Chasing a moving target—peak HP RPM!

Too many trail riders/ racers come here to tune their engines, and still think that they need clutches to shift at dyno test torque peak, and then slide up to dyno test HP peak on long runs. And too many smart people still think that shifting at peak torque creates best acceleration. While completely incorrect from a physics standpoint, that concept can work because the cool-pipe horspower peak is often about the same RPM that the hot dyno test pipe max torque occurs at! I spend lots of valuable dyno test time explaining/ showing this, so that performance sled people can maximize their clutching. Confused? You won't be after you read this.

There is a treasure trove of information in the archives on this website. There are so many things we've learned about, and recorded for posterity beginning 25 years ago, and it's all there for reading/ rereading. Everything that we know today was learned on the dyno, and much of it was learned back in "the good old days" when 130 HP could win open mod dragraces! Most young people who join this website have 130-160 HP stockers and are not interested in antique things that made half of the power you get today, and ignore the archives. But there is much valuable info there! Our association with Kevin Cameron has been vital in our understanding of two-stroke engines, and in explaining/ clarifying the many things that bewildered us during dyno testing/ tuning over the years—I tried to document all of that back then, along with Kevin's helpful explanations. We would have surely been lost without access to Kevin Cameron's experience and knowledge that he has graciously shared with us over the years. In the archives there are dozens of tech articles by KC (The Cellar Dweller) that I go back and reread to refresh my thinking every year.

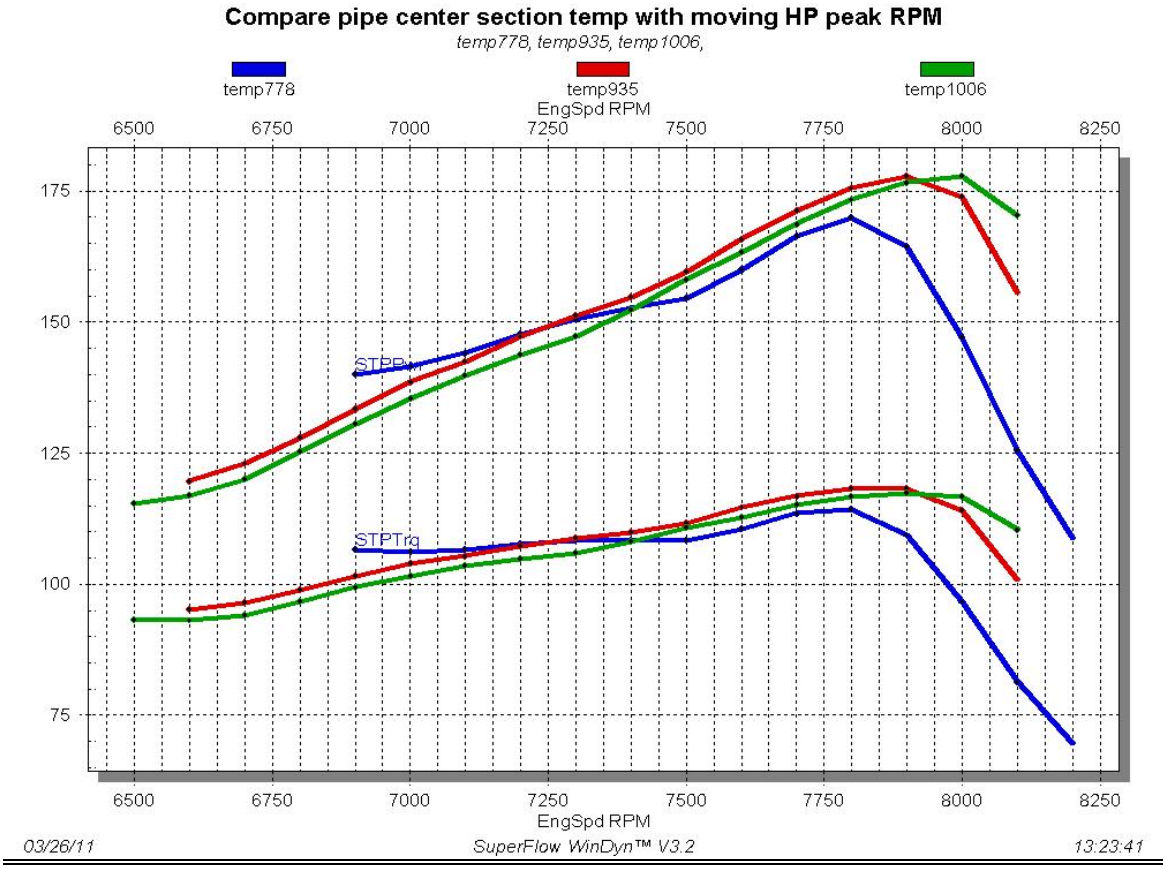
I recently reviewed the TCD article on pipe temperature in Volume 5 #4 beginning on page 13. This was a collaboration between Kevin and me, about 15 years ago, to show/ explain how and why exhaust pipe temperature influences the RPM that peak horsepower occurs at.

