How Two-stroke Engines Work

by Marshall Brain

If you have read How Car Engines Work and How Diesel Engines Work, then you are familiar with the two types of engines found in nearly every car and truck on the road today. Both gasoline and diesel automotive engines are classified as **four-stroke reciprocating internal-combustion engines**.

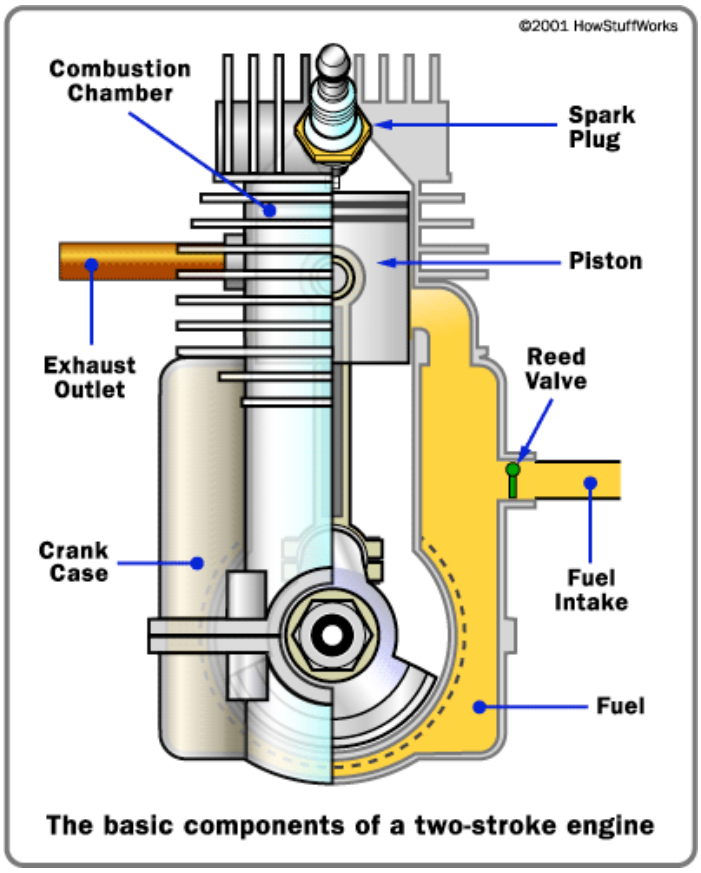
There is a third type of engine, known as a **two-stroke engine**, that is commonly found in lower-power applications. Some of the devices that might have a two-stroke engine include:

- Lawn and garden equipment (chain saws, leaf blowers, trimmers)
- Dirt bikes
- Mopeds
- Jet skis
- Small outboard motors
- Radio-controlled model planes

In this edition of **HowStuffWorks**, you'll learn all about the two-stroke engine: how it works, why it might be used and what makes it different from regular car and diesel engines.

Two-stroke Basics

This is what a two-stroke engine looks like:



The basic components of a two-stroke engine

You find two-stroke engines in such devices as chain saws and jet skis because two-stroke engines have three important advantages over four-stroke engines:

- Two-stroke engines do not have valves, which simplifies their construction and lowers their weight.
- Two-stroke engines fire once every revolution, while four-stroke engines fire once every other revolution. This gives two-stroke engines a significant power boost.
- Two-stroke engines can work in any orientation, which can be important in something like a chainsaw. A standard four-stroke engine may have problems with oil flow unless it is upright, and solving this problem can add complexity to the engine.

These advantages make two-stroke engines lighter, simpler and less expensive to manufacture. Two-stroke engines also have the potential to pack about twice the power into the same space because there are twice as many power strokes per revolution. The combination of light weight and twice the power gives two-stroke engines a great **power-to-weight ratio** compared to many four-stroke engine designs.

Horsepower
For a complete explanation of what horsepower is and what it means to performance, check out How Horsepower Works.

You don't normally see two-stroke engines in cars, however. That's because two-stroke engines have a couple of significant disadvantages that will make more sense once we look at how it operates.

