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#4 - Budget Bench Electronics

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06-28-2008, 08:32 AM

[#1 \(permlink\)](#)


[DavidVizard-GFN](#) OFF
 Pit Crew

Join Date: Apr 2007
 Posts: 840

Porting School #4 - Budget Bench Electronics

GFN Porting School

Here is where you can learn the intricacies of cylinder head design, porting techniques, building of flow benches and anything else that pertains to the flow of air through an engine.

Principle Contributor - David Vizard

#4 Bench Electronics

On a super low budget.

By
David Vizard and Bob McDonald

So how would you like to take the bench build described in part 2 and very substantially upgrade it?

Such an upgrade would include an electronic readout in cfm pre-corrected to the depression of your choice (probably 28 inches) and that alone would convince most of you wanting a more up-market bench to take the plunge. But that is far from all that we are going to look at. If you want to hook up your bench to a computer then, when we have finished here, you will be able to record data by a push-to-read button that, while held down, will average the readings for as long as you do so. In addition to this the system will also display graphs of your porting efforts as well as print out fancy reports with your name on the top of the sheet (customers like this). The best of all though is that you will only be out of pocket by about \$700 (or may be less). If all this sounds

appealing then let's make a start on why and how to get from here to there.

Here GFN's McDonald/Vizard team put the Audie Technology Flow Quik through a bank of rigorous tests. At the end of a week we have most certainly sized up the value of this piece of equipment to the budget constrained racer/porter.



The big question we asked was can a shop vac seemingly marginal for the task be used as a pressure/vacuum source for a flow bench intended to flow typical small block V8 heads. This Sears 2½ hp 6 gallon unit cleans the shop just fine but would flowing a head be simply out of it's operational range?

You don't need to have moved that much up the ladder from novice to realize that maximizing power means maximizing cylinder head capability. Everything else in the loop simply utilizes the cylinder head capability to make power. If we further analyze the performance equation we find that at least 60% of cylinder heads performance is airflow related. The upgrades about to be shown and tested here will endow even the low buck bench shown in part 2 of our series- ([Porting School #2 - Super Cheap Flow Bench](#)) with a totally professional capability. This will allow it to meet the needs of those who port and prep high dollar 4 valve heads for equally high dollar clientele as well as more regular applications. But in our case meeting the needs of a high roller is maybe not quite as important as meeting the needs of the racer on a tight budget – and that is probably most of us here.



Here is the Flow Quik's readout. The reading shown here is corrected to 28 inches depression. The selector knob on the right of the unit allows a 10 or 28 inch correction to be shown as well as the metric equivalent.

There are plenty of both drag and circle track race classes that limit head castings to less expensive production style items. Such a limitation puts a greater emphasis on even small flow differences and if you want to win it's important that whatever you have is better than whatever your competition has. Although hardly the only category to do so the IMCA racer falls squarely into this group. Since the motor can be claimed for a fixed fee it's good to get power without parting with a bunch of cash. If you are building a motor for this or a similar class of racing you have to ask yourself just how much money you can afford to give away to be competitive? Like it or not time and money are closely linked. We may resent giving away a pair of heads with a \$800 porting investment but not feel anything like as bad parting company with similar heads we have personally spent 10-15 hours porting. The bottom line is most racers have far more surplus expendable time than surplus expendable income!

You don't have to tour many head shops to realize the most popular bench used by pros is the SuperFlow 600 – possibly with electronic support. You probably also understand the reason you don't have one of these benches is because it can cost as much or more than the race car you are aiming to build. So, for most racers and enthusiast engine builders, a \$10,000 – \$15,000 bench is simply out of the question. What I am going to cover here is not.

Naming Names.

Within Pro engine/cylinder head circles Audie Technology is well known. They produce, among many other things, the 'Flow Pro' data acquisition unit that is an add-on for non-computer supported benches such as the big SuperFlow units. In addition to this they also produce the cost conscious 'Flow Quik'. The Flow Quik, which sells for a little over \$600, is not a flow bench in itself but a means for measuring flow. By adding this unit to an existing flow bench we can achieve as much as can be done with a big blue flow bench but at a fraction of the cost.

