The Cause of Load Pressures Variances among Precision Rifles. By Jim See

My goal with this article is to give the reader some ideas as to physical properties that can cause pressure and velocity differences from a sample cartridge fired in one rifle versus another rifle. Hopefully this information will dispel some of the assumptions that may be floating around the net, and guide you into a more reflective thought pattern as you use internet loading advice.

For the sake of this discussion I am going to reference one particular rifle cartridge so as we don't involve any assumptions based on any other type of cartridge which may interfere with the discussion. We will example the 6.5x47 Lapua with 140 grain bullets in any referenced data or comparisons in this article.

First we need to outline some guidelines to draw our conclusions from. These ideas are generally accepted in the world of internal ballistics;

> An increase in peak chamber pressure generally results in an increase in velocity, when the pressure curve duration is the same.
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> An increase in the pressure curve duration generally results in an increase in velocity, when the peak chamber pressure remains the same.
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> Generally an increase of friction between the bore and the bullet, will create increased peak chamber pressure, and will extend the pressure curve duration.

I don't want to waste a lot of time on the obvious. Let's get to the most often overlooked creators of friction and pressure influencers.

1. Rifle bore geometry; generally barrel makers create bores to our bullets diameter so in a 6.5mm this would be a groove diameter of .264". Land top diameters are typically set to .256" or .257" depending on the manufacturer. The "lands" are the raised ribs in the barrel that engrave the bullet and impart the rotation to the bullet for stability. These lands are one of the most critical influencers to our friction. The more surface area the lands take up in the barrel the greater the friction, thus creating an increase in pressure and velocity. Land configurations vary by manufacturers. Today we can choose barrels of different makes with 3,4,5 and 6 lands in the .264" bore. Each of these manufacturers may use a different ratio of land to groove surface area, causing differences in friction and pressure. Add to the fact that some are also 5R or 5C barrels, (a designation for special radius or canted lands) which are designed to reduce friction and you can see this area of internal influence can greatly affect our end velocities. These differences are created by the differences in the "hooks" of cut rifled manufacturers, or the "buttons" of the button rifled manufacturers. Each has their own "special" geometry that they feel gives there barrels an advantage over the competition.

A quick example, I had 2 5R Bartlien barrels chambered in 6.5x47 Lapua, 2 of my Team mates had Hawk Hill 4 groove Barrels chambered with the same reamer. The rifle barrel lengths and assembles were nearly identical, we were given a supply of ammunition made in the same day with the same lot of component parts. The velocities in my Bartlien barrels were hovering at 2780 fps. The 2 hawk hill barrels were running at 2850 and 2865 fps range respectively. Clearly the land and groove geometry came into play. It was clear that the stout load of Varget was just a bit too stout in the Hawk Hill barrels, but they produced amazing accuracy with that load.

The lesson here is when comparing load data with your buddies or internet friends it may be very wise to share your barrel manufacturer and barrel specs with the person you're sharing load data with. It may be that added key that gets them to a proper load quicker.

2. Chamber Throat geometry; historically most factory built rifles pre 2000 were chambered with a lead angle of 3 degrees. This carried over to some custom rifle reamers as well. In the world of custom rifle smiths it has been a common practice to reduce the lead angles in chamber throats for many years, dating back into the early 80's or possibly earlier. Today most rifle smiths use reamers with 1.5 degree lead angles. The lead angle, which is a shallow taper cut across the lands during chambering, is what help to guide and engrave the bullet onto the lands of our rifles bore. Obviously the shallower the angle the less abrupt the transition of bullet to bore, thus reducing the engraving pressure of the bullet, and minimizing any type of bullet deformation which could be caused by steeper lead angles.

   Today many factories who have begun chambering of modern cartridges have adopted the modern 1.5 degree lead angle typified by now factory chambering like the 6.5 Creedmoor and 6.5x284 Norma.

   Hand in hand with the lead angle is the lead length or what is commonly referred to "free bore". Free bore is the area of bore just ahead of the chamber "neck" where the lands and a miniscule part of the groove are cut away, creating a place for the full diameter portion of our rifle bullet to rest in the bore when the cartridge is chambered and put into battery.

   We all understand the concept of "bullet jump" or "jamming the lands" this is where the free bore length affects our friction thus increasing pressures. The farther we can seat the bullet out of the case AND the farther the bullet is "off the lands", the less pressure a given load will generate given all else is the same.

3. Surface finish of the bore; it's hard to explain this one without some rebuttal, but I am confident in my conclusions because I have made this a point of intense investigation. "The smoother the finish of the bore the more friction is created". Now that's not to say an excessively rough bore will not also increase friction. BUT what I'm trying to relate is; the barrel manufacturers have a very specific finish they lap there barrels to. Doing this promotes minimal copper fouling, and maximum accuracy. I have bore scoped barrels where the owner decided using an abrasive

paste every 20 rounds was a good thing, and the finish had the reflection of a mirror polish, completely unlike the nice lapped textured finish a new custom barrel blank has. These barrels with a smooth high polish will increase; friction, heat, pressure, and copper fouling. We proved it; if you choose to try it you will ruin a barrel. After we took 10 JB soaked patches on a tightly fit jag, each stoked 10 times in an experiment barrel, and the same load fired in the gun pierced primers every shot.

My point is Barrel finish can affect friction/pressure/velocity, so if your concerned that your identical rifle to your buddies runs 20 fps slower with the same load , don't have a complex, it's not a big deal. Also we don't want to change the surface finish of our barrels from what the factory produced, so use abrasive cleaners sparingly and carefully, or avoid them all together.

4. Powder charge weight and powder burn rate; most of us should have the proper understanding of this. Given 2 different powder speeds that generate the same peak pressure. The faster the burn rate of our powder the sooner we hit peak pressure and the sooner our pressure curve declines. With the proper burn rate powder we get a peak pressure that sustains itself longer while the bullet is in the bore thus accelerating our bullet faster with the same amount of pressure. On the same token if our powder is too slow our peak pressure comes too late and our pressure curve was too post mature to get our bullet up to the proper speed.

   The perfect example of this in the 6.5x47 Lapua is the relationship of Varget to H4350 to H4831sc. Varget is on the fast side for the 6.5x47, it produces great accuracy but will show ejector marks at a lower velocity rate than H4350, which is seemingly the ideal powder for both accuracy and velocity. Whereas H4831sc is capable of excellent accuracy, the pressure curve starts too slow in the small 6.5x47 case and is incapable of driving the 140 grain bullets to an acceptable velocity level.

So you may be asking why Jim tossed in this bit about powder when it seems the entire article revolved around fixed parameters inside the barrel and chamber. Well I want you to consider the anomalies of bore geometry to the proper burn rate powder choice. I know for a fact most 5R or 5C barrels take more powder to get the same velocities as some other rifling styles, so with the change in barrel land groove geometry it may be wise to consider trying a different powder in those barrels that show early signs of pressure that we are normally surprised and upset by. Combining that with a radical change in seating depth may be just the ticket to get a new powder choice performing in a barrel.

What makes us unique is our ability to reason and seek answers to problems, I hope this article stimulated you to consider the possible causes of anomalies you may have encountered in your shooting career. By grasping these concepts you may set yourself onto understanding any past or future issues you may encounter.

Keep them on the Steel.