

Why Carburetors Will Be Around Forever

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Harley-Davidson has not fitted a carburetor to any of its motorcycles for almost two years. They will not mount another, nor should they. The contemporary electronic fuel-injection (EFI) system is better than carburetors can ever be, because EFI is or can be more accurate, more reliable and more versatile, and it can more easily meet the stringent EPA standards. Anyone who has ridden a 2007 or later stock EFI Harley has experienced the improvement EFI represents.

However, the overwhelming majority of Harleys on the road today are carbureted. This will remain true for many years hence. And carburetors, when accurately tuned, work very well indeed.

The problem is that very few are accurately tuned. Even completely stock Harleys have poorly tuned carburetors. They are legally but not accurately adjusted. In addition, any modification that affects engine airflow, such as non-stock air cleaners, mufflers or cams, further skews the carburetor adjustments.

Most Harley riders have little need to replace the stock Keihin carburetor. That is, if they can find the correct parts to get it tuned for their engine package and if they can find someone who actually knows what those parts ought to be, how to get them and what to do with them. The parts selection is very limited and few Harley mechanics know how to use them correctly anyways.

While the scarcity of alternate parts for the stock Keihin carburetor severely limits its versatility, it is possible to modify the Keihin so that it works well on relatively stock Harleys. I have done so and have written about how to do so. Still, this otherwise excellent carburetor is limited by a lack of tuning information and parts.

Many who are seeking increased power or who cannot get acceptable results replace the stock Keihin with one of several aftermarket alternatives. Many of the aftermarket carburetors flow more air and can support more powerful engines. However, they are often limited in their versatility and responsiveness. All those I have tested, used, and tuned cannot match the stock carburetor in one or more important ways. Those shortcomings include, but are not limited to, variations in mixture accuracy, sensitivity to altitude

changes, and poor throttle response. The one exception is the Mikuni HSR series carburetors.

The Mikuni HSR carburetor design is the best I know for installation on Harley engines. The three sizes that are available make it versatile enough to feed Harleys from Ironhead Sportsters to 140-cubic-inch monster motors. These are the most responsive carburetors I have ever used spanning many brands and several decades.

The Mikuni can be tuned with great precision throughout its throttle range. Because of this tuning precision the HSR can deliver excellent fuel mileage while remaining responsive to throttle input. The largest can flow enough air to support nearly 200 horsepower. The smallest is not too big for 883 Sportsters.

The HSR is available in three throat sizes: 42mm, 45mm and 48mm named HSR42, HSR45 and HSR48 respectively. Mikuni produces various installation kits featuring the three sizes. They have promoted the HSR42 kits more than the larger ones and consider it to be their standard carburetor. The HSR45 is a better choice for those seeking maximum power at high rpm. The HSR48 offers little more than the 45 even on large racing engines.



Both the Mikuni HSR42 and HSR45 carburetors have their advantages. The 42 (top) is easier to install while the 45 can deliver more peak

Many otherwise capable mechanics know little about tuning carburetors. It is an arcane discipline, partially art and the rest knowledge of when and which part does what. When I taught mechanics, it was the most difficult and time-consuming subject my students needed to learn. Many never did, and shame on me for that.

What any carburetor tuner needs are proper information, and the skill to properly use it. He needs to know how the particular carburetor actually works—which adjustments and parts affect idle, transition from idle, midrange throttle settings, and full throttle. Further, he needs to develop the ability to interpret the effectiveness of his modifications (this is the touchy-feely art part). This information and skill are almost more important than the quality of the carburetor.

Any carburetor tuning requires detailed knowledge if one is going to do more than make idle adjustments or select a main jet. Part of the value of the HSR is that Mikuni supplies that knowledge on their website, over the telephone, or through their HSR Tuning Manual.

As delivered, HSRs are reasonably well tuned for most stock or near-stock engines. Very few installations require more than an idle-mixture adjustment and the occasional main jet change. Mikuni includes a couple of main jets, bracketing the one installed.

Each Mikuni carburetor is shipped with the HSR Tuning Manual, which I wrote for them. Unfortunately, few manuals get into the hands of bike owners simply because the installer fails to give it to them. Mikuni can supply the printed manual if you contact them or you can download it from their website (www.mikuni.com).