Accuracy.

Any piece of measuring equipment that comes in at less than a 1/10 of the cost of its principle competition might rouse some concern about its functionality and accuracy. Since the Flow Quik is a measuring instrument fellow GFN tech writer Bob McDonald and I decided to put it through its paces to see how it fared. The plan was to check ease of use, repeatability and, most importantly, overall accuracy. To allow all this to happen that much quicker Audie Thomas of Technology shipped us the Flow Quik unit they exhibit at PRI. Bob and I extensively tested this over a period of a full week.

Audie's show unit consists of a flow box on which the dummy cylinder is mounted. This is connected via a 2-inch ID hose to the tube containing the measuring device. Up and down stream of this orifice is a pressure tapping which is connected to a box of electronics. The pressure transducers within this box convert air pressure signals to electronic signals which, via a microprocessor, are displayed as cfm on an LED readout.

The vacuum source for this unit was a second box housing a pair of Ametek vacuum motors. Also within this box was a flow reversing gate valve that allowed for either intake or exhaust tests to be made.

At this point we come to the critical issue as far as our basic floating pressure drop bench is concerned. For those of us building such a bench Audie claims a regular shop vac can be used and can successfully test heads with final flow figures up to about 300 cfm at 28 inches. The bottom line here is that to actually get up and running with the Flow Quick takes little more than adapting the Flow Quik into the pipe work that feeds into the bottom of the bore of the block used to mount the head on. Connecting that to a good shop vac will put us in business. But, before running with a shop vac Bob and I put this Audie Technology unit through its paces as received with the Ametek motors.

Fixed Depression Versus Floating

Before we start talking test results let's be sure we are all up to speed on this floating test pressure measuring technique. Quantifying airflow on a conventional bench involves pulling a fixed pressure drop across the test piece. The first benches from SuperFlow were calibrated to test at 10 inches (the 110 model) and 25 inches (all the big models) and all was well until Smokey deemed that the magic number was 28 inches of water (just a shade over 1 psi) and that quickly became the norm. But the GFN budget bench described in part 2 of our series employs a floating pressure drop. Doing things this way is not only a lot cheaper as the size of pump needed is reduced dramatically but, as discussed, also a lot nearer reality. Because the Audie Flow Quik continually monitors the pressure drop it is totally suited for use on a 'floating' flow bench. This produces high-pressure drop at low valve lift and a significantly lower pressure drop at high lift. Employing this technique allows flow testing with far less vacuum motor (s) than the half dozen or more normally used. As has been said before this technique actually flows heads in a more realistic manner than the fixed pressure drop method.

Fig 1. What you see here on this somewhat busy graph is the depression between the cylinder and intake port on a well specced race engine. Note that at 30 degrees before TDC where the intake valve is open 0.075 inches, the depression is just a little over 100 inches H2O so why would we want to flow test at 28 inches at this lift? Also note that the port velocity at TDC is 120 ft/sec (about 90 mph) but the piston is parked! The seat velocity is actually the velocity at the seat ID. At peak torque the port Mach number was at 0.46.

Although it was the principle topic in part 2 of our series let us once more look at the reasons why we should be testing with a floating pressure drop rather than a fixed one. Take a look at Fig 1. The red curve shown here is a smoothed curve of the pressure difference between the cylinder and the intake port throughout an induction stroke. Although the curve can vary quite substantially from one similar engine to another (due to relatively small changes in lengths diameters and cam characteristics) this curve can be taken as representative of a 650 hp, single 4 barrel, 355 inch motor. The first point to take in from the graph is that the draw on the intake valve/port is greatest at low lift where the suction reaches 100 inches H2O while the valve is at just 0.075 lift. What this means is that testing at 28 inches at this low valve lift is far from representative of the real world. By contrast a test method employing a floating pressure drop tests at high pressure differentials at low lift and lower ones at high lift.

