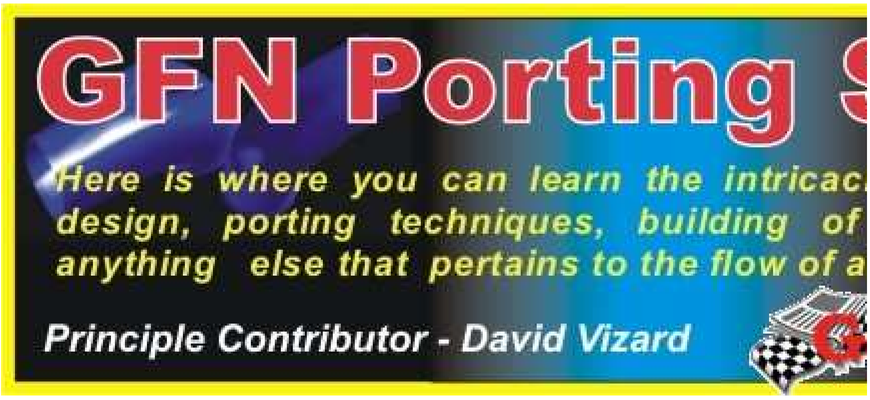
Porting School #10 - Pushrod Pinch Point Power Issues

09-13-2008, 11:33 AM

DavidVizard-GFN OFF
Pit Crew

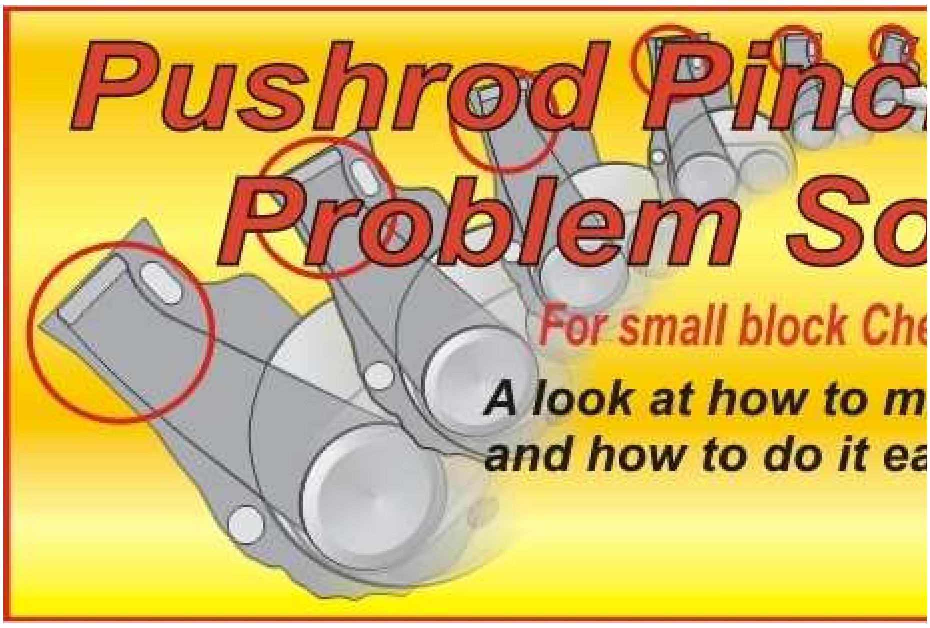
Porting School #10 - Pushrod Pinch Point Power Issues



Here it is -

- the subject every beginner needs to porting and every Pro needs to know

cake.



