



Tuning SU Carbs

Addendum Morgan Driver's Bedside Reader 2/3/98

"I wish I didn't know now what I didn't know then." Bob Seeger

'Tuning vs Setting SU Carburetors' By: Fred Sisson

(Edited for the Morgan Web page by John T. Blair Webmaster – SOL's Morgan Web page)

Most of us are totally naive when it comes to really "tuning" SU carbs and their potential. In truth, what we all call "tuning" is really not much more than setting the idle mixture. And it usually works... OK...

However, there is probably a 95% chance that you don't have the best choice of needles in your carburetors for optimum performance throughout the entire RPM/load range! That's heavy odds.

-When you "tune" SUs according to the book- ALL you are doing is synching the air density between the two carburetors and then setting the idle mixture. Someone set a needle specification from the factory (maybe years ago.) and chances are that you can get the car to run fine with that needle. But let's get beyond that. How do you know that it runs fine. How do you know that there is not more potential horsepower. How do you know that it is not lean (or rich) on hard acceleration. Are you absolutely sure that it is not rich only at mid-range cruising (washing of the rings and causing excessive wear)?

If you have any miles/age on your engine, different air cleaners, maybe a set of headers or a different muffler, smaller/larger tyres, different compression ratio, etc... you are a definite candidate for a needle change. But, which needle?

I saw a couple of guys with an old GP car swapping SU needles at a vintage race. Hoping to learn more about the "art" of needle swapping and tuning SUs, I asked them what logic they used to determine which needle to use. "Oh, we just had some extra needles and thought we'd see if any of them will make it run any better".

I must admit- that for over forty years, my approach was the same.

PICK A NUMBER BETWEEN ONE AND THREE HUNDRED...

Did you know that there are 354 needles listed for (the most common) .090 jet SU! To further compound the problem of choice – your particular car will probably run lousy on 40% of them, OK on 30%, feel great on 20%, run really great on 5% and really kick butt on 5%. No wonder so few people change needles. Where do you start?

Other's recommendations, even "factory" recommendations are probably off somewhere in your driving range... maybe WAY off! Just remember "different is not the same". Different car (and EVERY one is different) – different requirements- different needles...

We all know that the big-bucks racers have their engines checked on a dynamometer, simulating race conditions, with lots of very expensive instrumentation. This is a bit beyond my modest means and... expertise.

Still – there is a way to improve your engine's performance that is not too costly and is very rewarding. Read on....

ARE YOUR NEEDLES CORRECT FOR YOUR ENGINE?

This is not about "thinking"- this is about "knowing". How do you know?

As far as I am concerned, the ONLY way to tune SU carburetors is with an on-board exhaust analyzer (\$100 bucks). This way, you can check your car while you are driving it, on your roads (or track). Anything else is groping in the dark.

Many companies make exhaust analyzers today. They run somewhere around \$100.00. They use an O2 sensor that fits into your exhaust system and are described in the book. Racer Wholesale (listed in "Source" section or the Bedside Reader) now offers an analyzer that will read two sensors. This is the hot setup for twin carbs as you can exactly balance the carbs.

The analyzer itself is a 'bitty thing. Mine is about 1 1/2"X2". It has a series of LEDs that instantly read the fuel/air ratio – as you drive! Real world stuff here.....

I doubt that any standard carburetor will give the absolute perfect ratio at all times. However, you can get darn close and the reward for your time and effort might just be a very dramatic improvement in performance. At the very least, you will have peace-of-mind, knowing that your engine is not being hurt from the effects of a drastically rich or lean mixture

Many of the hot sports racers have the analyzer permanently mounted in their car. They "tune for the course". Exhaust analyzers are available as in-dash instruments also. I personally use the analyzer with the temporary mount as the in-dash units are a bit out of place in a vintage car.

There is also a choice of O2 sensors. I have been using the cheap kind which runs around \$30.00. The 70 buck O2 sensor is better as it is electrically heated and comes to the initial readings quicker, but the cheapy works fine once it gets hot. I tape the gage to the windscreen with "racer tape" so that I can see it at all times while driving/testing. It reacts instantly so you can even use it to set the powervalve for a Holley carb. Pretty neat. When I am done – remove the gage and O2 sensor. There is a blank plug that screws into the sensor hole.

HOW ABOUT READING SPARKPLUGS?

I always tried to "read" my sparkplugs to determine the mixture. This is a dark art that is way beyond me. Doing "plug cuts" may work (for someone) but in the real world – they are time consuming, tricky to do right, and even then I never could get much out of them. My friend Tucker Madawick (Autosport- Bloomington Indiana) is one of the best mechanics/tuners around and he told me a few years ago that unleaded gas reads "different". GREAT! Now what?

Is the plug hot or carb lean? Is the plug cold or carb rich? Being neither "rich" nor "lean"... I certainly was flailing on plugs too... which compounded the mixture setting procedure. So – I set the idle & lived with it.