We used our Helgesen plate (left) as a reference to test the Flow Quik's overall accuracy. Seen on the right is the flow calibration device housed in the Flow Quik's measuring tube.

The first tests we ran were to compare the end results of a test run at 28 inch fixed pressure drop and one run with a floating pressure drop. To do this we ran the bench both ways and used our Helgesen calibration plate as the test piece. In the 'floating' mode the test pressures seen on the bench by the Flow Quik ranged from about 72 inches down to under 10. The resultant corrected numbers and the accuracy produced compared to corrected 28 inch numbers are shown in the chart Fig 2.

Fig 2 What you see here is a comparison of our Helgesen plate flow tested on the floating depression method as used by our budget bench in conjunction with the Audie Technology Flow Quik unit. As can be seen it produces creditably accurate numbers in this mode and, in terms of accuracy, compares well to fixed depression tests done on a SuperFlow 600.

Supplied with the Flow Quik is a calibration tube that is installed in the system and the readout adjusted to 80.9 cfm on the 28-inch scale. In this instance the unit was calibrated with the 80-cfm orifice in our

Helgesen calibration plate hence the zero error at that point. As far as the overall accuracy is concerned it is far better than the majority of benches out there in the performance world. Compared with a typical big blue bench the Flow Quik, from 40 cfm up, averages about the same error i.e. about 2%.

Although overall accuracy is important for us to make comparisons from different benches the #1 requirement for a head porter is consistency from one month to another. We were able to make a relatively good check of that because of a dramatic weather change during our time testing the Flow Quik. Readings taken seven days apart showed the Flow Quik's repeatability to be about 1%. At the end of the day we can say that the Flow Quik's accuracy against a calibration plate was as good as a bench costing ten times the amount.

Computer Program.

At this point our tests turned to determining just how well, bearing in mind the floating pressure drop, the Flow Quik's performance to date, translated into accurate and repeatable results on a real head. The LED readout on the Flow Quik box is far from the only function this part has. On the side this box also has connections to allow the output from the microprocessor to be input into a computer.

The 'take-reading' button shown left averages the readings for as long as the button is held down. We found that a 5 second interval produced repeatable results. The graph on the left is what comes up on the computer screen.

In addition to this a push-to-read or take-reading button can be used to transfer the measured cfm to a Flow Quik program. The Flow Quik program allows the user to type in info relative to the head being tested. This head spec info is then used to calculate many factors important to the serious head porter. Such things as valve discharge co-efficient and port velocities at various pre-determined points are calculated and displayed. The take-reading button also greatly improves accuracy and repeatability by virtue of it's averaging capability. During our tests a 5 second interval was used as the averaging period.

To put the Flow Quik through it's paces we used a Holley 23 degree, high performance street SB Chevy head. This would push the Flow Quik to what we perceived to be about 80% of it's limit with the dual motor vacuum source being used.

Head Set-up.

Although installation of the test head on the bench was as per any other bench there was a point that had to be taken into account in a different manner to say a SuperFlow bench. The point being that the Flow Quik does not directly cater and compensate for any extraneous leakage. Although leakage at any point other than the intake valve can be deducted from manual readings the same cannot be done in the computer-supported mode if accurate number crunching is expected. This meant making sure there are no leaks in the equipment itself. Secondly, because the test depression goes so much higher than on a regular bench the springs holding the valves closed must be at least twice the stiffness.

Test Pressure Comparisons.

Our first tests with the Holley head as the subject were made in the floating pressure drop mode by allowing the Ametek motors to pull whatever maximum test pressure differential they were capable of. At 50 thousandths lift 62 inches of vacuum was seen across the intake valve of the test head. As the lift increased the pressure dropped such that at 700 thousandths it was down to just over 12 inches. Several tests run under identical conditions showed readings spanning less than 1%.

