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• LAST UPDATED - Friday, January 05, 2001 •

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Everything you need to know about carburetors

The ultimate carb connection

BY STEVE POND 1 • 2 •

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Learn to tune your nitro engine, and you'll have a tremendous advantage over your competition. Tuning is one of the extra dimensions of running a nitro vehicle. This "learning" can, however, be frustrating to nitro newcomers.

The carburetor is the heart of the engine. The engine's other parts don't require adjustment, and unless they fail completely, they will function well without your attention. Having a correctly adjusted (tuned) carb is, however, essential to proper engine operation, and to ensure this, you have to understand the carburetor's function.

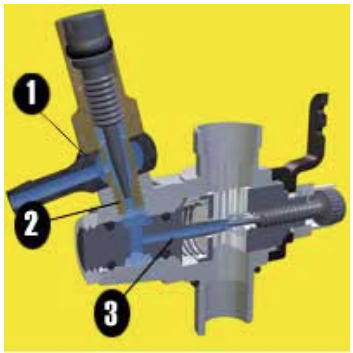
WHAT DOES THE CARBURETOR DO?

The carburetor simply regulates the flow of air and fuel (air/fuel mixture) through the engine in a way that optimizes performance throughout the engine's rpm and load range.

• **Airflow** is regulated by the throttle's position. Whenever you move the trigger on the transmitter, you're manipulating how much air is being allowed into the engine.

• **Fuel flow**, on the other hand, is regulated by as many as three "needles." These needles are really screws; each has a tapered tip that extends into a hole (seat) in the path of the fuel flow. Fuel flows around the needles, through the seats and into the engine. If a needle is screwed inward, it blocks more of the seat and reduces fuel flow. Conversely, when it is screwed outward, more of the seat is "open" and the fuel flow is therefore greater.

MIXTURE-NEEDLE BASICS



All RC engines have at least a main, or high-speed, mixture needle; some also have a low-speed needle; and a select few have both, plus a third, mid-range, needle. A needle is a type of valve; in motocross speak, it's often referred to as a "needle and seat assembly." The needle passes through the center of the "seat," and because its tip is tapered, the fuel flow is regulated according to its position in the seat. As the needle is screwed farther into the seat, it reduces fuel flow through its opening.

WHY WE NEED CARBS

To run properly, all engines require the proper mixture (ratio) of air and fuel. The carburetor must be adjusted to deliver the correct amount of fuel for the amount of air entering the engine.

So why must mixture settings be adjustable? After all, once the needle(s) have been set to deliver the ideal mixture, why should you need to mess with them ever again? The ambient temperature, humidity, altitude and even the barometric pressure alter how much air (specifically oxygen) goes into the engine, and the mixture must be adjusted to compensate for changing conditions; for example, those with keen eyes will pick up on the mini weather centers in the pits at motor sports events. These engine tuners closely monitor all the factors mentioned, and they adjust the air/fuel mixture to suit prevailing weather conditions.

CLICK IMAGE TO ENLARGE

Fuel enters the carburetor through the banjo fitting (1); it then travels into and through the main needle assembly (2) and eventually exits into the venturi via the fuel inlet (3). The low-speed needle as shown here isn't a factor at full throttle.

This holds true for all engines—RC and full-scale—though in my opinion, engines that run on alcohol-based fuel such as those used in RC engines are the most affected. That's why questions such as, "Where should I set the mixture needles on my XYZ engine?" are so tough to answer. Some manufacturers suggest needle settings, but the ideal settings for a particular day may be as much as a full turn of the mixture needles in either direction. Your fine-tuning will be based on the conditions under which you run. Simply knowing that you'll have to make adjustments to maximize performance to compensate for changes in the weather puts you a step ahead of the game.

THE MIXTURE NEEDLES

The high-speed needle is inside the housing where the fuel inlet (banjo fitting) is. It regulates how much fuel is allowed into the engine when running at any speed, although it mostly affects fuel mixture in the medium to high rpm range. Its setting has the greatest effect on overall engine performance.

The low-speed, or idle mixture, screw on carbs so equipped further regulates how much fuel comes from the main needle. Even engines that don't have an adjustable low-speed needle usually have one that's fixed in place. Without the low-speed needle, the fuel flow allowed to pass through the main needle would be too much for the engine to burn at idle and low speeds, and this would soon cause the engine to flood and stall. The low-speed needle is usually inside the throttle barrel or slide, and this makes it effective only when the carb is at partial throttle or idle. As the throttle is moved toward fully open, the low-speed needle retracts entirely from its seat and allows full fuel flow from the main needle.