The Two-stroke Cycle

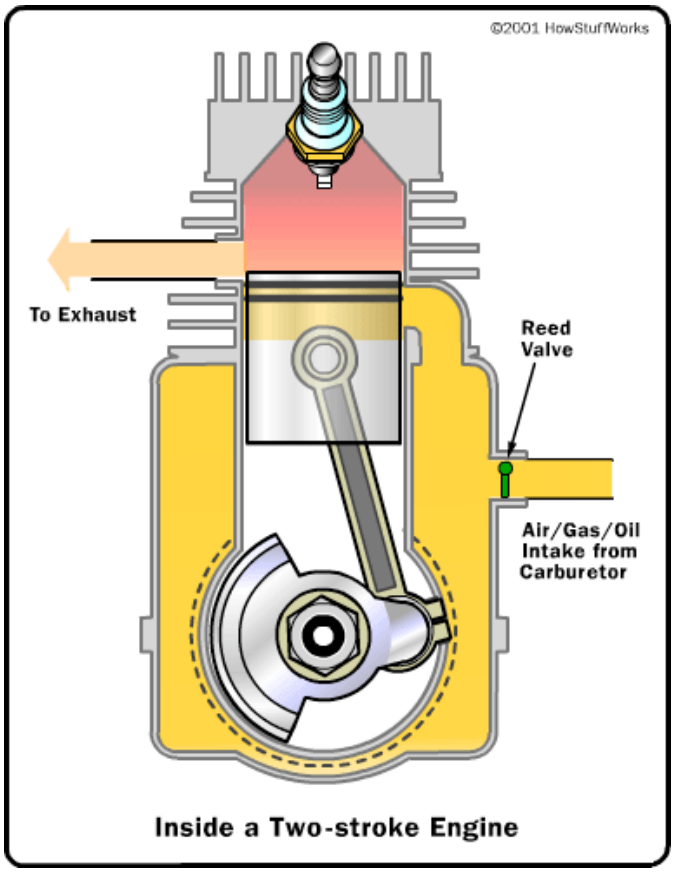
The following animation shows a two-stroke engine in action. You can compare this animation to the animations in the car engine and diesel engine articles to see the differences. The biggest difference to notice when comparing figures is that the **spark-plug fires once every revolution** in a two-stroke engine.

This figure shows a typical **cross flow** design. You can see that two-stroke engines are ingenious little devices that overlap operations in order to reduce the part count.

Sparks Fly

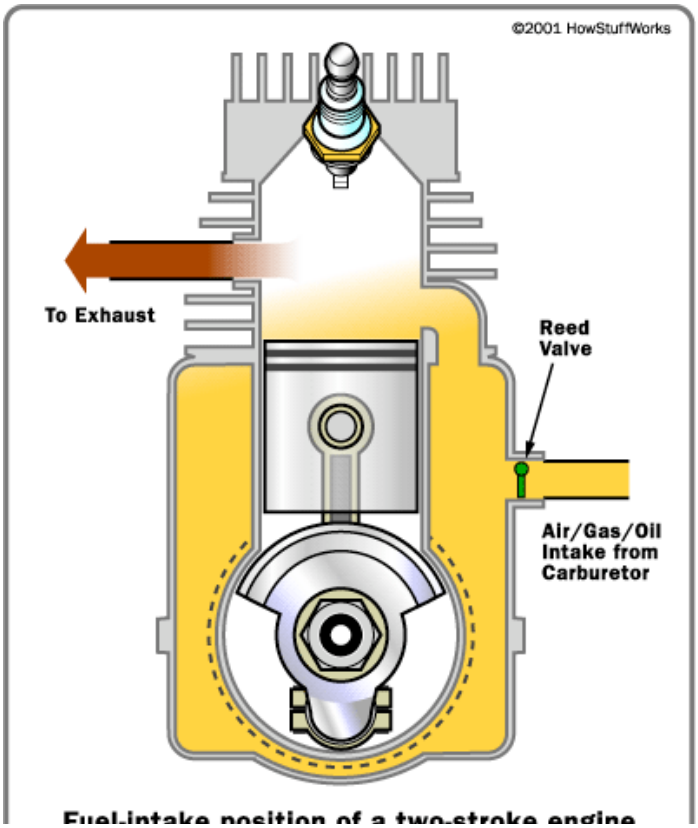
You can understand a two-stroke engine by watching each part of the cycle. Start with the point where the **spark plug** fires. Fuel and air in the cylinder have been compressed, and when the spark plug fires the mixture ignites. The resulting **explosion** drives the **piston** downward. Note that as the piston moves downward, it is compressing the air/fuel mixture in the crankcase. As the piston