Our next test was designed to simulate a lesser pressure/vacuum source. To do this we bled off vacuum by introducing a fixed leak prior to the measuring point. Running the same tests run with about half the vacuum and comparing the readings with the full vacuum source produced the results seen in Fig 3. As you can see the microprocessor computations compensated and corrected, to within a close margin, for the difference between the floating test pressure and the 28 inch fixed test pressure. Comparing these

numbers with those achieved from a freshly calibrated Super Flow 600 using a fixed 28 inches showed a maximum difference of 2.8% below 200 thousandths lift and 2.2% above. The average difference from 50 to 700 thousandths was only 0.9% with the Flow Quik showing slightly more flow than the SF 600. The bottom line is that the figures produced by our test Flow Quik unit, (which could be expected to vary a little from unit to unit) are closer than is normally seen between two conventional and supposedly identical fixed depression benches.

And Now – The Shop Vac Test

The last and, from our point of view, the most important test was to run the Flow Quik with a regular shop vac. Since the point was to see if a vacuum cleaner could be used we did not go out and select the biggest there was. Our goal was to see if we could get respectable CFM readings with an average shop vac. Sears had a 2 ½ hp model on sale for less than 40 bucks so that is what we went with. Fig 3 shows the results of this test. From these curves we can see that even with a low power shop vac errors did not start to creep in until about 220 cfm (350 thousandths lift in this instance) mark. Although this modest shop vac got the job done for a 260 cfm it was on the ragged edge. At somewhere just below about 4 inches of depression parts of the port may have become laminar. Under these circumstances the Flow Quik's corrections, as with any other bench, will no longer be valid.

What these graphs show is that in spite of a dramatic change in test pressure the Flow Quik compensated well. Only when the test pressure/vacuum dropped below about 10 inches did we start to see a noticeable change (in the upward direction as would be expected) in the final result. Regardless the readings, even at 5 inches depression were still within about 3% of those achieved at the higher preferred pressure drop.

Conclusions.

Our first thoughts on the performance of the Audie technology Flow Quik is that it far surpasses both Bob and my expectations. Ease of use, speed and accuracy were far beyond what either of us expected of such a cost conscious unit. In it's least expensive form the unit from Audie will set you back about \$ 600. Add to this the cost of building the bench as per GFN Porting School Part 2, a dial gauge and a means of opening valves and you are in business. If the shop vac selected is about 6 hp as per a big Sears unit then we estimate a realistically accurate range of flow capability of about 330 cfm. Think about this - a professional capability floating depression bench for under \$750. Port two sets of heads and you will more than recover your investment!

PS

Before checking out on this subject let me tell you just how impressed my cohort Bob McDonald was with the Flow Quik. Bob has a SuperFlow 110 which he has owned for better than 10 years. After this week long test with the Flow Quik he made the decision to abandon the 110 and build a bench just to utilize the Flow Quik. That bench is now up and running so if he gets a moment or two he will relate to you how things are going with his new bench.

Audie Technology, 23 North Trooper Road, Norristown, Pennsylvania, 19403. Tel: 610-630-5895. Fax 610-630-5894 Web: [Audie Technology | Home](#)

Other parts in this series are at:

- #1 [Porting School #1 - Why engines need airflow](#)
- #2 [Porting School #2 - Super Cheap Flow Bench](#)
- #3 [Porting School #3 Budget Bench Calibration](#)
- #4 [Porting School #4 - Budget Bench Electronics](#)
- #5 [Porting School #5 Identifying Primary Restrictions](#)
- #6 [Porting School #6 - Secrets to reduce valve shrouding](#)

#7 [Porting School #7 - Power & Port Volumes](#)

#8 [Porting School #8 Optimal Port area's](#)

#9 [Porting School #9 - 5 Rules to Goof-Proof Porting!](#)

#10 [Porting School #10 - Pushrod Pinch Point Power Issues](#)

In addition to the Porting School articles there are directly related cylinder head development subjects at the following sites:

Wet Flow :-

[Six Wet Flow Mistakes](#)

Combustion Dynamics:-

#1:- [Turbulence and Combustion Dynamics](#)

#2:- [In cylinder Turbulance and Combustion Dynamics](#)

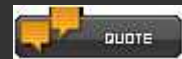
#3:- [Turbulence and Combustion Dynamics - Part 3](#)

#4:- Coming soon

#5:- [Turbulence and Combustion Dynamics - Crevice Volumes - Stealth Power Thief](#)

**Want to learn how to develop and port heads for high performance professionally?
If so click on the link below.**

Last edited by DavidVizard-GFN; 09-18-2008 at 09:22 PM.