So it might be good now to just scroll down in the archives to V5 #4 see what we did back then. It was the first time we had instrumented an exhaust system with internal temp probes—5 in all—so we could see how the average temperature of the exhaust gas would change over time at WOT, drastically changing the speed of sound inside the pipe, and changing the effective tuned length! And the results are explained there by Kevin Cameron.

And here is a modern graph of several tests we did on a mildly modified 2010 Arctic Cat Crossfire 800 with D&D Y pipe/ single pipe tuned to max HP on pump gas for hilldragracing. Here, I removed the factory temp sensor and installed a mechanical dyno sensor that measures temperature and pipe backpressure. On late model 800 cats, disconnecting the temp probe causes the ECU to default to 960 degrees F where max timing is delivered (the ECU usually retards timing at lower EGT to speed the rise in pipe temperature to what AC feels is optimal). But I wanted to show this fellow what RPM his HP would max at with varying pipe center section temps. So each test is shown in

degrees F measured at the factory probe location in the middle of the center section. Now keep in mind that on typical dragracing the pipe temperature is probably closer to 4-500 degrees F when the throttle is first whacked open, causing the HP peak to very likely be 7600-7700. But if I just handed him the green test dyno sheet with 1006 degree temp with no explanation, he might try to get clutched to shift at 8000 RPM, or if he was trying to clutch for the "torque peak" shifting at 7900. Even trying for "torque peak" which is still much higher RPM than cool-pipe HP peak he might lose 25 to 50 HP, until the pipe gained the heat necessary to match the clutching!