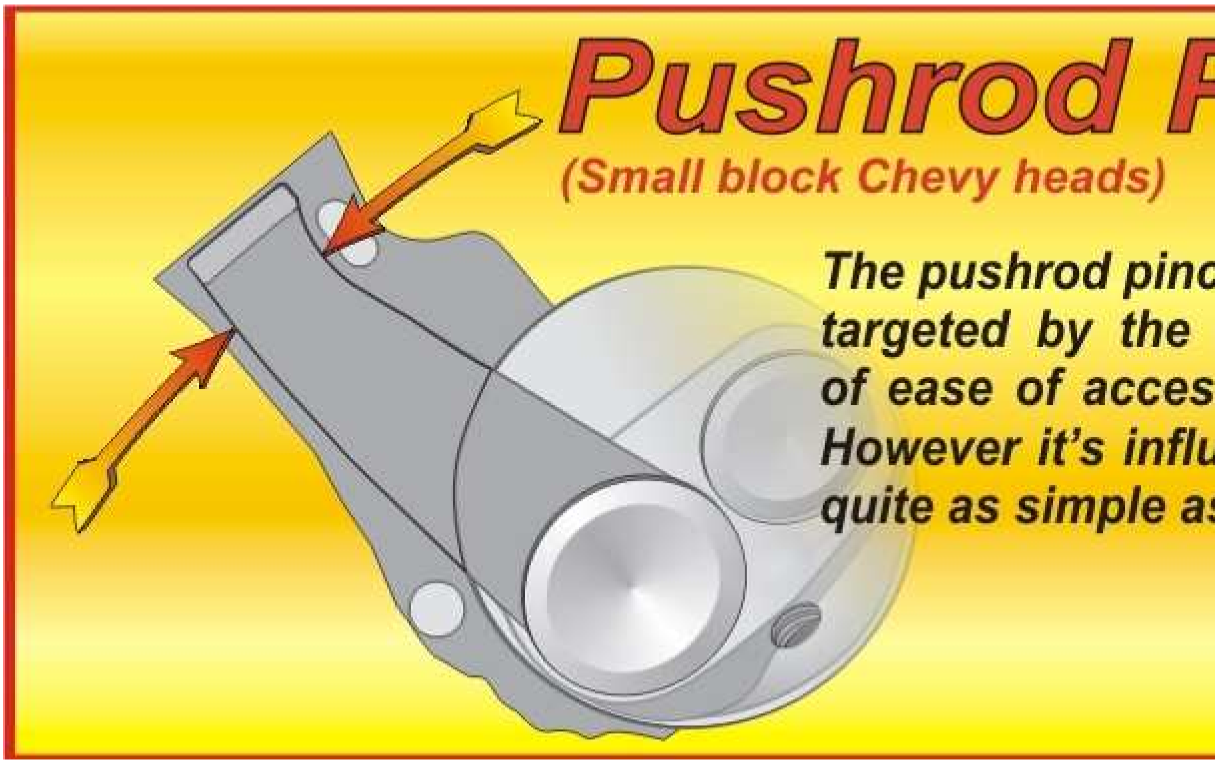
Pushrod Pinch Point Po

Problems and Solu

By

David Vizard

We will start by defining the pinch point of a typical small block Chevy intak point simply because it is by far the worlds most modified engine and therefore represents a majority c lesser degree, to those heads that closely resemble the small block Chevy heads. The Chrysler 318 – 3 the only ones. If the engine you are working on has a port that is Chevy like in appearance then much define the pushrod pinch point. Below we see an illustration that does just that.



The top and to the right arrow above shows how the port wall is pushed inward by the n response to this squeezing in of the port is that it must be a prime restriction to flow. Th restriction is not the power robbing element that it may first seem. Also it's elimination ca flow may have increased. All this points toward the fact that when it comes to cylind