06-29-2008, 01:42 AM

#2 ([permalink](#))

Travis Gibson



Garage Sweeper

Join Date: Mar 2008
Posts: 22

Advantages of 'Flow Quik'...

David,

What are the advantages of using the Flow quik over using a calibration plate coupled with a bare-bones 'comparator' bench? Or maybe I should say, is there any reason not to have this Audie unit on your basic "flowbench" other than price?

Am I correct in thinking that the Flow Quik will eliminate the need for correction from atmospheric changes or the need to finely regulate voltage to the vacuum motors, as is the case with the more basic bench?

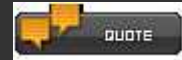
By the way, another fantastic addition to the series. Thank you for dedicating all of that time to do a thorough and interesting experiment. I really appreciate getting a general idea on what kind of air source would be needed for larger CFM heads - amongst many other things.



06-29-2008, 09:10 AM

#3 ([permalink](#))**DavidVizard-GFN** OFF
Pit CrewJoin Date: Apr 2007
Posts: 840

Travis,
The advantage of the Flow Quik is that it does turn a bare bones bench into a sophisticated pro quality result bench. You are correct in assuming that with the Flow Quik you will not need to stabilize voltage or worry about atmospheric changes because all significant aspects are catered for in the computations.



06-29-2008, 04:24 PM

#4 ([permalink](#))

rookie's Avatar

**rookie** OFF
Pit CrewJoin Date: Apr 2007
Location: In The Woods
Posts: 571

David,
I've had several people tell me where to put my test orifice, some of those suggestions positively would not work on a flow bench, so I will ask you.
Should the test orifice be mounted directly to the bench with out the bore jig in place or mounted on top of the bore jig?

Has anything you've done made your life better?



06-29-2008, 07:47 PM

#5 ([permalink](#))**Randy W.** OFF
Garage SweeperJoin Date: Jul 2007
Posts: 15

Hello David:
I was thinking of another way to attach the vacuum source.
How about installing the oil pan on the test block and attaching the vacuum source to it. Plugging all the holes in the block and installing intake manifolds to test. After installing a camshaft to open the valves simulating the position they are in the running engine to produce conditions they would be in a running engine.
Regards
Randy



06-29-2008, 11:04 PM

#6 ([permalink](#))**FlowSpecialist** OFF
Tire ChangerJoin Date: May 2008
Posts: 129

Quote:

Originally Posted by **DavidVizard-GFN** 
The last and, from our point of view, the most important test was to run the Flow Quik with a regular shop vac. Since the point was to see if a vacuum cleaner could be used we did not go out and select the biggest there was. Our goal was to see if we could get respectable CFM readings with an average shop vac. Sears had a 2 1/2 hp model on sale for less than 40 bucks so that is what we went with. Fig 3 shows the results of this test. From these curves we can see that even with a low power shop vac errors did not start to creep in until about 220 cfm (350 thousandths lift in this instance) mark. Although this modest shop vac got the job done for a 260 cfm it was on the ragged edge. At somewhere just below about 4 inches of

depression parts of the port may have become laminar. Under these circumstances the Flow Quik's corrections, as with any other bench, will no longer be valid.

Here's the nub of the article for people wanting to build their own flowbench. Can a shop vac do the job properly and at what point does it actually start to create errors in the flow readings - if in fact "errors" is the right word?

To answer this we have to look at something called the Reynold's Number which determines whether flow is turbulent or laminar. There's a nice introduction to Reynold's Number in Wikipedia which saves me a lot of typing.

