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# EVO: Carburetor, Intake Manifold & Exhaust - Sub-02A

## Carb tuning by Lee C. Bussy - 2006

Reprint by sportsterdoc of the XLFORUM® <sup>1)</sup>

- This was in the technical section of Sportster.org, along with info from Maurice Riggins. Lee bought his first Sportster the same year as I and we had many exchanges on Sportster.org. Although I do not share the level of his reliance on dyno tuning for street use, Lee was meticulous in his research and application. "Art" and "Dale" are Land Speed Record holders for a normally aspirated Sportster. "Some folks using a 48" is me. That was done before sufficient knowledge was gained on needles, but worked well on a California bike, up to about 5,000'. By the time I got my second Sportster, I used a 45 with an N65C needle. At that time, Lee was not aware of the differences in California bikes.
- How to (properly) Re-Jet a Carburetor, contributed by Lee C. Bussy (2006)  
For many years, the "common wisdom" of going up one to two jet sizes when adding pipes and an intake on the Sportster has been gospel. In order to eliminate carb farts, people recommend going up a size on the low-speed jets. When I bought my first Sportster back in '03 I dutifully followed the advice and was rewarded with fair results.
- When shortly thereafter I began my quest for more power, I began to apply a more critical set of criteria and examination to this methodology. I had some lengthy discussions with Art Northrup and Dale Amsden about a starting point for tuning my new 1200 conversion, and that's when it hit me: these things are no different than any other internal combustion engine. There's no secret to it, you add gas and air in the correct proportions and they reward you by making noise. Once I began to apply what I already knew from tuning cars and import bikes, the rest was easy. I'll share what I learned, all in one place, so that in the future I don't have to type this in bits and pieces as folks ask questions.
- Disclaimer: This works for me. If you did it differently, you probably will feel the need to argue with me. I don't care, I know this works.
- Greatly simplified for discussion purposes, there are three ways that the Keihin Constant Velocity 40mm (CV) carburetor meters fuel for us under normal, fully warmed up riding conditions. These are the idle circuit, the midrange metering, and the main circuit. Each of these must be tuned correctly, and in some cases they "overlap" so they must be tuned in the proper order. I will explain the tuning of each circuit and when this must be done.
- First up: the idle circuit. This is the one that 95% of the folks I see posting, and talk to in person, don't do right. It's also the one that stands to have the greatest impact on their riding satisfaction. Most people here would be completely happy with the results obtained by just doing this adjustment. One of the biggest complaints about a carbureted Sportster is the "carb farts" or the

big stumble that happens right off idle as you start out. There are two areas that can impact this and the idle is one of them. Many dealers, many "experts" recommend going from the stock 42 to a 45 low speed jet. I've even heard of some folks using a 48. This is way wrong in most cases. Yes it works but it's a crutch and is simply not optimal.