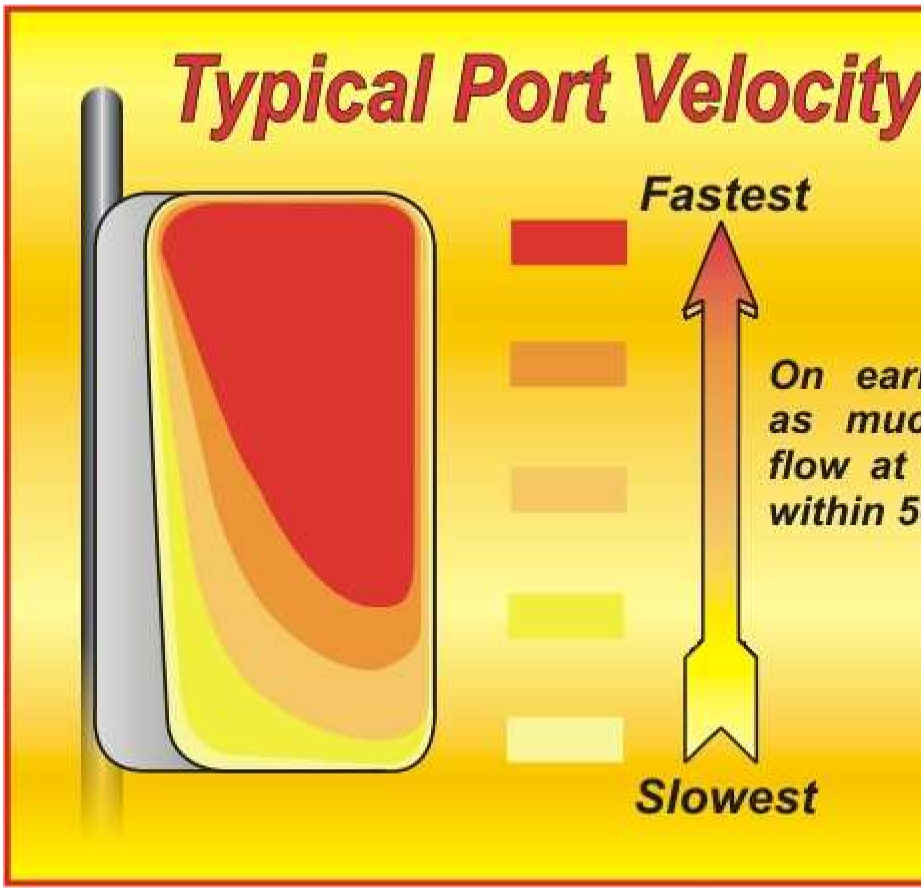
Pinch Point Efficiency.

The prime reason the pinch point is attacked in the first place is to free up what appears to be dorman The logic here is that this move will free up flow so that the rest of the port downstream has access to investigate further it proves to be far less positive than might be initially expected. Here's why. If we lo a venturi.

From this illustration it can be seen that the 'Pinch Point' at the pushrod location closely m i.e. really well. In practice it's flow characteristic would also closely follow what you woul down stream of it.

Unfortunately as much as it simplifies how we visualize it the pinch point's is strongly influenced by the simple an issue to deal with as might be initially supposed. In other words there is more to it than just

An important aspect to appreciate here is that the flow is not uniform across the port at the pinch poin of a typical 'as cast' production small block Chevy head.



Note how most of the air is flowing in the top right had corner – that, on this handed port is thew cylin image of this. The difference in velocity between the red area and the yellow is about a 3 to 1 ratio. Th moving at 100 ft/sec. By the same token it also means that the kinetic energy per unit area of the red s the yellow section. The form of this velocity map brings about some porting aspects that we need to gi enlarged in an area where activity is low then the effect toward increasing airflow will also be low. This establish why they are flowing at such a high velocity and ask ourselves if this high velocity makes the our options here.

On the left is our basic pinch point velocity map. To the right of that are some of the
immediately up and down stream of the p

In the above diagram port #1 is about average for what we see in a stock casting. Whether intentional at the top than at the bottom. This is OK as the top of the port is far busier than the bottom. What this extras flow achieved was mostly from the widening of the top half of the port.

If we know that the airflow is predominantly toward the top of the port we should ask ourselves if port greater part of the port would be flowing at high speed so not only would the flow have gone up but al has would have gone up. This would have done so in proportion to the flow increase and as a square f

There is also another factor here. Fuel drop out always congregates on the floor of the port. Generally, onto the floor of the port. Here we see a prime example of applying porting rule #2 (from porting Scho wants to go, not the way you think it ought to! If we work the area where the port is most active we a

Let's go one step further with efforts to rework the busy part of the port to the fullest extent allowed b two adjacent ports is 3/16th to as much as ¼ inch. There is no reason why this needs to be as wide as the illustration above. And guess what – it works!

