Understanding The True Value Of Anti-Seize

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Learn how material, temperature, torque, and load all play a role in which anti-sieze composition to choose.

Although the purpose of an anti-seize may be obvious due to its name, it is a subject not well understood and certainly under utilized. Anyone who has snapped the head off a bolt or screw would sympathize that a lot of time, blood, sweat, and maybe even tears, are wasted when anti-seize is an afterthought. A bolted joint, which experiences a high temperature environment and requires future maintenance, is your typical application for an anti-seize. They can also be used to improve gasket performance, provide a more consistent clamp load, prevent galling, improve electrical conductivity, and protect against harsh corrosive environments. Anti-seize has been around since the 1940’s, but now there are several anti-seize products on the market of varying composition. These compositions are often tailored to a specific need, so the question you may ask is — which one is best for your application?

Choosing Your Anti-Seize

Anti-seize formulations consist of two stages of lubrication. High quality grease serves as a base lubricant up to 400 degrees F, and lubricating solids suspended in the grease serve up to 2,400 degrees F. When the temperatures of the joint exceed 400 degrees F, the grease dissipates and the remaining lubricating solids, which have now softened, plate the surfaces. It should be noted that due to the solids, anti-seize products are not used to lubricate dynamic loads. An exception to this rule is made for those formulas containing molybdenum disulphide, which can be used as an aid in the assembly of press fits or on splines and gears subjected to high static or slow moving loads. Anti-seize lubricants highly filled with molybdenum disulphide provide the best lubrication.

Copper and aluminum are the most common and traditional lubricating solids in anti-seize. Copper based formulas are limited to 1,800 degrees F and aluminum based formulas to 1,600 degrees F — and should serve well in most applications. The oil and gas industry demands greater chemical resistance in applications where acids, chemical corrosion, and oxidation are present. Some of the processes in a refinery cannot tolerate copper because it can poison a catalyst bed or reaction chamber. Nickel based anti-seizes are used to fill these needs. In addition to their superior chemical resistance, they also have increased temperature limits up to 2,400 degrees F.

Graphite is an excellent conductor of electricity and high temperature solid lubricant (up to 900 degrees F). It is therefore widely used in formulations of anti-seize. In assemblies with electrical current running through a fastened joint such as the threads of spark plugs, ground screws, and antennae connections, anti-seize can be used with minimal increase to resistance. Corrosion of a threaded joint increases the electrical resistance. The use of anti-seize on these types of connections will ensure current is transmitted reliably by preventing corrosion.

Aluminum is a soft metal and therefore sensitive to galling and stripping of your threads. A softer or non-abrasive solid lubricant is required in these situations. A zinc dust filled anti-seize is your top choice but several metal-free products also offer adequate performance.

Metal-free formulations are increasingly utilized and have performance meeting or exceeding traditional soft metal based formulas. Calcium fluoride and calcium oxide match the temperature resistance of nickel based anti-seize products at 2,400 degrees F. One problem industry faces is heavy metal discharge. Companies can be fined for the use of products containing heavy metals due to the environmental impact of heavy metal discharge into lakes and rivers. Metal-free anti-seize products eliminate the fines incurred due to anti-seize usage.

There are other circumstances where the important criteria of an anti-seize is what it does not contain. The nuclear industry and other forms of power generation require anti-seize lubricants of high purity. Sulphur, halogens, and low melting point metals are tested and certified for high purity products to ensure they are at low levels in parts per million. The food processing industry requires a formulation void of ingredients unsafe for incidental contact with food. These formulations are typically capable of handling oven temperatures and are excellent on stainless steel, a material widely used in food processing equipment. The base lubricant is often a mineral oil.

Not to be overlooked in importance, the base lubricant makes up the largest percentage of the composition. Various types of thickeners are added to petroleum or synthetic based oils to create grease. In marine or other high humidity environments, the grease is responsible for sealing the joint and preventing the electrolytic environment required for galvanic corrosion. Water washout resistant products tested according to ASTM D1264 are suggested for these situations. It should be noted that the ASTM test is conducted at 38 degrees C and 79 degrees C, and does not cover elevated temperature applications. The base lubricant is also what assists in the assembly process and can have a significant effect on the clamp load of a bolted joint.

Torque-Tension Relationship

Much time, thought, and effort is needed to design a proper bolted joint or threaded fastener assembly. It is, however, the person with the wrench who has the most influence over the success and overall reliability of this design. If the improper torque value is applied, the magnitude of the clamp load is affected; clamp load is the most critical factor in the behavior of a bolted joint. As much as 90 percent of the torque applied to a fastener is used to overcome the friction of the interfacing surfaces. When applying an anti-seize to your components, the torque value to achieve the same clamp load will be lower. If anti-seize is used with the torque specified for a dry assembly, you risk exceeding the proof load of the fastener.

How do you determine what your torque value should be? The torque-tension relationship is often expressed in its most simple form as the torque applied equals the bolt tension multiplied by the nominal diameter of the bolt multiplied by the “K factor” (T=KFD). The “K factor,” also known as the “nut factor,” is an empirically derived constant used to describe all frictions involved in achieving the desired clamp load.

Testing on dry, 3/8-inch, coarse threaded, zinc plated, grade 5 bolts torque to a 5,000 lb bolt tension has shown a deviation of 22.5 percent in the “K factor” for ten samples. When Loctite Heavy-Duty Anti-Seize was applied to the threads of the bolt, the deviation was reduced to 3.2 percent. The lubrication of the anti-seize helps to diminish the scatter and achieve consistent results. You can find the “K factor” for most anti-seize products published, and that may be acceptable in non-critical applications. However, that “K factor” was calculated for a particular assembly. There are many variables which determine the overall friction of assembling a fastened joint. Applying torque to the head of the bolt, versus the nut, changes which surfaces are sliding past one another. The size, thread pitch, and material all effect friction and cannot be exempt as variables when a lubricant is used.

Measuring Clamp Load

In order to determine the appropriate torque to use, you must have a way to measure bolt tension or clamp load and measure how much torque was required to obtain that tension. Typical methods used actually measure the length of the bolt. Based on the known tensile strength of the fastener material, the elongation allows the load to be calculated. The length can be measured by strain gauges, ultrasonic extensometers, or measuring the angular rotation and using the thread pitch to calculate the screw extension.

There also exists a method which directly measures clamp load. These bolt tester setups require the fasteners to be loaded into a fixture which prevents the nut or bolt from rotating. As you torque the nut or head of the assembly, two plates of an oil filled reservoir are compressed. The pressure produced by the compressive force is calibrated to indicate the clamp load on a dial or digital display.

The main advantage of a bolted joint over a weld is to create an assembly that can be serviced in the future. When seizure occurs, servicing becomes a time consuming and frustrating challenge. With the utilization of anti-seize, and when the proper, testing-verified torque is applied, the reliability of these assemblies is ensured.