The manual explains in detail how the carburetor works, which parts do what, how to adjust or change them and how to diagnose when you need to change something. It also includes an expanded view with a complete list of part numbers. Almost any Harley or aftermarket shop can get any of these parts from several distributors.

I have spoken with a large number of mechanics and Harley owners who have used the Mikuni manual to correctly adjust and tune the HSR. Chances are if you can do normal maintenance on your Harley, you can tune the HSR using the manual.

Carburetors work by creating a partial vacuum in the throat (venturi or choke) of the carb body. The difference in air pressure between the throat and the outside air causes fuel to flow into the carburetor through any orifice it can find. Tuning a carburetor consists of controlling the size of those orifices so that the resulting air/fuel mixtures are correct.

The Mikuni HSR is an Amal-pattern carburetor, as is the stock Keihin. Amal-pattern carburetors have three basic air/fuel control elements: idle, main (mid-throttle) and the main jet. The HSR also has an adjustable accelerator pump, which I consider an important fourth tuning element. All tuning elements are supplied with fuel by the float bowl at the bottom of the carburetor.

The idle system is a separate carburetor built into the main body. There are appropriate connecting passages, a replaceable jet, and an adjustment screw. The screw controls the air/fuel mixture at dead idle. The jet controls mixture as the throttle begins to open. By about 10 percent throttle, the idle system is delivering all the fuel it can. It continues to provide this fuel all the way to full throttle.

The main system operates as the throttle slide is raised above about 5 percent, and it begins to deliver fuel and assumes control of the mixture. Yes, there is an overlap between the idle and main systems. However, it is not difficult to get this overlap area right if one follows the manual's advice.

The main system consists of the throttle slide, a tapered needle (jet needle), and a needle jet. The needle is mounted in the center of the slide. The needle jet is mounted in the carb body. As the throttle slide rises and falls, the needle moves in the needle jet. The needle is tapered. The relative sizes of the needle and jet determine how much fuel is forced into the carburetor throat at any particular throttle setting. More fuel flows as the slide rises, due to the needle's taper.

The main jet is mounted to the bottom of the needle jet and limits maximum fuel flow. It assumes control at about 75 percent of the throttle opening and has no effect until then.

The accelerator pump's purpose is to supply a squirt of fuel when the throttle is suddenly opened and there is too little vacuum for the main system to work properly. It has a replaceable nozzle and can be adjusted for starting and ending points.

Advanced tuning is a bit involved as it is for any carburetor. The individual steps are simple and clear. The great advantage of Amal slide-type carburetors such as the Amals, Bings, Dell'Ortos, Mikunis, and others is that their entire operating range can be adjusted in the field. We have a four-step tuning procedure for these carburetors that has served well for more than 80 years.

First Step

Adjust the idle system. Set the adjustment screw for best idle. Fit the idle jet that gives the smoothest response as the throttle is slightly and slowly opened.

Second Step

Adjust the main system. Accelerate with the throttle between 10-to-25 percent open. If the engine responds cleanly and briskly, the needle diameter is correct or nearly so. If the engine seems lean, a smaller-diameter needle is needed. Too rich needs a larger needle. In practice, needle changes are seldom required.

Third Step

Accelerate in the 25-to-75-percent throttle range. The needle taper controls the mixture strength in this range. There are five needle-height adjustments. If the mixture seems rich, lower the needle; if lean, raise it.

Fourth Step

Accelerate at full throttle. The main jet that makes the most power is the one to use. A dynamometer is not needed for this test. Accelerate between two points on the roadway. The highest speed at the second point defines the correct main jet.

Accelerator Pump

As I said, the accelerator pump adds fuel when the throttle is first opened. This is to both richen the mixture for maximum throttle response and to compensate for low vacuum over the needle jet. The HSR pump has three adjustments: starting point, end point, and nozzle size. Nozzle size determines the fuel delivery rate and how long the squirt lasts.

The stock settings start the pump at about 1/8th throttle and end its stroke at around 1/2 throttle. The jet is a number 80 (0.80mm in diameter). I use and recommend different settings, which I'll detail later.

This simple set of procedures works well and can remove most of the mystery from carburetor tuning.

Does Size Matter?