I mentioned fuel drop-out a moment ago and that brings me to a wet flow situation that is worth addre slower than the top the wet flow along the floor is difficult to reintroduce into the air stream. Take a lo area. In this instance the floor and the sides have been filled to cut the less functional area of the port normally makes a marginal reduction id flow from the mid point up but it works wonders for the wet flo is a vertical wall. In other words it looks like a perfect manifold miss-match in as much as it is a step. W stream from entering the head port without any impediment. When the fuel reaches this 'dam' it builds

So does the floor located fuel dam work? Yes -- but you need to understand the circumstances under w effectiveness of the short side turn. The higher the short side turn is the better the approach there is to pinch point a more active area. This leads to less of a problem with wet fuel drop out. If we add to this atomization and an intake manifold that has good fuel support and distribution the need for the port fu gains with highly functional CNC heads when an intake manifold mismatch that forms a step at the bot the port in the head) actually delivers better results everywhere.

What's Most Important – Approach or Departure?

One aspect that is worth highlighting is the form of the approach too the pinch point and the form of th down stream of the pinch point is more important than the approach. This is sort of bad news if you ar streamlined form on the approach side but far harder, due to access limitations, to do so on the down see it, don't short change it. Apply as large a radius as possible, consistent with retention of casting int

you have a swirl meter you can expect to see diligence here rewarded with more flow but slightly less s
the cylinder wall side of the port from the pinch point right down to the bowl and around the guide bos
near future.

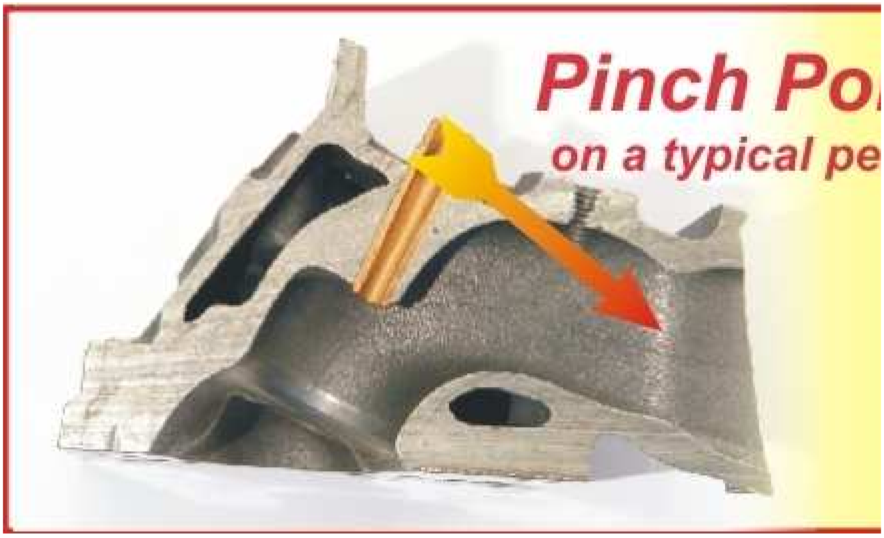
Eliminating the Pinch Point

Way back I decided that it looked like a good idea to eliminate the pinch point. I had a set of Brodix he
chance. Some offset rockers would be needed to do this as would a set of lifters with the pushrod picku
pinch point bumped top end flow – but not by that much. Still every bit counts. On the dyno the results
up and at 7800 there was an advantage of about 7 hp over the best I had done to date. But below abo
disappointing. So what was different here? When I cut the pinch point out entirely I noticed a measura
would be below the rpm the engine would run at while racing. Obviously that was not the case. The pi
onto the cylinder wall side of the port. That's the area that needs to be busiest to generate the best sw
in an effort to maximize high lift flow is not actually a good way to go. If you are hopping up a true str
the presence of a reasonable pinch point is actually an advantage.

Although the pinch point might just be a good source of swirl we still would like to maximize flow so is
answer here is there is not an easy 100% fix but there is a simple half way solution toward generating
the illustration below.

