WEEKLY BLOG

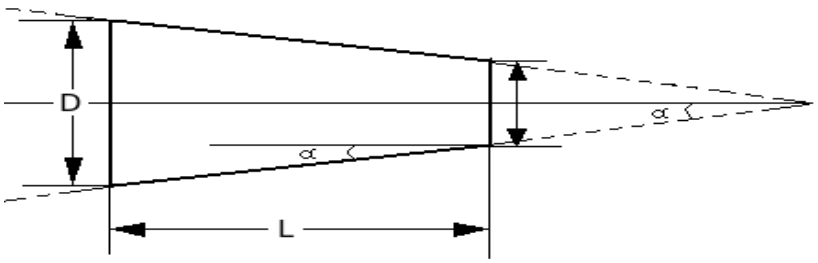
The Total Breakdown of Taper

Here at Gauge Training Inc., we aim to keep you informed on all the most up to date information on thread measurement, proper inspection techniques and correct gauging practices. In this weekly blog, we will focus on one specific aspect within the above mentioned gauging categories. The purpose of this blog is to educate the industry on proper gauging and inspection techniques which will in turn increase productivity, decrease waste and improve the overall quality in the industry. Every other week we will choose a new subject and detail to focus on, define it, and finally provide you with details on how and why it is so important.

This week's gauging category takes a step back and focus on Thread Taper as a whole. Sometimes when we focus on a specific detail, we can lose sight of the big picture. This week we will define thread taper, discuss the importance of taper, how to properly measure taper on the various connection types, the effect taper error has on standoff and lastly, we will touch on the differences between different manufacturers gauges.

What is Thread Taper?

- API Definition – the increase in pitch diameter of the thread, measured in inches per inch of thread.
- Physical Description – the increase of diameter within a specified length along the pipe. Typically measured over 1" intervals.



For round threads and line pipe threads, taper shall be defined as the increase in the pitch diameter of the thread, in "inch per inch of thread" ("millimeter per millimeter of thread"). For buttress threads, taper is defined as the change in diameter along the minor cone of the external threads and the major cone of the internal threads. On all threads, taper tolerances are expressed in terms of "inch per inch of thread" ("millimeter per millimeter of thread") and taper deviation shall be determined accordingly. The measurements are made for the specific interval lengths and the observed deviation shall be calculated to the "inch per inch of thread" ("millimeter per millimeter of thread") basis.

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When measuring Thread Taper, you are essentially measuring the pitch diameter of a thread then comparing it to another pitch diameter of a thread further up the connection. All taper measurements are taken by using a specific contact point size, depending on the pitch of the thread, which sets inside the thread contacting each flank tangent to where the pitch line (pitch cone) is located. The pitch line of a thread is an imaginary line that runs through the middle of the threads so that along the pitch line, the distance of the thread is the same distance as between the threads. If you are not using the correct contact point size, then the contact point will not sit in the thread where it should be causing an incorrect reading. The inspector must make sure the contact points are the correct size using a caliper or a micrometer to verify before inspection.

Why is Thread Taper important?

Depending on the application for your pipe, will determine if you need a tapered thread or straight thread. Just like the other individual thread elements, API says that you shall measure it, so it is a necessity.

Piping and fittings are primarily used to carry liquids or gases to the surface. In order to properly carry the liquids or gases to the surface, the threaded connections must have a gas tight seal when torqued together. Tapered threads make for better seals when torqued together. When torqueing the connections together, the male and female threads compress and wedge themselves together resulting in a stronger and more leak resistant seal. In order to guarantee that gas tight seal when torqued together, a sealant is applied to the threads to fill any voids between the two mating threads. These sealants also function as lubricants between male and female threads.

How does Thread Taper effect Standoff and functional diameter?

As we focus in on each of these individual thread elements, in this case taper, we must also look at the bigger picture and how it will affect the rest of the connection. Many companies will use ring or plug gauges to measure standoff or functional diameter of a part. This will give you a general outlook on how the connections will fit together, but it doesn't give you the full scope of what is affecting the standoff reading. Using ring or plug gauges cannot give you specifics about any one individual thread element, because it is a measurement of diameter, taper, lead, flank angle and form error all at once. Is it very common for a ring or plug gauge to show bad standoff measurements, when the actual individual thread elements are all within tolerance which means it is actually a good part. First, let's define standoff and then look at how taper will affect this reading.

- **Standoff (API Definition) –** the distance between faces of gauges or gauges and product reference planes when mated.
- **Physical Description –** the distance between the ring or plug gauge face and the connection face or shoulder.

Now that we have defined taper and standoff, let's examine how they correlate to each other. In order to properly calculate the effect on standoff, you must first know the taper of the part you are inspecting as well as the deviation in pitch diameter. We need this information because standoff is a function of taper and pitch diameter. Once you have these dimensions, we can find the deviation needed to locate standoff with the following formula:

(12/TPF) X PD (deviation) = Standoff

Ex: (12/.75) x (+.003) = +0.048"

First you divide 12 by the TPF of the part and then multiply the result by the pitch diameter deviation value. In the above example, we used the TPF of ¾" and a pitch diameter deviation of +.003". Based off these dimensions, we calculated the standoff at +.048". For standard API ¾" TPF 8 round connections, the tolerance for your standoff is +/- one turn or +/- 0.125". So, based off our calculated value, any calibrated ring gauge should achieve the correct standoff. This of course is not accounting for the other individual thread elements, which could further affect the standoff reading. This calculated value is also the amount of material needed to be removed in order to bring the part to the proper standoff tolerance.

Another important aspect to remember is: the less steep the taper, the greater effect that a change in pitch diameter will have on the standoff. After seeing how the standoff is effected by ¾" TPF on Tubing & Casing connections, let's see the effect is has on Rotary Shouldered Connections with steeper taper degrees.

(12/TPF) X PD (deviation) = Standoff

Ex: (12/2) x (+.003) = +0.018"

As you can see in the two examples above, the RSC connection has a much larger degree of taper, yet the resulting effect on standoff is less than that of the T&C connection example. You can see that the resulting effect on standoff is significantly higher when the taper is less steep.

Common causes of Taper Error

- Hardness of the material
- Thickness of the material
- Speed of the threading
- Tool push off
- Chuck not level

Preventative Actions

- Check you taper on parts in the machine
- Measure taper independently
- Always check you program information
- Check your threading inserts

In conclusion, you can see how taper error can exponentially affect standoff as well as pitch diameter across the various connections. Taper error is a huge problem for companies using ring and plugs to quantify functional diameter. What most people don't realize is that ring and plug gauges aren't taking a true pitch diameter measurement, they are taking a cumulative measurement of diameter, lead, taper, flank angle and form error. Each of these dimensions will have a profound effect on the standoff measurement, which is why taper should always be checked separately. Just like all the individual thread elements called out in the various API specs. With the equations in this newsletter, you can now calculate the affect your taper error is having on your standoff to ensure your connection will accept the mated part.