How to torque lugs…and why!

Let's first start with the "Why?" aspect of tightening lug nuts. Books have been written on the science of torquing fasteners. It can get very, very complicated, but we will do our best to break it down so that you are armed with everything that you need to know in order to be safe.

The maximum amount of torque applied to either the lug bolts or the lug nuts follows the recommendations of the ***fastener*** manufacturer (not the wheels) and always applies to the male portion of the threaded fastener. In other words, you could change wheels and/or lug nuts and the recommended torque value would stay the same (please note that aluminum lug nuts are not always included in that statement).

Almost every aftermarket stud/lug bolt manufacturer that we have spoken to has recommended 95 ft lb for the torque specs of their wheel fasteners. And most of us know that the stock Vanagon studs/bolts have a much higher torque value than that (122-133 ft lb, depending on the source).

Over torquing any fastener can result in catastrophic failure. Here is the reason why:

When you torque a fastener, the male threaded portion elongates and the female threads compress. The interference fit between the elongated male threads and the compressed female threads, combined with the residual tension left in the bolt, is what gives you the proper clamp load that holds the wheel in place. In other words, the combination of the male and female threads locking together and the stud or bolt stretching to a specified point are what keeps your wheels on tight.

The specified torque value given to a particular fastener ensures that the male threaded portion stretches to a point that maintains elastic deformation. Elastic deformation of a fastener is below its yield point and is sort of like a rubber band. You can stretch it out (to a certain point) and it returns to its original length when the torque load is removed.
If you over torque a fastener, the male threaded section can reach a point where plastic deformation occurs. This is an irreversible state where the metal has stretched beyond its yield point and will no longer return to its original length. At that point, the fastener is junk and can no longer be considered safe to use.

Now luckily for us, and just like a rubber band, there is a reasonable range between where the wheel fasteners are torqued enough to keep the wheels on tightly and the yield point where the fasteners will begin to fail. This means that there is decent range of tightening specs that can allow for varying torque wrench values (or lack of any torque wrench at all), varying forms of thread lube (each lube changes the friction between the threads differently) or anything else that may have an impact of the torque of the lugs. While this range is forgiving, it is not infinite. This is the exact reason why it is so important to use a decent torque wrench when tightening lugs. Without a torque wrench,

you have no way of knowing if you have stretched the fastener tight enough to stay tight long term or if you have over-stretched the fastener resulting in damaged parts (seen or unseen).

Adding any form of lubrication (oil, grease, anti-seize, etc.) to the fastener can allow the fastener to easily be over-torqued. Here is why:

With 100% clean and dry threads, roughly 85-90% of the torque that you apply to the fastener goes into overcoming the friction between the male/female threads and between the head of the fastener and the surface beneath it (this would be the lug seat area of both the lugs and the wheels). That leaves only about 10-15% of the torque value that is actually applied to the clamping load that puts tension in the fastener and keeps the wheels clamped in place.
If you were to add any sort of lubrication to the threads and the head of the fastener, the amount of friction between those two areas will be reduced during torquing which will translate to more of the torque value being applied to the threaded/shank area of the fastener. In other words, let's say that you reduce the friction between the head and the threads by 20% by adding lubrication. This means that now only 65-70% of the torque value is being used to overcome friction and 30-35% of the torque value is applied to the threaded/shank area of the fastener. This would result in a fastener that is over-torqued by roughly 20%, which could result in the fastener reaching plastic deformation and therefore rendering it unsafe for use.

Now here is where it gets a bit tricky when this information is applied to lugs and wheels.

Most of the charts and information that we have seen about how much to reduce a given torque value when adding lube to the mix seem to assume that lube is added to both the threaded portion of the fastener as well as the head/clamping surface. Most of the information and charts suggest somewhere around a 15-20% reduction in torque value when lube is included.

When talking about wheels, we don't (shouldn't) ever add lubrication to the head of the lug nuts or bolts where the heads meets the wheels (this area is called the "lug seat").

Since roughly 50% of the friction created during torquing comes from the friction between the head and the mating surface (and roughly 40% is used to overcome thread friction), and since we only lube the threaded portion of the wheel hardware, we feel that it is safe to assume that we can reduce the normally recommended 15-20% reduction in torque value (if using lube) to around 7-10% without getting into a situation where we are over-torquing our wheel hardware.

Now, since we are only talking about a 7-10% reduction in torque value when adding lube to the threaded portion only of the wheel hardware, and considering that there is a reasonable amount of tolerance within the limits of the wheel hardware in regards to what is tight enough and what is too tight, we usually don't make too much of a big deal

between lubed or unlubed wheel hardware. In other words, if the recommended dry torque value is 95 ft lb and we add lube to the threads only, a 7-10% reduction in torque value would be roughly +/- a 6-9 ft lb difference. In our opinion, that is usually within the tolerance of most quality wheel fasteners and isn't really worth getting too worked up about.

On the other hand, under-torquing lugs can be just as bad as over-torquing. Tests have shown that under-torqued fasteners will loosen sooner than slightly over-torqued fasteners.

