Choosing Carbs using Math

In the past I've written about wiring, ignitions, spark plugs, and other electrical subjects because that is what I do for a living at C5 Performance. This article is all about carburetors. Why?? Because ignitions and carbs work together when it comes to performance. Some days I spend more time helping customers fix carb issues than I do working on timing maps.

Earlier this year I became a student of my friend who a carb inventor, master tuner, and all around genius. He taught me many useful things about intake systems so with his help I would like to share some of what I learned with HOOK readers.

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You just built a fire breathing tractor or made a few upgrades to your existing ride. Do you need a larger carb? How would you determine what size to purchase? Do you:

1. Ask friends and strangers on Facebook and hope they provide accurate info
2. Purchase a huge carb because your engine is awesome and shiny and loud
3. Read articles about cfm requirements, signal strength, air/fuel ratios, and use proven math to determine the best carb for your vehicle

I think most people rely heavily on #1 and #2. Watching tractors blow clouds of smoke, only to run lean at the end of a pull is something we all see regularly. But why does that happen? How can you use science to help you choose the best size?

Terms you should read about and understand are CFM, vacuum signal, VE, atomization, air-fuel ratio, emulsion tube, and venturi … I suggest you do further reading.

It helps to understand the function of a carburetor. Your engine gets fresh air via the carb throat. As the air passes the venturi, it speeds up and sucks liquid fuel from the bowl using an emulsion tube (like a straw), atomizing the fuel droplets with the incoming air. It's a giant slurpee!

If the mixture is correct and your manifold and head aren't hogged out messes, the perfectly blended air-fuel mixture reaches the cylinder with a 12.5:1 (or close to it) air fuel ratio where it is efficiently ignited and converted to horsepower. If the fuel mixture is incorrect, the lean or rich condition causes all sorts of tuning and timing problems, some of them harmful to your engine. Choosing the correct size carb is always important.

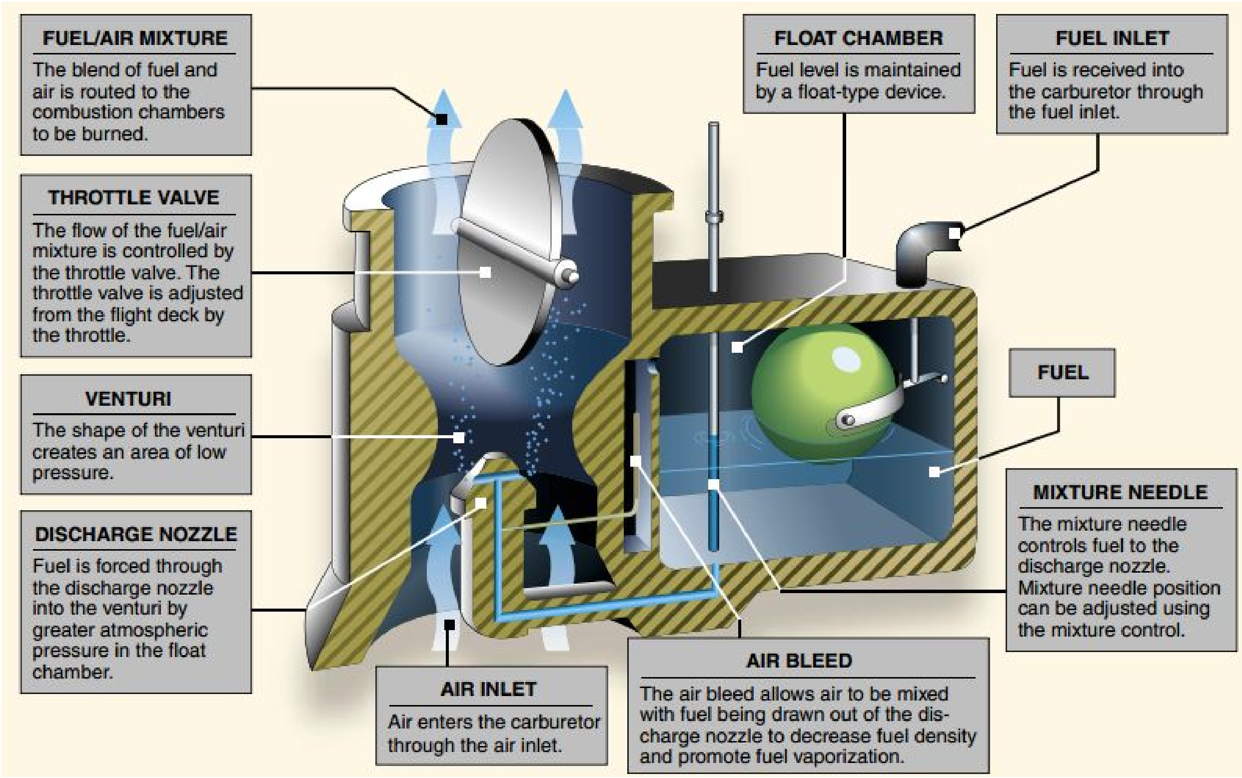

Photo credit: CFI Notebook

Calculate the correct carb size in 4 easy steps...

<u>Step 1</u> - Calculate the size carb that fits your application using this formula

$$CFM = \frac{CID \times RPM \times VE}{3{,}456}$$

Engine size (Cubic Inch) x max rpm x Volumetric Efficiency (use .8) then divide by 3456 = cubic feet per minute (CFM) your engine will require

Using a Farmall M with a 436 cubic inch engine turning 1920 rpm (20% over)

436 x 1900 x 0.8 / 3456 = <u>192 CFM</u>   This is your target carb cfm flow.

If you have never used this formula to calculate carb size, don't feel bad. Most people refer to the throat size and CFM never gets mentioned. Heck, even carb sellers/resellers pay little attention to matching cfm to your engines needs, which can get you in trouble once "tuning day" arrives. I learned this over 30 years ago with motorcycle racing. Get it close or waste the season fighting your mistake.

<u>Step 2</u> Choose a carb that flows your target CFM at a reasonable pressure drop (manifold vacuum at full throttle). A good target would be 1.5" Hg (Mercury) which is 20.4" of water. In the automotive world, carb suppliers provide CFM and pressure drop at that rating. I am not aware of a reliable source for agricultural carb CFM but we are working on it. Ask before you buy.

<u>Step 2a</u> On modified carbs, if the person doing the work is not paying attention to how the carb meters fuel, and only concentrates on getting more air flow, the common result is a poor running engine. A smaller carb that meters correctly will outperform a larger carb that doesn't. A properly sized carb that meters fuel correctly at all rpm will get the full potential of power. Sizing the air flow at 1.5" Hg is a critical step in that process.

<u>Step 3</u> Pay attention to bends and restrictions. Installing a carb onto a poorly designed manifold or clamping on a small intake tube with tight 90° bends and a restrictively small filter will destroy air flow. Research, test, and pay attention to the finishing touches of your air intake system.

<u>Step 4</u> Use an air-fuel meter and tune your system. Run the coolest spark plugs you can, install your meter where there is no reversion or air leaks, and look for rpm areas where your engine runs excessively rich or lean under load. That will affect performance and timing requirements. Make one change at a time until it's perfect from idle to full throttle.

We all pride ourselves in having strong mechanical abilities, and using math to select components does not make you less of a tuner. In fact ALL winning race teams use math to build their vehicles and so should you!
Choosing random parts make it tough to beat teams who pay attention to details. Get the right carb, tune it using a meter, and gain the consistency that's needed to win on any given weekend. Once you get your carb working as it should, then you can start to design timing maps that compliment your engine at all rpm ranges.