What you see here is the cylinder side port wall depressed opposite the bulge of the pinch point. As dra
on the port wall at this spot. In reality you can only depress this wall about 0.030 inches and then only
the flow gains reverse to losses. The good part about this is that the swirl usually goes up a little as we
aftermarket iron heads showed, with a before and after test, gains from just before peak torque on up.
especially when it comes with no downside.

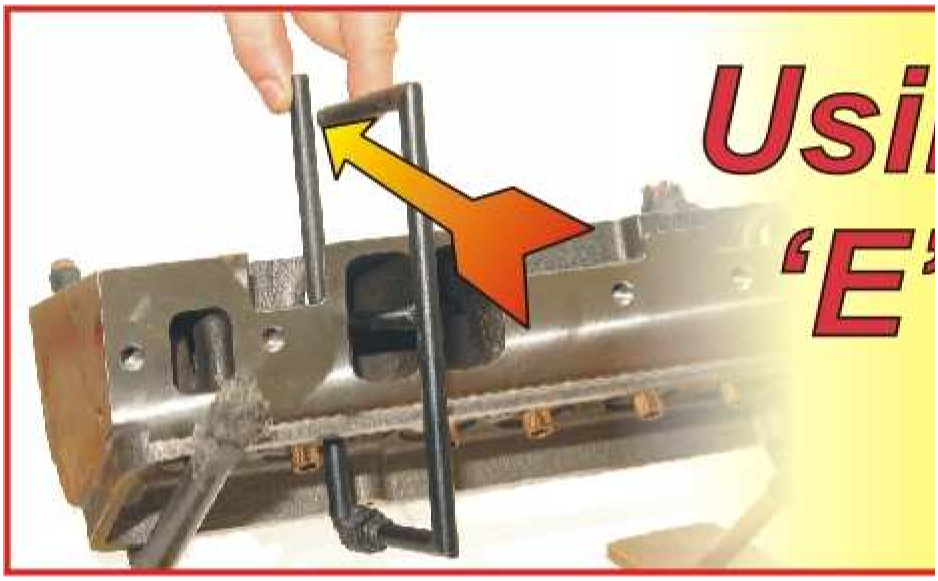
Physically Optimizing the Pinch Point



What you see here is a cross section through a highly functional aftermarket iron perfc position of the pinch point and secondly the large approach radius on the short side turn half of the pinch point a more flow active area. On a head casting like this making the important issue – especially if the intake valve sizes are maximized. The questi

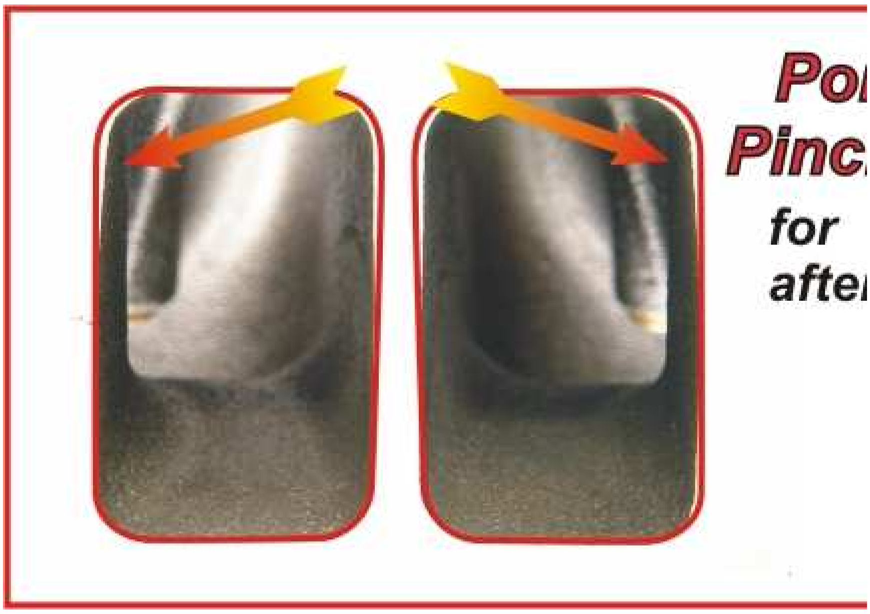
Let me tell you how I used to rework the pushrod side port wall at the pinch point. I would painstaking small squares continually check to see what material was left. At best it was slow especially as the limit experience there were more than the odd few occasions when I went through into the pushrod void an experienced porter. The answer here is the 'E' Tool from Dr J's Performance, 436 Montgomery Street, (Performance - Home.