Yes and no. Those people who have worked with true Amal-pattern carburetors, which have round slides, know that the larger carburetors help make more high-rpm power by flowing more air. However, that greater power potential is accompanied by a loss of low-rpm throttle response.

The more recent flat-slide variations, such as the Mikuni HSR, greatly reduce this power/response trade-off. It is now possible to fit a "top end" carburetor and still get good throttle response in the lower rpm and throttle range.



A 42mm HSR42 adds about 3 horsepower to the output of a stock Twin Cam or EVO engine. The 45 adds 7 horsepower with no loss of part-throttle response, fuel mileage or tuning sensitivity.

The performance advantage of the 45mm carb means very little to most of us. Its power advantage only begins to show at well above 5,000 rpm. The HSR42 is easier to mount as it uses the stock manifold while the HSR45 needs the larger Harley Screamin' Eagle or Mikuni manifold. It's your choice. If you are chasing maximum power with cams, porting, etc., then your choice is obvious. Otherwise it makes no difference which one you choose.

The HSR48? Don't bother. Our testing shows that the HSR48 only adds 2 or 3 top-end horsepower to an already powerful (120-plus horsepower) engines.

My Tuning Recommendations:

Mikuni's default jetting and adjustments cover most engine setups, as they should. Tens of thousands have been sold with very few complaints about how well they work. However, the stock settings are fail-safes and are on the fuel-rich side of ideal. I have no complaint about the stock tuning, except for the accelerator-pump settings, which I am convinced are just plain wrong.

I have developed a set of jets and adjustments for the HSR42 and 45 that work better on most properly tuned engines. By properly tuned I mean that the engine is sound, there are no long straight pipes, drag-race cams, or stylish air cleaners that don't flow much air. Many hundreds of Harley owners have adopted my recommendations and have gotten excellent results. They report that throttle response is improved, fuel mileage is better, and their engines sound and seem "happier." The changes I recommend include accelerator nozzle size and adjustments, idle jet size, and needle size.

Here is what I change and do:

Parts:

- 17.5 idle jet, leaner than the stock 25 or 20.
- 98 needle, leaner than the stock 97.
- 50 accelerator pump nozzle, smaller than stock 80.
- The main jet is whatever it needs to be. The stock jet is generally correct.

These parts are available individually or in kit form from Fox Distributing in St. Charles, Illinois, 630-513-9700. The kit is called the Mikuni Mileage Kit and there are separate kits for the HSR42 and 45 carburetors because the needles are different. The kits come with simple installation and tuning instructions.

Adjustments (See The Manual For Details):

- Adjust the accelerator starting point so that the pump starts working immediately. Adjust the end point for maximum travel.
- Fit the smaller idle jet and adjust the mixture screw for best idle.
- Fit the leaner needle with the clip in the middle notch.



Consequences:

- Performance just off-idle is cleaner and more immediate. This is because the idle jet is more correct and the pump delivers fuel sooner but at a lower rate than stock.
- The engine is more responsive, cleaner and "happier" sounding because of the leaner mixtures in the 10-to-25-percent throttle range, where we do most of our riding.
- Fuel mileage increases, sometimes dramatically. Don't be surprised if you record 48-to-49 mpg at 65 mph. Even baggers do better.
- Midrange throttle response is greatly improved and the engine is much more pleasant to use. Expect bugs in your teeth.

Howevers:

- Engines with high cranking pressures (high compression) may detonate at low rpm when accelerating. The original 97 needle should fix this.
- Nothing, not this kit, not this carburetor, nor any carburetor, is going to make an engine suffering with open straight pipes run well.
- Big cams, those with intake-closing angles of close to 50 degrees ATDC, aren't going to run well below 4,000 rpm. No Mikuni or any other carburetor can fix this. Either race the thing or install a more appropriate cam for street use.

Finally

If you do not feel comfortable installing and tuning a carburetor, find someone who can. This may be more difficult than doing it yourself. All too many mechanics think they know more than they actually do about carburetion. If you can find someone with an open mind and can get him to read the Mikuni manual and this article, have him do the work. If your regular mechanic is someone who thinks, "he knows better," find another guy or do it yourself.

There are hundreds of thousands of carbureted Harley-Davidson engines powering their riders for millions of miles over America's roadways. They are going to do this for decades to come. It is good that this fine carburetor is available to make those rides more pleasant.