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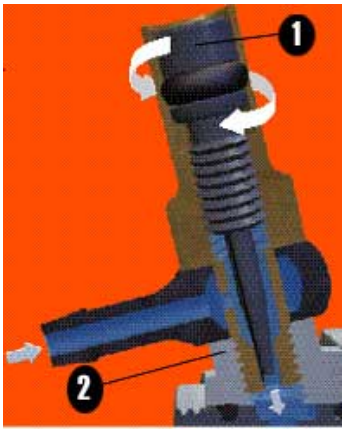

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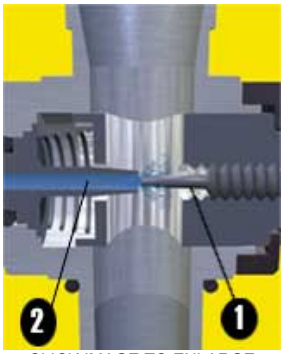
Left: when the main needle (1) is adjusted counterclockwise, it is retracted from the seat (2) near its tip; this increases the fuel flow and gives a richer air/fuel mixture.
Right: adjusting the main needle (1) clockwise threads its tapered tip farther into the seat (2); this restricts fuel flow to lean the air/fuel mixture.

The low-speed needle is primarily responsible for the engine's idling quality and its off-idle performance. If the low-speed setting is too rich (too much fuel in the air/fuel mixture), the engine will "load up"—the crankcase will start to fill with fuel—and this will at least compromise idle quality. At worst, an overly rich low-speed setting will allow far too much fuel into the engine; the cylinder will be flooded as soon as throttle is applied, and this will douse the glow-plug element, and the engine will stall. Even richer settings will stall the engine almost immediately. A lean setting here is equally disruptive: it makes it hard for the engine to idle down and causes the bogging that cripples acceleration.

Engines that are designed to be user-friendly typically have carbs with a fixed low-speed needle. There aren't any inherent design differences that allow this type of carb to run any better under identical conditions; it's simply a way for engine manufacturers to simplify engine tuning for their customers. A fixed low-speed needle limits adjustment choices to the high-speed needle only. This does simplify engine tuning, but it also hampers performance in all but the conditions for which the fixed needle has been set; the carb setting will be ideal only for a limited range of conditions. If the weather, etc., is outside this range, the engine will run too rich or too lean at low speeds and at idle.



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The low-speed needle (1) simply regulates how much fuel flows from the inlet (2) at lower engine speeds. At full throttle, however, the low-speed needle is fully retracted from the inlet to allow maximum flow.

THE THIRD NEEDLE

The third "needle" isn't actually a needle at all; it's an adjustable seat. These third adjustments are found exclusively on slide carbs because their design allows them (I'll get to the variety of carb designs later). In most slide carbs, the low-speed needle is in the center of the slide valve. The seat for the low-speed needle is fixed in the body of the carb, opposite the slide valve. As a slide carb opens, the vacuum helps to draw fuel into the engine. Once the airflow has a direct path over the fuel inlet, fuel draw is increased slightly. By adjusting the low-speed needle and the third "needle" at the same time, you can adjust the throttle position at which the fuel inlet is fully exposed to the air flowing through the carb. For example, if the inlet is fully exposed at 1/4 throttle, an extra dose of fuel can be expected at that point. If, however, the low-speed needle and the seat are adjusted in the same direction—farther into the carb's venturi—the inlet may not be fully exposed until 1/3 throttle is reached. This is why the third needle is often referred to as the mid-range needle. Its use will marginally alter the rate of fuel flow in the mid-throttle range—an extra tuning option for the accomplished tuner.

It's often recommended that the third needle be left alone by all except very experienced engine tuners. More harm than good can potentially result from trying to use this adjustment without knowing the consequences. You'll never get the experience without trying, however, so use your best judgment. Even if you opt not to use the third needle as a tuning tool, a three-needle design offers a secondary benefit: another way to adjust the low-speed mixture. The conventional way to adjust it is to adjust the needle, but simply by adjusting the seat or the third needle without adjusting the low-speed needle an equivalent amount, you accomplish the same thing. This is helpful in applications in which the low-speed needle isn't very accessible because it's blocked by some hardware on the chassis.

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