[Reynolds number - Wikipedia, the free encyclopedia](#)

Note the bit about flow in pipes, which is what we are doing on a flowbench, and that turbulent flow turns laminar at an Re of about 2400. Ideally we avoid Re's between 2000 and 3000 if we want to be sure that flow is either turbulent or laminar.

So let's play it safe and say we don't want Re to drop below 3000 in our flow tests. Can we calculate the pressure drop required for something like a Chevy head at high valve lift to stay above 3000? If you have a computer program that has the full flow equations built into it then happily the answer is yes. That answer is going to surprise you. Assuming a throat diameter of about 85% of the valve size the Re drops to 3000 at a pressure drop of 0.85mm of water!

Yes that's not a typo. 0.85mm i.e. about 33 thousandths of an inch of water pressure drop. That's not just a bit smaller than a shop vac can pull it's a country mile smaller. In fact it tells us that we could power a flowbench with an aged and asthmatic fieldmouse sucking through a straw and still generate a high enough pressure drop to generate valid flow tests.

So if the shop vac is not only big enough but big enough by at least an order of magnitude why is there a difference between flow corrected to 28" from tests performed at low and high pressure drops?

Again the flow equations come to our rescue. The way that everyone corrects flow at one pressure drop to another is with the square root law. Multiply measured flow by the square root of (desired pressure drop / test pressure drop).

Here's the deal. **The square root law doesn't work.**

It's only an approximation. The full flow equations do indeed contain a term that includes the square root of the pressure drop but there are also a number of other terms such as the Discharge Coefficient and the Expansibility Factor. These terms also both change as the pressure drop changes. As the pressure drop goes up so does the flow rate and so does the Reynold's Number. The discharge coefficient alters with Reynold's Number and the Expansibility Factor alters with pressure drop.

The net effect is we get a change in flow that's close to the change in the square root of the pressure drop but not exactly.

Can we quantify the change more precisely? Tricky one to answer. With known shapes like orifice plates and venturi tubes where nice people have already done the research for us yes we can and my program does exactly that as it calculates the flow for every flow test I do. However for irregular shapes like cylinder heads we will never know exactly how the Discharge Coefficient and Expansibility Factor alter with pressure drop. I can take a stab at it though by assuming that a test head will behave something like an orifice plate.

The highest flow figure shown in the graph is about 260 CFM. If I input to my program a shape flowing 260 CFM at 28" what will it flow at 4" which is what the shop vac was pulling at that point? The answer is 100.54 CFM. Now let's scale that back up to 28" with the square root law.

We get $100.54 \times \sqrt{28/4} = 266.0$ CFM. About 2.3% higher than we actually get if we test at 28" pressure drop. Near as dammit that's exactly what DV's tests showed. In other words the flowbench, the Flow Quik and the shop vac are doing exactly what the flow equations predict they will. No error as such other than the basic one of trying to correct flow at one pressure drop to flow at another with a square root law that's only an approximation.

So what's the big deal with testing at 28" pressure drop if a shop vac will do the job at much lower

pressure drops? 20 years ago about the only flow bench you could buy was the Superflow 110 which tested at 10". Then the SF600 came out which tested at 25". Then, according to what I understand someone called Smoky Eunuch came along and said you're all doing it wrong guys you need to test at 28" and everyone said yes sir, three bags full sir and jumped accordingly.

The answer is that testing at 28" is a crock. It bears no more relation to average true engine conditions than any other pressure drop and won't generate any more meaningful results. If you can keep the pressure drop above about 1mm of water at high valve lift for something as big as a Chevy head you'll get results as good as any other method. What you won't be able to do is correct flow at one pressure drop to flow at another unless you apply the full flow equations and the number of people who know how to do that can probably be counted on one hand. However if you see a gain of 10% at whatever flow drop you test at it'll still be a 10% gain at any other.

