

Combustion Theory

Screen 1:

Introduction to Combustion Theory:

Welcome to the Combustion Theory module of the 7FDL Diesel Engine Basic course. Millions of engines are in use every day, the most common being the engines that power our cars. The lifestyles we all are accustomed to would be non-existent if it were not for the power provided by the internal combustion engine. With a device as important as this, it only makes sense that we should have a basic understanding of how a combustion engine operates.

At the end of this module, you will be able to:

- Describe how a combustion engine operates.
- List the differences between a gasoline engine and a diesel engine.
- Describe the four strokes of a diesel engine.

Screen 2:

Combustion Engine Theory:

The internal combustion engine is a device that utilizes a chemical reaction between a combustible fluid, better known as fuel, oxygen, and heat. This chemical reaction is used to produce captive, controlled, synchronized explosions. The energy produced by these explosions is used to rotate a primary shaft commonly called a crankshaft. While this may sound complicated, it really is not.

Screen 3:

Gasoline and Diesel Engines:

As with any product as all-encompassing as the combustion engine, variations and improvements have developed over time. One of the prominent and well-known deviations from the traditional gasoline engine was the development of the diesel engine. So, how is the diesel engine different from the gasoline engine?

Screen 4:

Gasoline vs Diesel:

Obviously, there is a difference between the types of fuel used for the gasoline and diesel engines. But another important difference is how ignition of the air-fuel mixture is initiated. The combustion chamber of a gasoline engine receives a mixture of gas and air and compresses it. The mixture is then ignited by means of an electronic ignition source, commonly called a spark plug. Like the gas engine, the combustion chamber of a diesel engine receives and compresses air but initially it is not mixed with fuel. Typically, the compression ratio of a diesel engine is higher than that of a gas engine. Due to this high compression ratio, the air reaches a temperature high enough to spontaneously ignite the fuel that is injected directly into the combustion chamber. No electronic ignition source is used to ignite the fuel.

Screen 5:

Gasoline vs Diesel (Cont'd):

Normally, a gasoline engine would have a compression ratio in a range of 8:1 to 12:1, while a diesel engine would normally compress at a ratio from 14:1 to 25:1. If the ratio is 8:1, you can think of this as taking a column of air that is 8 inches high and 1 inch wide, and compressing that column down

to a 1 inch high and 1 inch wide column. The higher compression ratio of the diesel engine leads to higher fuel efficiency. The higher compression ratio also raises the temperature of the compressed air.

Screen 6:

Gasoline vs Diesel (Cont'd):

Diesel engines use direct fuel injection, where the fuel is injected under high pressure directly into the combustion chamber when the air temperature is high enough to instantaneously ignite the fuel. Gasoline engines generally use carburetion or port fuel injection. Port fuel injection is where the fuel is injected in the intake air manifold just prior to the fuel entering the combustion chamber through the intake valve located outside the cylinder. Carburetion is where air and fuel are mixed long before they enter the combustion chamber.

Screen 7:

Four-Stroke Diesel Engine:

As with most automobile gasoline engines, our diesel engines are four-stroke-per-cycle engines, often referred to as simply four-stroke or four-cycle engines. Regardless of the naming convention used, one complete cycle of a four-stroke diesel engine includes four strokes of a piston inside a single cylinder: intake, compression, combustion, and exhaust. During the four strokes, there are three items needed for combustion: oxygen, heat, and fuel.

Screen 8:

Intake Stroke:

The intake stroke is the first stroke of the four-cycle diesel engine. During this stroke, the piston is traveling in a downward motion inside the cylinder. Intake valves located in the combustion chamber are open, allowing air to enter into the chamber. This provides oxygen-laden filtered air to the combustion chamber. The intake stroke provides oxygen, one of the three items needed for combustion.

Screen 9:

Compression Stroke:

The compression stroke is the second stroke of the four-cycle diesel engine. During this stroke, the piston has changed direction to initiate a new stroke, and is traveling in an upward motion in the cylinder. The intake and exhaust valves, located at the top of the combustion chamber, are closed, sealing off the combustion chamber. The piston is compressing the air that was drawn into the cylinder during the previous stroke, the intake stroke. As the air is compressed, the temperature increases rapidly to typically 700 to 1100 degrees Fahrenheit (approximately 370 to 590 degrees Celsius). This produces the second item needed for combustion, heat. At the end of the compression stroke, diesel fuel is injected into the combustion chamber at a very high pressure. Fuel, the third and last item, is now present for combustion. The fuel ignites spontaneously when the fuel mist comes into contact with the very hot air. This starts the third stroke of the cycle: combustion stroke. The crankshaft has now rotated one full turn.

Screen 10:

Combustion Stroke:

The combustion stroke is the third stroke of the four-cycle diesel engine. During this stroke, the piston is being forced in a downward motion in the cylinder by the rapid expansion of gases created by the ignited fuel. This energy is used to power the engine. This is the only stroke that creates

mechanical energy. The energy produced from the chemical reaction of the oxygen, heat and fuel is transformed into mechanical energy to rotate the crankshaft.

Screen 11:

Exhaust Stroke:

The exhaust stroke is the fourth and final stroke of the four-cycle diesel engine. During this stroke, the piston has changed directions, and again is traveling in an upward motion in the cylinder. The exhaust valves located in the combustion chamber are now open, allowing the piston to push the exhaust gases out of the combustion chamber and into the exhaust manifold. This completes the four strokes of the diesel engine. The crankshaft has rotated two complete turns to complete this cycle.

Screen 15:

Summary:

You have reached the end of this module!

In this module, you learned to:

- Describe how a combustion engine operates.
 - An internal combustion engine utilizes a chemical reaction between fuel, oxygen and heat. This chemical reaction is used to produce captive, controlled, synchronized explosions, which provide the energy to rotate the primary shaft commonly called a crankshaft.
- List the differences between a gasoline engine and a diesel engine.
 - A gasoline engine draws in a mixture of air and fuel into the combustion chamber, whereas a diesel engine initially charges the combustion chamber with just air.
 - In a gasoline engine an electronic ignition source is used for ignition, whereas no electrical ignition source is used to ignite the fuel in a diesel engine.
 - A diesel engine has a much higher compression ratio than a gasoline engine, which provides the high temperature to ignite the fuel.
 - Diesel engines use direct fuel injection while the gasoline engines generally use carburetion or port fuel injection.
- Describe the four strokes of a diesel engine.
 - In the intake stroke, the piston travels in a downward motion in the cylinder, allowing air to enter into the chamber.
 - In the compression stroke, the piston travels in an upward motion in the cylinder, compressing the air that was drawn into the cylinder during the previous stroke.
 - In the combustion stroke, the piston is being forced in a downward motion in the cylinder by the rapid expansion of gases created by the ignited fuel.
 - In the exhaust stroke, the piston travels in an upward motion in the cylinder, pushing the exhaust gases out of the combustion chamber.