Was I selecting the plug according to mixture – whatever that was? I guess really, I was just messing around 'till it ran OK – and I called that "tuning.."

However – once you KNOW that your mixture is right with the analyzer – it doesn't take a NASCAR mechanic to recognize if the plugs are running hot or cold. More peace-of-mind.

FINDING THE NEEDLE IN THE HAYSTACK

SU needles taper and the taper is very specific. All 354 needles for the .090 jet are different, according to their taper.

SU needles each have a number/letter designation which is of little value unless you know just how the needle taper is contoured. There are really very few needle designations among the 300+ that are "progressive" in any way. You gotta consult the chart & compare numbers. The full SU needle chart shows the diameter of all the 354 needles at 1/8" intervals. Guaranteed to make you blind..

Each 1/8" increment is called a "station", starting with #1 (thickest diameter) and progressing on down the needle. Stations 1-2 are basically idle and are the same for most of the needles. As you progress up the stations (down the needle), you are affecting off-idle, low mid-range, high mid-range & W.O.T. (wide open throttle)

Smaller diameter is richer and there are at least 12 stations per needle! There is a lot of tuning potential there.

My car ran GREAT. No problems – drove it daily & I was completely satisfied that it was spot on. Then one day I checked the mixture with the K&N analyzer and found that it was off-the-meter lean when accelerating! I never would have guessed....

NO "adjustment" will cure that. If I richen up the carb (drop the jet a few flats) – I could get more acceleration – noticeable by the seat-of-the pants too!! However – now idle and mid-range would be very rich. A different needle was needed.

What needle to use?

Time to look at the needle chart for another needle that is the same diameter up to say, station 6 or 7 – and then progresses to a smaller diameter. This should affect only hard acceleration. Then you gotta try it in the car and check it with the analyzer. It is amazing just how much difference you can affect in your engine's performance by getting the mixture right.

Example- here's how the needles are listed. The numbers are the diameter of the needle at 1/8" increments .890 is station 1...

AH 890 862 830 803 775 756 733 711 690 670 650 630 610

AH1 890 860 820 790 765 750 730 710 690 670 650 630 610

(AHI is slightly richer in mid-range)

AAM 890 850 824 785 752 715 673 630 590 567 543 519 496

(compared to AH – would be much richer- off idle on...)

AI 890 850 817 798 780 765 750 732 712 693 685 675

Compared to AH – would be richer low-mid range progressing to leaner high-range)

Somewhere in those 354 needles is one perfect for your particular car! We won't reach perfection, but I guarantee you that you can get damn close and you will be amazed at the difference!

USE YOUR HOME COMPUTER

There is a DOS based program called "SUNEEDLE" ; that lists all the needles and helps you to find the next logical needle by searching specific stations for you. That, combined with an analyzer can keep you busy playing for months..

SUNEEDLE consists of all the listings of SU needles for .090, .100 & .125 jets (over 500 needles listed). It will sort the needles by stations – there is a "convert" program that lets you determine needle/jet conversions – a "find" function that finds needles different from your baseline needle according to your tolerances and stations, etc. It is an old DOS program and a bit awkward to use but a damn site better than looking at thousands of numbers....

(Ed. – I have removed Fred's comments about downloading the file as it is hotlinked above.)

I love the dichotomy of using my computer to aid in the tuning of my 60 year-old Morgan trike.

SU carbs have a LOT of potential. When someone says that they can't tune their SU's – I guarantee you that they mean they have set the idle and simply "trusted" that the needle was right throughout the driving range – and it wasn't..... And – no amount of "tuning" with that needle is going to make it right.

Only recently did I "discovered" what the SU designers had been up to all these years, and it certainly opened my eyes to the potential of SU carbs. I learned from my friend Paul Pell. Paul is almost anal about tuning and "feels" symptoms that completely elude me. Paul had been searching for some months for the right set of needles for his fire-breathing Sprite. – HOWEVER – he was searching by looking at plugs, swapping needles and "feel".

I had the K&N analyzer and had used it for tuning the Holley/Weber on a supercharged +4. We installed a port for the O2 sensor on the Sprite, hooked up the analyzer and went for a drive. He was so far off on needle choice that he would hardly believe the meter. Everything had indicated to him "lean" on hard acceleration – the exhaust sound, plugs, feel and years of experience... but the meter indicated rich! With reservations (mega-bucks engine) he went to a leaner needle on the higher stations and the car just came alive. Power and performance beyond his wildest dreams.