That in a nutshell is all we are really interested in. Flow gains after we've ported our heads. You can measure those with a shop vac and a Flow Quik as well as anything else. On that basis I heartily recommend you buy one.

Dave



06-29-2008, 11:43 PM

#7 ([permalink](#))



DavidVizard-GFN OFF
Pit Crew

Join Date: Apr 2007
Posts: 840

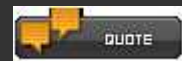
Dave,

Thanks for doing such a great post and for that matter keeping me on my toes. I had never calculated the pressure drop for a laminar to turbulent situation in a typical port but had assumed it was about half to one inch of water depression. Just shows how far out I was on that one! One and all - I want you to note here that any time you see a comment concerning porting that says (in so many words) that the porting was done to get rid of turbulence rest assured that the writer had no idea what they were talking about. Because the Reynolds number is in excess of 2300 the flow in a port is turbulent no matter what. What Dave's calculations have shown here is that it is deep into the turbulence as well - not just marginally. That means there is nothing we can do porting wise to make in not turbulent!

All that said reading your post Dave also brought to mind (inspired might be a better word) that I forgot one important factor here that will account for some of the correction error seen and I just flat overlooked it (tut tut). When air goes around a tight short side turn it separates but the lower the pressure drop the less it separates and visa versa. When a port is flowed at a high pressure drop the break away is bigger and 'plugs' the port more. The result here is that, at say 28 inches, we see a regular SB Chevy exhaust port flow numbers almost as big as a trick Cup Car port. The reality here is that if these two ports were flowed at say 100 inches there would be a far bigger difference between them because the regular port would had a large amount of flow separation on the short side where as the cup car port, having a huge inside turn radius and about a 65 degree angle, would not. So what might only be a small difference as measured at a low pressure drop would be a much bigger one at a high pressure drop.

Other than to reiterate my thanks for a great post and for keeping me on my toes the only question that I still have is - will we see a 'Baker Plate'?

DV



06-30-2008, 03:49 PM

#8 ([permalink](#))

FlowSpecialist OFF

Tire Changer

Join Date: May 2008
Posts: 129

We're certainly covering some very productive ground here Dave and I hope all this discussion is of interest to people. If I were to sum up my own views on the best way of flow testing heads it would be simply this.

There is no one single perfect way to flowtest.

No matter what method, what pressure drop, fixed or floating, you pick there'll be pros and cons. Your own results will never be directly comparable to those of other people using a different method and frankly that doesn't even really matter most of the time because you'll never know whether someone else's results are accurate in the first place. Choice of bore size adaptor and the length of that, position of pressure tappings, accuracy with which the valves are opened every 50 thou are all going to impact on the numbers you get. Chasing those differences with even further corrections by converting flow at one pressure drop to another is just adding to the variability.

The only really important thing is that what you do is repeatable and internally consistent. That way you'll be able to look back at your own results year after year and know that they're properly comparable.

After 20 some years of studying flow I certainly don't feel the slightest need to spend a lot of money on a 'professional' bench with umpteen motors built in to it just so I can test at high fixed pressure drops compared to the low variable ones my little shop vac produces.

I think the only downward limit on the sort of pressure drops you can realistically test at is when the manometer readings become so small you can't read them accurately. That limit probably comes at about 50mm of water or a bit less. However even then a very nice effect comes into play which helps you out. The error in the flow figures you get is a smaller percentage than the error in the manometer reading. I'll try and explain a bit further.

If I enter the following notional set of readings into my program I get these results.

Pressure drop across head 50mm, drop across orifice plate 410mm, flow at 25" = 300.0 CFM. Now if I was 1mm out, that's 2 percent, on the reading across the head and it should really have been 49mm it changes the flow figure to 303.0 CFM. Only a 1% change in the CFM for a 2% change in the manometer reading. That's a very handy effect to have on your side of things. It almost seems like the laws of physics are going out of their way to help you retain accuracy.