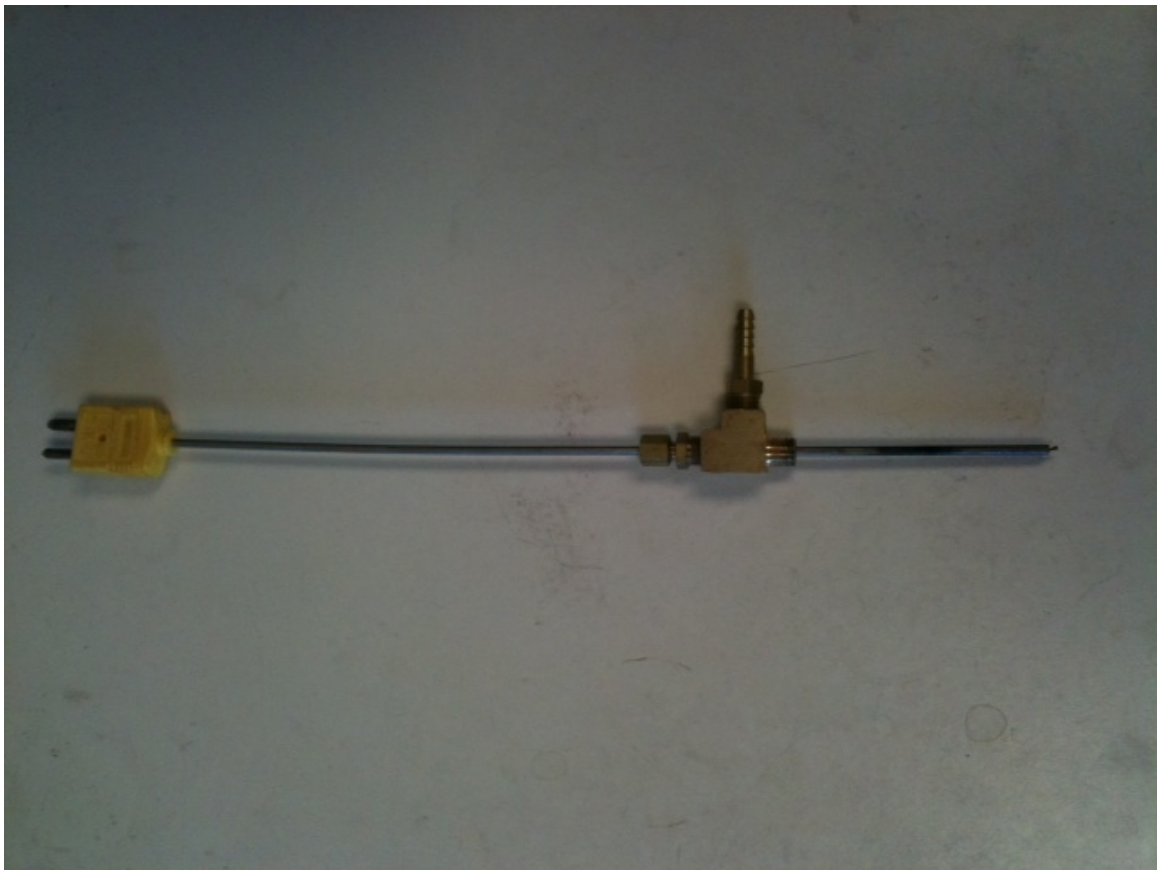
I googled "speed of sound temperature" and found that at 60 degrees F it's 1117 ft/sec, 500 F= 1519 ft/sec, 778 F = 1725 ft/sec, 935 F = 1831 ft/sec, 1006 F = 1876 ft/sec, hence the rising peak HP RPM.



Ideally, trail riders, dragracers, hillclimbers and radar runners should know their pipe center section temperature before coming to tune on the dyno! That will enable us (or whoever their dyno tuner is) to pinpoint the exact RPM their best HP occurs at. This is as simple as taking a clamp-on or welded OPEN ELEMENT (quick responding) EGT probe and fitting it to the rearmost part of the center section (or exactly in the middle of the center section on pipes with internal stingers). All we need is a low and high temp reading—then we will match those temps on the dyno, and some temps in-between to allow the owner to create exactly perfect clutch tuning, with no need to guess. For the dyno, we like a female 1/8npt fitting welded or brazed to the center section (or even the rear cone of non-internal stinger pipes) to accept the dyno temp/pressure sensor. When

you examine the temp data in V5 #4 you will se we may get better resolution in the rear cone temp, where we saw a 25% change in temp from cool to hot. But the temp in the middle of the center section changed only 15% from cool to hot—both are good areas but the added resolution of the rear cone readings could be even more precise.

Here's the temp/ pressure fitting we use on the DTR dyno—note that it's just a 1/8npt brass street T, with a skinny open element temp probe that allows pressure to be measured at the barb. All very important data!



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Today, modern data-logging equipment is within reach of most racers. No need to spend $5000 for racepack stuff. The most savvy snowmobile clutch tuners can use on-track pipe temp data along with dyno test pipe temp data to make sure their engines are at peak HP RPM from start to finish.

An example of this was Sean Ray, working in his auto engine dyno cel at Delphi in Rochester NY, helped Tim and Brian Tyler clutch their mod Polaris 600 twin drag sled at the HayDays drags last summer. Tim Tyler just emailed Sean the data downloaded from each time trial, and by matching pipe temp to revs Sean was able (on his lunch hour of course) to recommend the proper tweaks to clutching to create maximum acceleration.

We've come a long way from looking at spark plugs and guessing!