approaches the bottom of its stroke, the **exhaust port** is uncovered. The **pressure** in the cylinder drives most of the exhaust gases out of cylinder, as shown here:



Fuel Intake

As the piston finally bottoms out, the **intake port** is uncovered. The piston's movement has **pressurized** the mixture in the crankcase, so it rushes into the cylinder, **displacing** the remaining exhaust gases and filling the cylinder with a fresh charge of fuel, as shown here:



Fuel-intake position of a two-stroke engine

Note that in many two-stroke engines that use a cross-flow design, the piston is shaped so that the incoming fuel mixture doesn't simply flow right over the top of the piston and out the exhaust port.

The Compression Stroke

Now the momentum in the crankshaft starts driving the piston back toward the spark plug for the **compression stroke**. As the air/fuel mixture in the piston is compressed, a **vacuum** is created in the crankcase. This vacuum opens the **reed valve** and sucks air/fuel/oil in from the **carburetor**.

Once the piston makes it to the end of the compression stroke, the spark plug fires again to repeat the cycle. It's called a two-stoke engine because there is a **compression stroke** and then a **combustion stroke**. In a four-stroke engine, there are separate intake, compression, combustion and exhaust strokes.

You can see that the piston is really doing three different things in a two-stroke engine:

- On one side of the piston is the **combustion chamber**, where the piston is compressing the air/fuel mixture and capturing the energy released by the ignition of the fuel.
- On the other side of the piston is the **crankcase**, where the piston is creating a vacuum to suck in air/fuel from the carburetor through the reed valve and then pressurizing the crankcase so that air/fuel is forced into the combustion chamber.
- Meanwhile, the sides of the piston are acting like **valves**, covering and uncovering the intake and exhaust ports drilled into the side of the cylinder wall.

It's really pretty neat to see the piston doing so many different things! That's what makes two-stroke engines so simple and lightweight.

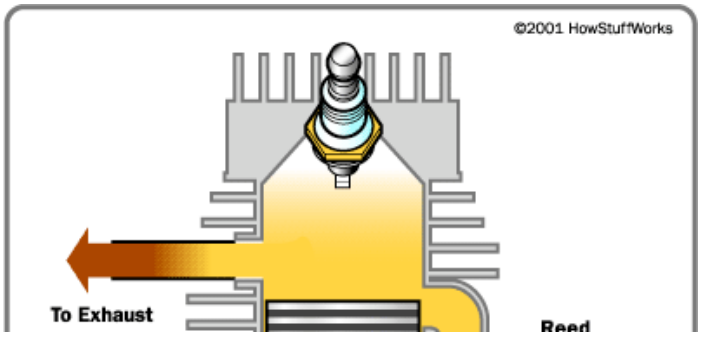
If you have ever used a two-stroke engine, you know that you have to mix special **two-stroke oil** in with the gasoline. Now that you understand the two-stroke cycle you can see why. In a four-stroke engine, the crankcase is completely separate from the combustion chamber, so you can fill the crankcase with heavy oil to lubricate the crankshaft bearings, the bearings on either end of the piston's connecting rod and the cylinder wall. In a two-stroke engine, on the other hand, the crankcase is serving as a **pressurization chamber** to force air/fuel into the cylinder, so it can't hold a thick oil. Instead, you mix oil in with the gas to lubricate the crankshaft, connecting rod and cylinder walls. If you forget to mix in the oil, the engine isn't going to last very long!