FWIW the pressure drop my little 1kW shop vac gives at the same sort of flow figures you were testing at above, 260 CFM, is about 80mm but then it's a good bit smaller than the one you were using. I still have a bit of leeway though before my notional 50mm limit and I feel quite happy to test at levels up to 300 CFM or even a bit over with such a small motor. I'd therefore absolutely agree with Flow Quik that you can use just a single shop vac on Chevy sized heads and get perfectly good results.

Dave



06-30-2008, 08:18 PM

#2 (permalink)



DavidVizard-GFN OFF

Pit Crew

Join Date: Apr 2007
Posts: 840

Dave,
You have some good points that I would like to expand on for our GFN readers.
Out of your post I have picked the most relevant text for getting repeatable results and the significance of comparisons. Here the text:

No matter what method, what pressure drop, fixed or floating, you pick there'll be pros and cons. Your own results will never be directly comparable to those of other people using a different method and frankly that doesn't even really matter most of the time

because you'll never know whether someone else's results are accurate in the first place. Choice of bore size adaptor and the length of that, position of pressure tappings, accuracy with which the valves are opened every 50 thou are all going to impact on the numbers you get. Chasing those differences with even further corrections by converting flow at one pressure drop to another is just adding to the variability.

The only really important thing is that what you do is repeatable and internally consistent. That way you'll be able to look back at your own results year after year and know that they're properly comparable.

Taking one point at a time:
Your own results will never be directly comparable to those of other people using a different method

This is true and should be borne in mind that there will always be a difference so making caparisons on an outright basis is always a dodgy practice to indulge in. However careful measurement on your part will allow you to make a judgment call as to whether or not you are doing OK,

frankly that doesn't even really matter most of the time because you'll never know whether someone else's results are accurate in the first place.

When you have been in the industry as long as I have you will better understand the significance of Dave's statement. It is not out of the question for commercial flow benches to be out by 10% or more - and for some reason they always seem to read high (wouldn't you now it). That make guys like me who try and sell real numbers look a little less competent than maybe we really are - which can be a little aggravating when trying to sell ones porting capabilities to a high rolling client who has looked at everybody else's numbers first.

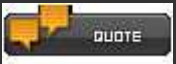
Choice of bore size adaptor and the length of that, position of pressure tappings, accuracy with which the valves are opened every 50 thou are all going to impact on the numbers you get.

From emails I have had and from what has been said/asked in various posts on GFN it seems that some people have found out for themselves that the size or even presence of a dummy cylinder bore affect readings of the calibration plate. But one factor mentioned here which I see overlooked time after time is the accuracy of the valve opening. At low lifts this is very important to get right as it can induce as much as a 10% error. At higher lifts the one thousandths or so is not anything like as significant. Part of the error I see on many benches is that the opening fixture flexes and those 25, 50 and sometimes 100 thousandths figures just go out the window in terms of acceptable accuracy.

The only really important thing is that what you do is repeatable and internally consistent. That way you'll be able to look back at your own results year after year and know that they're properly comparable

That's the real cruncher right there!

DV



07-01-2008, 01:04 AM

#10 (permalink)

doc OFF

Garage Sweeper

Join Date: Oct 2007
Location: Ohio
Posts: 9

Thanks David for the great testing and information.
I started out with a comparator bench, and one problem I found is simply, two different people get two different results. It is like reading micrometers. The digital output gets rid of the HUMAN factor. One other problem is if the manometer isn't steady. The human wanting, a better reading, may average it with his eyeball for the better. That is why I just about pried the Flow Quik (I have serial number 2) out of Audie's hands. Repeatability is the most important factor in my book. Big numbers are what too many people rely on to make the sale. I have talked to guys that have air conditioners that run the temperature down to 44 degrees or less in an effort to get bigger flow numbers than anyone else has

for their final test. Flow benches are like dyno's, they vary from one operator to another. It would be nice if they all agreed, but even the same head, flow bench brand, model, and day vary quit a lot from one shop to another. Remember, the engine doesn't care about that sheet of paper with numbers on it, satisfying the engines air flow demands wins races. This should be a interesting series.

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