Here is what the 'E' Tool looks like and here is ---



------------ how you use it. When located as shown here the gap at the arrow is twice the w the pushrod void and the horizontal bar in the port. It's fast and simple. In most instances the head to continue working. One you have used this tool you

I have been using this tool for the best part of 18 years now and the first time I used it I came to the c (it's that guy again) Roger 'Dr. Air' Helgesen this tool offers more than convenience and speed. It's use Not only can the amount of remaining material be super quickly determined but also by moving the toc the point of minimum width needs to be. This in turn give a clear picture of the point at which the port radius can be applied here for best flow results. In all, this tool finds CFM fast and saves the embarrass



What you see above is a typical shape I target for a hi-perf aftermarket head casting wh Points to note are as follows. First the width is only maximized at the top of the ports as in about the half way mark . At the bottom of the port the pinch point is only given a clean u it. On the other side of the port – that's the cylinder wall side – the port is widened right c trimmed to suit here). As can be seen the form will mean that the port is wider at the top t part of an overall mod program that results in CFM numbers bigger than normal for the p

than average top end power without the often seen l

Here is the pinch point on one of AFR's entry level budget CNC heads. The light color arou radius in case you wondered why it was not shinny and picture perfect. The subject here i executed but none-the-less conventional looking parallel wall top to bottom pinch point. F they want is the large short side turn radius used on the approach to the seat. This allow more nearly parallel pinch point opening. Also take note of the port size. This is a 195 cc p be too small for their need to satisfy there power lust. But sound port design has allow space/volume available. We have seen very good results with these heads

David Vizard

Other parts in this series are at:-

In addition to the Porting School articles there are directly related

following sites:

Wet Flow :-

Six Wet Flow Mistakes

Combustion Dynamics:-

#1:- Turbulence and Combustion Dynamics

#2:- In cylinder Turbulance and Combustion Dynamics

#3:- Turbulance and Combustion Dynamics - Part 3

#4:- Coming soon

#5:- Turbulance and Combustion Dynamics - Crevice Volumes - Stealth Power Thief

Last edited by DavidVizard-GFN; 09-18-2008 at 09:06 PM.

09-13-2008, 05:54 PM #**2** (**permalink**)

99R/T OFF
Garage Sweeper

Join Date: Jul 2008
Posts: 5

Another great article, thank you David.

A few questions though.

Assuming you raised the port as high as possible, and opened the pinch and opposing wall as far as you could (as in shape #4), but the minimum CSA was still too small, would it be better to continue opening the pinch as in shape #2 to achieve the required CSA, or would it be better to keep the CSA on the small side and keep the velocity higher along the floor?

Is there a rule of thumb regarding the angle/distance/shape of the reverse taper on the pushrod side between the pushrod pinch and the bowl?

And tying these together, if there is a rather steep taper between the pushrod pinch and the bowl, and the minimum CSA required you to open the full length of the pushrod pinch, wouldn't this be the way to go in order to reduce the amount of taper angle in the CSA between the pushrod pinch and the bowl?

Thanks,

John

QUOTE

09-16-2008, 10:41 AM #**3** (**permalink**)

Join Date: Apr 2007
Posts: 840

DavidVizard-GFN OFF
Pit Crew

99R/T

John,

I am going to make a bet here that this question is one that many other readers have also framed in their mind. It is not an easy one to answer as it means making a judgment call or dyno testing a few configurations to establish. However let's go through this and build on a couple of scenario's that will illustrate the situation as it relates to the CSA.

Here is your post:

Q. - Assuming you raised the port as high as possible, and opened the pinch and opposing wall as far as you could (as in shape #4), but the minimum CSA was still too small, would it be better to continue opening the pinch as in shape #2 to achieve the required CSA, or would it be better to keep the CSA on the small side and keep the velocity higher along the floor?

