISCUSS FREQUENTLY ASKED QUESTION</p> <p>HANDS-ON TASK: Using service information, have the students look up what symptoms would result from excessive exhaust back pressure.</p> <p>30. SLIDE 30 EXPLAIN FIGURE 4-29 The exhaust is split into two outlets and has slits to help draw outside air in as the exhaust leaves the tailpipe. The end result is cooler exhaust gases exiting the tailpipe</p> <p>31. SLIDE 31 EXPLAIN FIGURE 4-30 Diesel exhaust fluid costs \$3 to \$4 a gallon and is housed in a separate container that holds from 5 to 10 gallons, or enough to last until the next scheduled oil change in most diesel vehicles that use SCR (Selective catalytic reduction)</p> <p><u>Diesel Exhaust Fluid</u></p> <p>32. SLIDE 32 EXPLAIN FIGURE 4-31 Urea (diesel exhaust fluid) injection is used to reduce NOx exhaust emissions. It is injected after the diesel oxidation catalyst (DOC) and before the diesel particulate filter (DPF) on this 6.7 liter Ford diesel engine</p> <p><u>DEMONSTRATION:</u> On a newer vehicle equipped with a DOC and a DPF, point out the components on the vehicle.</p> <p><u>SAFETY</u> Usually regeneration of particulate filter occurs when vehicle is driven. At times a vehicle may require regeneration in the shop. Make sure that the vehicle is parked outside away from any other vehicles before starting regeneration process.</p> <p>HANDS-ON TASK: Using service information, have the students look up what symptoms would result from excessive exhaust back pressure.</p>

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	<u>DEMONSTRATION:</u> Using a scan tool on vehicle equipped with a particulate filter, show students scan tool data that relates to particulate filter regeneration
	<u>DEMONSTRATION:</u> If you have access to a vehicle with urea injection, show students the components that comprise the urea injection system. (This system has just been introduced in the 2010 model year ON GM DURAMAX ENGINE)
	<u>DEMONSTRATION:</u> Using a scan tool on vehicle equipped with a particulate filter, show students scan tool data that relates to particulate filter regeneration
	<u>DEMONSTRATION:</u> If you have access to a vehicle with urea injection, show students the components that comprise the urea injection system. (Introduced in 2010 model year GM DURAMAX ENGINE)
	<u>HANDS-ON TASK:</u> Have the students search for sources and prices of diesel urea
	Some states do random smoke tests on heavy duty diesels as part of their clean air program. If the vehicles fail this smoke test there can be heavy fines, or vehicle may be required to be parked until repaired.
	Some states do random smoke tests on heavy duty diesels as part of their clean air program. If the vehicles fail this smoke test there can be heavy fines, or vehicle may be required to be parked until repaired.
	33. SLIDE 33 EXPLAIN FIGURE 4-32 pressure gauge checking the fuel pressure from the lift pump on a Cummins 6.7 liter diesel
	34. SLIDE 34 EXPLAIN FIGURE 4-33 compression gauge that is designed for the higher compression rate of a diesel engine should be used when checking the compression.

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	<p><u>DEMONSTRATION:</u> Show how to perform diesel engine compression test</p>
	<p><u>HANDS-ON TASK:</u> Have the students perform a compression test on a diesel engine.</p>
	<p><u>DEMONSTRATION:</u> Show the students how to perform a cylinder balance test on a vehicle that is equipped with glow plugs.</p>
	<p><u>HANDS-ON TASK:</u> Have the students perform a glow plug resistance test</p>
	<p><u>DISCUSSION:</u> Ask why a diesel engine requires such a high fuel pressure.</p>
	<p>35. SLIDE 35 EXPLAIN FIGURE 4-34 typical pop tester used to check the spray pattern of a diesel engine injector</p>
	<p>EXPLAIN TECH TIPS</p>
	<p>36. SLIDE 36 EXPLAIN FIGURE 4-35 The letters on the side of this injector on a Cummins 6.7 liter diesel indicate the calibration number for the injector</p>