ANOTHER USE FOR THE HOME COMPUTER

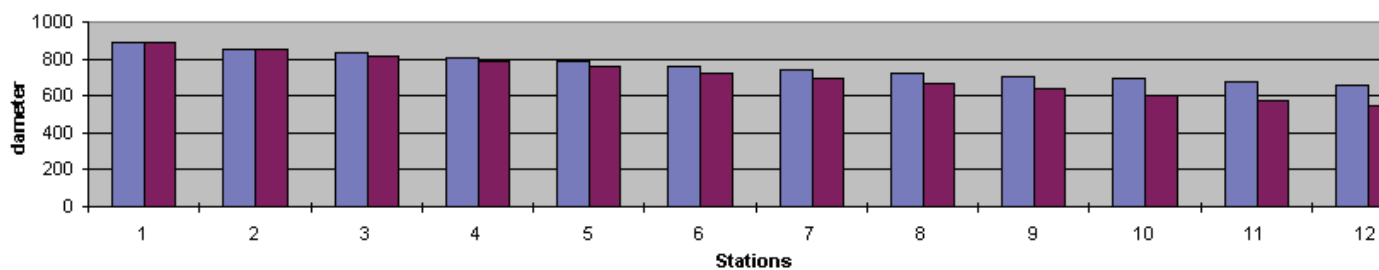
To get a good "feel" for the difference in needles, I make a graph of the stations using the Excel spreadsheet program, in Windows 95. This way I can just look at the graphs and see the differences rather than interpolating numbers from station to station.

The left column of the graph is the needle designation and the top row is the station number along the needle.

I think that you can see that the graph makes it much easier to get a feel for the differences among the different needles.

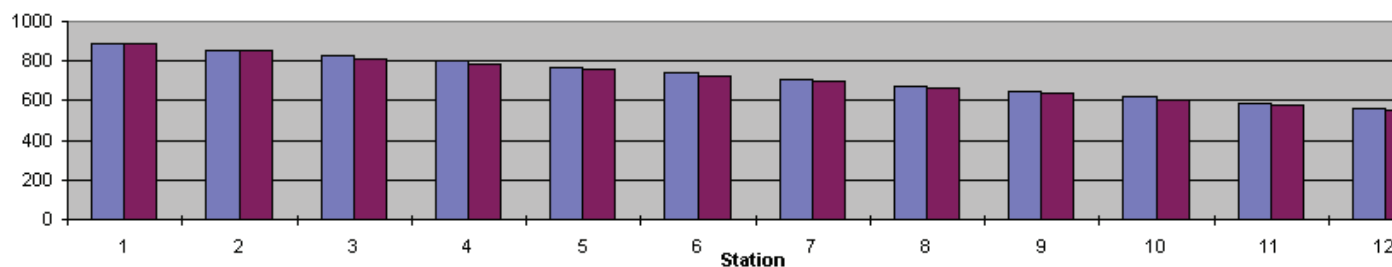
At the moment I am running #6 needles. So I made graphs of the #6 stations compared to the other needles that I had in hand. Two graphs are shown to give you an idea of what I am talking about...

Both graphs are comparing other needles to the #6 that I have in the car.



The EM needles start getting leaner around station 5 and are considerably leaner on up to station 12. This would show as slightly leaner reading at high load cruising and a considerably leaner reading upon hard acceleration. I had been running this needle. By dropping the jet, the car ran quite good, albeit with a rich idle. I had no idea that the acceleration was lean until I installed the analyzer. When I leaned the idle to correct stoichiometric (15:1) the car still ran OK, just not as “responsive”.

The analyzer told the story, the “SUNEEEDLE” program provided an answer . But... only by installing the needles and testing again with the analyzer, can the choice be confirmed. There are lots of close choices.



You can easily see that the GS needles would run just a tad leaner at the high end. And that was the case. Still lean on hard acceleration. So I went to the #6. Right on. It ran like a scared rabbit. I had no idea it could have so much punch.

With the #6, it runs right on the money at cruise. When I stab it at 2000 rpm it will drop off the scale (lean) for maybe a half second, then go to a slightly rich mixture while accelerating. If I stab it at 3000 rpm, the lean drop time is shorter. When I stab it at and at around 3500, there seems to be no lean drop. I suspect that this might be a characteristic of the SU (no accelerator pump), but my experience is limited – it may be curable with yet another needle.

Then I changed to a better exhaust header. This made it run leaner – I am searching again...

WHAT IS PERFECT?

That’s not even a question to ask. You’ll never reach it. But it’s fun to get close.

While a stoichiometric correct air/fuel mixture is around 15:1, it can vary from around 12:1 for power to 1:16 to one for economy. Try to stay within those boundaries and you will be OK.

Don’t go crazy over this. It is supposed to be fun. In most instances function will follow theory and you will both feel and see the improvement. Go for small changes – not large ones. You may have to go in several steps, depending on how critical you are.

When you install another needle – drive the car and make mental notes of how the analyzer read at idle, high speed cruise, high speed cruise & then flooring it, and hard acceleration through the gears.

If I was still off on the readings, then I would make another graph, comparing needles (either from those that I had – or from a needle selected from the SUNEEEDLE program) to find one that might correct the mixture in the range that was off- install ‘em & try again.

It is a fun pursuit and will give you knowledge beyond what you may wish for as to how it all works.

Sing to me Bob...