Everything above is based on theory combined with tests of known parameters. In reality, we deal with so many different variables when it comes to wheel hardware that it's best to take the information above and combine it with experience to come up with a reasonable set of parameters for torquing our lugs. In our experience, torquing aftermarket 14x1.5 lugs to 95 ft lbs, lubed or unlubed, has proven to be a very reliable method of attaching wheels. For stock VW Vanagon hardware (bolts or studs), we usually increase the torque a bit just for peace of mind, but others have reported that they have years of reliable service when torquing to 95 ft lb, so again, there is some margin for manipulation here.

Now that you have a little better understanding of why torquing lugs is so important, let's have a look into the proper torquing procedure.

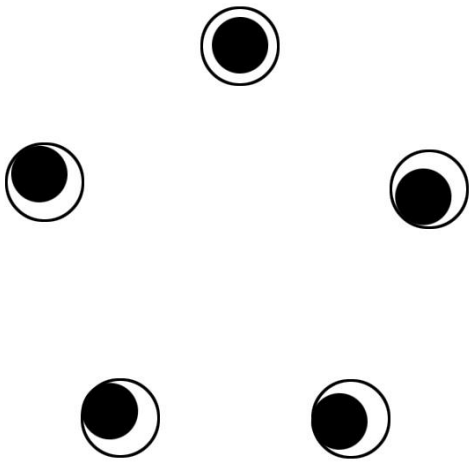
The number one rule of tightening your lugs is to ***NEVER*** use an impact wrench to tighten your lugs. A torque wrench is the only accurate way to know if your lugs have been tightened properly. Yeah, we know that you see guys using impact wrenches all the time at local repair shops. However, if you watch closely, a good, quick mechanic will only use the impact wrench to remove the lugs and to speed up the process of spinning the lugs back on to a point that is well below the torque specs. In other words, using the impact wrench allows the mechanic to speed up the wheel installation process, but experience is needed to know when to stop the impact wrench prior to reaching the maximum torque specs. Once the lugs are all run down close to being tight, a good mechanic will then switch to a torque wrench to finish the job. This process is much faster than spinning each lug on by hand, but extreme care must be taken when do this.

We have often witnessed "professionals" who do not know how to properly use an impact wrench to speed up their process. Instead, they use the impact wrench to tighten the lugs too tight, then they grab the torque wrench to finish the job. If you watch these guys closely, you will see that even though their torque wrench "clicks" (indicating that the torque specs that have been set on the wrench have been reached), if you watch the lugs, you will notice that they don't get any tighter. How can this be? Well, when you set a click-type torque wrench to a specified setting, say 95 ft lb, you will hear an audible "click" when that torque spec is reached. However, you will still hear a click at 95 ft lb if you try to tighten a fastener that is already torqued to a value higher than that.

So for example, say the inept mechanic uses the impact wrench to install the lugs and the lugs get tightened to 120 ft lb. Then he takes his torque wrench and sets it to the proper torque spec of 95 ft lb. On each of the lugs that he applies the torque wrench to, the torque wrench clicks at 95 ft lbs making it appear that all the lugs have been tightened properly when in fact, they are all over-tightened. So to the customer the mechanic looks like a true pro, but the reality is that they just over-tightened your lugs to 34% more than is acceptable.

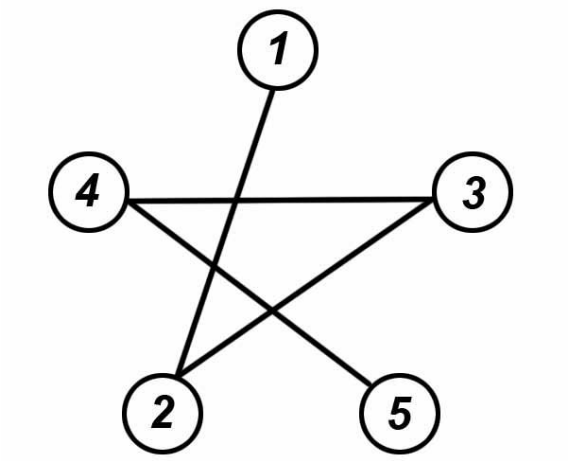
The lesson here is that unless you know exactly what you are doing with an impact wrench, never use it to tighten your lugs…ever!

Another common mistake that we see people making is to tighten one lug at a time all the way to the maximum torque specs before moving on to the next lug. When you do this, you run the risk of having the wheel tightened to the hub off center. By torquing the first lug all the way, it is possible to lock the wheel into a slightly off-center position which will cause a slight vibration at speed.
This problem compounds if the wheels are torqued with the weight of the vehicle on them.



The best procedure is to tighten each lug by hand whil wriggling the wheel to ensure that the lugs seat properly in the wheel. Do this a little at a time. If you have to use a lug wrench (or ratchet), just be sure that you very light on the tightening so that if the wheel is off-center, the other lugs can pull it back to center as they are tightened.

It is also very important to tighten each lug in a star-type pattern as shown below. This helps center the wheel and distributes the torque loads evenly.



Tightening sequence

If you follow all of the information and procedures offered here, you will be able to install your wheels with the confidence of kowning that you did it correctly and that you and your family will be safe.