A. - To best answer this I need to pose another question. Let us say that there is no (as in zero) air flowing at the bottom of the port. If this was the case then opening up the port to give the CSA you think it wants would achieve what? Answer - pretty close to nothing as nothing much other than the CSA will have changed. But when you calculate the port velocity at which peak power occurs the answer you get will be a lower number than before it was opened up. This little mind experiment will tell us that the CSA is not the be-all and end-all of port sizing.

But that example is an extreme case. If we back away from that situation a little we find that we are in a situation we looked at in PS#7 - namely the effect of port volume on the power curve.

Because most of the V8's we are dealing with will be of a displacement that is way too much for the heads flow capability we find that there will be a time when the engine becomes starved of air to the point that any extra flow, even if it is low grade from a slow moving part of the port, helps the engine make more power. The real issue here is a how effective the CSA is. If there is a big velocity gradient across the port then the peak power intake velocity based solely on the CSA will be much lower than the peak power velocity based on a port with near zero velocity gradient. An example here off the top of my head. The peak power Mach # for a typical pushrod engine with a typical velocity gradient will be about 0.55. However an all out, purpose designed, four valve unit along the lines of an F1 engine will have the peak power Mach # up around 0.65. The point I am attempting to make here is that the CSA can only be used as an absolute yardstick for determining the peak power rpm (or visa-versa) if the velocity gradient across the port is near zero.

If it is not near zero than the more we try to extract from the engine in terms of maximum output the more the power becomes dependant on total flow even if it's achieved from an area of the port that has a poor return in relation to the area increase. But in following this route we will usually see a substantial degradation of output below peak power. The old 'Tunnel Port' Fords of the 70's were a prime example of poor area utilization and as a result the power curve was best suited to a Bonneville engine.

To sum up the rule here should be to make the most of any high flow area first and then see where you might need to go for any additional flow that you think may be beneficial to output - even if it is low grade. This is where a dyno comes in handy.

Q.- Is there a rule of thumb regarding the angle/distance/shape of the reverse taper on the pushrod side between the pushrod pinch and the bowl?
A.- Best I can offer here is that the departing radius needs to be as large as possible and the departing angle needs to be 12 degrees or less.

Q. - And tying these together, if there is a rather steep taper between the pushrod pinch and the bowl, and the minimum CSA required you to open the full length of the pushrod pinch, wouldn't this be the way to go in order to reduce the amount of taper angle in the CSA between the pushrod pinch and the bowl?

A. - Exactly right - but this is a judgment call one again. If we are talking of maxed out inches we will see that any flow increase from almost whatever source is good but if there is a decent match between CID - RPM and head flow (lets say 300 cfm intake flow at 0.600, a 350 inch engine and peak power at 6000) then we could make the power curve worse by indiscriminately grabbing any flow from any low grade source.

Granted the CSA answer may seem a little convoluted but I am sure as we progress with our PS series it will become clearer.

DV

QUOTE

09-16-2008, 11:17 PM

#**4** (**permalink**)

old blue 75 OFF
Garage Sweeper

Join Date: Mar 2008
Posts: 83

David a couple of questions.

1. Can you draw up a little sketch to show where you are measuring this angle from.

Quote(Q.- Is there a rule of thumb regarding the angle/distance/shape of the reverse taper on the push rod side between the push rod pinch and the bowl?
A.- Best I can offer here is that the departing radius needs to be as large as possible and the departing angle needs to be 12 degrees or less.)

2. Can you at some point do a write up on how thin certain ares of a head can be before they get to week. Things like port dividing walls, bowl to water jacket port roof thickness, combustion chamber to water jacket and things like that.

Thanks old blue 75

QUOTE

01-30-2009, 07:51 AM

#**5** (**permalink**)

MCEcomp OFF
Garage Sweeper

Join Date: Mar 2008
Location: Melbourne Australia
Posts: 8

What happenes when you get a 23deg SBC with 280@.050 and you want to run it up to 8000.
Do you start enlarging the pinch as much as possible???

QUOTE

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