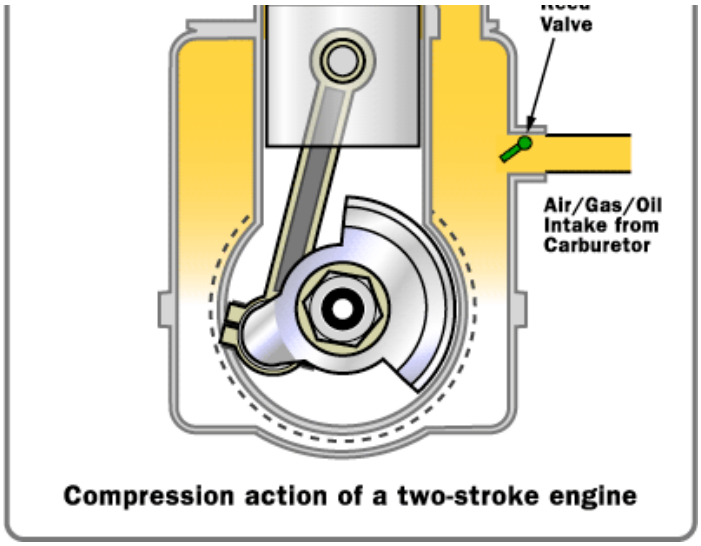
Disadvantages of the Two-stroke

You can now see that two-stroke engines have two important advantages over four-stroke engines: They are simpler and lighter, and they produce about twice as much power. So why do cars and trucks use four-stroke engines? There are four main reasons:

- Two-stroke engines don't last nearly as long as four-stroke engines. The lack of a dedicated lubrication system means that the parts of a two-stroke engine wear a lot faster.
- Two-stroke oil is expensive, and you need about 4 ounces of it per gallon of gas. You would burn about a gallon of oil every 1,000 miles if you used a two-stroke engine in a car.
- Two-stroke engines do not use fuel efficiently, so you would get fewer miles per gallon.
- Two-stroke engines produce a lot of pollution -- so much, in fact, that it is likely that you won't see them around too much longer.

  The **pollution** comes from two sources. The first is the combustion of the oil. The oil makes all two-stroke engines smoky to some extent, and a badly worn two-stroke engine can emit huge clouds of oily smoke. The second reason is less obvious but can be seen in the following figure:





Compression action of a two-stroke engine

Each time a new charge of air/fuel is loaded into the combustion chamber, part of it **leaks out** through the exhaust port. That's why you see a sheen of oil around any two-stroke boat motor. The leaking hydrocarbons from the fresh fuel combined with the leaking oil is a real mess for the environment.

These disadvantages mean that two-stroke engines are used only in applications where the motor is not used very often and a fantastic power-to-weight ratio is important.

In the meantime, manufacturers have been working to shrink and lighten four-stroke engines, and you can see that research coming to market in a variety of new marine and lawn-care products.

For more information on two-stroke engines and related topics, check out the links on the next page.

Lots More Information

Related HowStuffWorks Articles

- How Diesel Two-Stroke Engines Work
- How Car Engines Work
- How Diesel Engines Work
- How Gas Turbine Engines Work
- How Rotary Engines Work
- How Rocket Engines Work
- How Chain Saws Work
- How Gasoline Works
- How Ozone Pollution Works

More Great Links

- Rotax Aircraft Engines
- Honda's Innovative New Mini 4-Stroke Engines
- Ryobi 4-Cycle Trimmer Engine
- Two-stroke model airplane engines
- Bonanza News Service: California two-stroke ban passes test
- Small Engine Research and Design
- Small-Engine Emissions Research

Performance Tuning

- Basic Two-stroke Tuning
- The Tuned Exhaust System
- How Two-Stroke Expansion Chambers Work, and Why You Should Care
- Expansion Chambers: Exhaust Pipe "Theory"
- Two-Stroke Technology