- "Common wisdom" states that you adjust the idle mixture with the screw: if you cannot make the engine stumble by enriching the mixture then you need a larger jet. This is only partially true. While it's true that a larger jet will raise the band in which the idle may be adjusted, and it's true that you should split the difference on the idle screw adjustment between lean stumble and rich stumble, most folks set themselves up for a "false failure". What happens is the idle speed screw is set for a proper idle speed (900-1000 RPM) and this means the butterfly is open slightly. A view inside the intake port side of the carburetor will reveal the idle transfer ports. When the second set is exposed to the intake pulses/vacuum, the idle circuit does not pull as effectively. This is by design, it is supposed to stop adding fuel as the other systems take over.
- The solution? When one begins the tuning process, he or she should make sure the bike is warmed up fully. Then the idle mixture screw (IMS) should be adjusted to a good starting point - generally 2.5 turns out from lightly seated is a good place to start. At this point the idle speed should be adjusted as low as possible while still keeping the engine running. No it will not remain here, so we need not be concerned about oil pressure. Ideally the idle speed screw will be backed off fully, allowing the butterfly to close fully.
- At this point the IMS should be adjusted. It's not necessary to adjust one way or the other till the engine stumbles, only until the idle speed drops noticeably. Move the other direction until the idle speed drops, and then set the screw to the midpoint between those two settings. Raise the idle back to the proper level and your idle mixture is set properly.
- Notice I said nothing about replacing a jet. The stock 42 should be plenty to provide the gas an 883 or 1200 needs. At this point, many folks will have a bike that runs well and they will not want to mess with it any further. I say enjoy. If you are still experiencing carb farts, read on.
- I'll call this step "Alternate 2A": The Needle. The reason I say "alternate" is this is one path you may choose. If you are not going to be adjusting the white open throttle (WOT) mixture (and most people really don't need to) then this is the next place to go. The needle, it really looks more like a nail, is what slides in and out of the needle jet, providing more or less gas as the engine load and speed increases. The needle is tapered and this controls how much surface area of the main jet is exposed for a given position. The needle is part of the slide mechanism and protrudes from the bottom of the slide. It is visible by peering onto the carb throat, it runs right through the middle.
- As the velocity of air flowing through the carb increases due to engine speed, it creates a low-pressure area under the slide (Bernoulli's principle). This causes the slide to rise up, lifting the needle with it. The CV carb attempts to keep the same velocity going through the carb in this manner, hence the name. In this manner the carb uses the needle and the main jet to control the mixture at anything less than top RPM WOT conditions.
- When we get "carb farts" the bike is going extremely lean and the engine misfires. The reason is the butterfly has opened and the velocity, despite the best efforts of the carburetor, has not caught up with the engine and not enough gas is metered. The accelerator pump handles some of this, and some more advanced tuners do tinker with this area, but there is an easier way for us. In 1988 the CV was introduced on the Sportster and this first version had no accelerator pump. To combat the flat spot off idle with no accelerator pump, a needle was used that considerably richens the mixture at this point: its designation is N65C.
- We can use the N65C needle, or its close cousins the NOKK or NOKV, to richen the mixture slightly at this point without resorting to larger jet sizes that will likely cause the bike to run too rich everywhere else. A combination of the idle mixture and the needle change has "cured" 90% of the

bikes I've worked on. Some folks will tell you that opening the top of the carb is somehow more likely to create issues for you. Well I suppose if you are a hammer and pry bar type this may be the case. I'm going to assume for the sake of this post that you are capable of a reasonable amount of care. If, as happens in some instances, the needle change is not enough to fully cure the stumbles, the next step would be to shim the needle. Simply place a couple of small brass washers, commonly available in a hardware store, under the head of the needle to raise it slightly. For the more anal types, these are approximately 0.020" thick; I shoot for 0.040" of shim for a start.

- It is my earnest belief that coming this far is all most people need to do. If you have a big-inch motor, or have a highly modified set of heads or radical cams, the next step may be needed.
- The Main Jets: This is step "Alternate 2B". If you do this, this comes first before doing the needle. The reason is the main needs to be sized for peak HP at the maximum RPM the engine will run. You would use either plug chops or some sort of air fuel ratio (AFR) measuring device to set the main jet. The carb is running fully on the main jet ONLY at max airflow through the engine so for the first time through you ignore the AFR at anything but the area near redline.
- Once you get the correctly sized main jet, and assuming you first did the idle mixture properly, you then go back to the needle and make the cruise and lower RPM ranges operate at the correct AFR. This is really where the voodoo comes in - there's no reference for carb tuners for the CV's needles. Keihin says it's up to H-D and H-D provides nothing. The good news is the N65C or NOKK, with or without shims, seems to be an excellent all around needle for cruising and for performance.
- It's important to remember when looking at a dyno AFR chart that it shows only WOT if that's what you asked for. If you want to see what you are cruising at, ask the dyno operator to check at 70 MPH and 30% load to see where things are. Unless you are a drag racer, this is where you will spend most of your time. How do you interpret those graphs? There's some experience that comes in here of course. In general, the main jet will move the entire line up or down and the needle will affect the shape of the curve. If you need to "lift up" the left (low RPM) side of the curve then you would shim the needle. Here we can also get into spring rates and the size of the metering orifice on the slide.
- This is all pretty advanced stuff and if you get here, I hope you don't rely on printing this and reading it in the garage. You need the assistance of an experienced tuner and this is not really something you can learn reading email on the Internet. Get someone to take you under their wing. Research the subject, read everything you can about theory, because not only will you be messing with the carb at this point, but the exhaust, advance curve and timing as well. If you do end up asking here or elsewhere for help, having a dyno chart that shows the AFR will be a vital part of someone being able to help you.
- I hope this has helped or will help some of you either now or in the future. I have purposefully not gone into how to do the work, I assume that you know how to do it or have one of the other excellent resources available. Good luck, and remember: it's not rocket science.

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