

Stainless steel physical & chemical properties

Stainless grades : Chemical properties

This section is not intended to be a beginners course in metallurgy, far from it ! Its purpose is to try to help to "demystify" the product with regard to its application on motorcycles and also to give the answers to frequently asked questions concerning the product Inox fasteners sell.

Please also bear in mind that stainless steel is a multi faceted subject. These pages deal with stainless fastener grades and their likely application on Japanese motorcycles - nothing else. These information pages contain the absolute minimum in terms of jargon and flowery language.

Any weird sounding terms are explained (hopefully) as they are written. If you are a Metallurgist you'll probably find it a bit beneath you!

Stainless steel is not a single material, there are many different grades and qualities. The term "stainless steel" is actually the generic name for a group of steels containing a minimum of 10.5% Chromium.

Because of its perceived and apparent properties, people sometimes class stainless as non ferrous. stainless steels are ferrous, they contain over 70% steel and fall broadly into three basic groups, only two of which are suitable for fasteners:

FERRITIC

Minimum 12% Chromium, maximum 0.03% Carbon

Often referred to as "Chrome Steel" the cheapest of all grades - *strongly magnetic and VERY soft - not used for fasteners*

(Common uses; Car trim, Boiler Chimneys, sometimes called "Stainless Iron")

AUSTENITIC

Minimum 18% Chromium, minimum 8% Nickel

Known as "Food Grade T304 " is resistant to most acid attack and is probably the most commonly found grade of "Stainless". There is also an enhanced corrosion grade T316 'marine grade' that exceeds specifications for food use. 316 has added minimum 3% molybdenum.

(Common uses; T304 fasteners, kitchen sinks, food processing, T316 storage tanks, cryogenics, enclosures, chemical production, parts for constant salt water immersion)

MARTENSITIC

Minimum 12% Chromium, Carbon up to .20% in Grade 431

Magnetic 12% chrome steel with added carbon. Material is quenched rapidly during production, producing an extremely tough stainless grade

(Common uses; Cutlery, Tools, Precision Instruments)

The products we sell originate from either mills producing A2 & A4 alloys to the relevant ISO standard (we even specify one particular European mill for all our hexagons and socket caps wherever possible) and machined items such as raised heads / scoop heads etc we specify and source from quality machinists in UK.

The alloys used for fasteners and their respective key features::

Over 99% of the fasteners we sell are from the austenitic group, and it is both the chromium and nickel content that gives the improved corrosion resistance over the basic chromium ferritic types. Nickel is an extremely expensive material and due to its historic volatility on world markets has often been the reason for sharp overnight increases in prices of stainless.

BS970 T303S31 – Equivalent fastener ISO fastener alloy specification A2 or 18/8

Least expensive of the austenitic alloys machines easily, selenium and sulphur are added to this alloy to allow it to 'chip' when cut and therefore improve machining speeds. T303 is the most commonly available stainless alloy in hexagon and diameter form and offers general all purpose corrosion resistance. The material is not suitable for welding or constant exposure to salt.

BS970 T316S31 – Equivalent fastener ISO fastener alloy specification A4 or 18/10/3

Type 316 is the material to use for stainless components if at all possible. Suppliers usually charge over 60% more for this alloy and machinists always charge more to machine it because it has to be run more slowly and wears out standard cutting tools very quickly. T316 not only offers superior corrosion resistance but also polishes more reliably both mechanically and chemically.

All our Hexagon raised heads, scooped heads, machined dome nuts and small items are made from this superior quality enhanced corrosion resistant material. We promise the best **and** deliver it – as we understand it none of our competitors offer this alloy. If we cannot obtain a mill produced fastener of the requisite quality in A2 grade we supply A4 at no extra charge – compare that!

BS970 T431S29 – no commercial fastener spec equivalent

Not generally as common in bar form as 303/304/316, 431S29 grade offers improved strength characteristics. It is the most difficult commercial stainless alloy to machine. It is more susceptible to acid attack than the other two grades, but practical likelihood of this eventuality is quite low on a motorcycle. This alloy is not suitable for electropolishing or welding and being from the Martensitic group is magnetic. All our socket disc bolts are CNC* machined in UK from this enhanced shear resistant material.

*CNC = computer numerical control – computer controlled machinery can ensure 100% product consistency over thousands of items.

Corrosion Resistance

"Stainless Steel is highly resistant to corrosion under most circumstances, it is not corrosion proof! "

Essentially stainless works because its surface is covered in a passive film which provided it is not deprived of oxygen will prevent corrosion of the material substrate. If the passive film material is scratched or impacted it repairs itself immediately as it does when exposed to mild acids and saline solutions. Providing this passive film, (ie the surface of the metal) is not deprived of Oxygen, and assuming room temperature, the passive film works. The passive film is measured in Angstroms (a Swedish gentleman). An Angstrom is one ten millionth of a millimetre, the passive film thickness on stainless steel measures A130, thirteen millionths of 1mm.

However, it is theoretically possible to experience corrosion of stainless fasteners fitted to a motorcycle the corrosion types are "Pitting Corrosion" and " Crevice Corrosion"

In practical terms the potential aggressors are hydrochloric acid in virtually any concentration and also saline (salt water). Of course stainless isn't resistant to sulphuric acid either but if you are going to throw acid over the bike the fasteners are the last thing you need to worry about. Boiling nitric up to 50% concentration is fine though!!

Hydrochloric acid is found in some chemical cleaners, usually in very small concentrations - stainless steel grade A2 cannot resist its attack. Even the smallest levels of this chemical can have an effect. This sort of occurrence is becoming less common these days as chemical cleaners of the type mentioned have become far more environmentally sensible. Salt water as we all know is the nightmare of anybody with a pride in their machine, it gets everywhere and eats metal rapidly. Never underestimate the corrosive ability of salt water, especially if you live close to the coast or do a lot of coastal riding.

These are the facts - lets narrow things down a bit.....

Firstly, the passive film protective layer will always repair as long as oxygen is present. In essence that means that our A2 fasteners will not corrode the second they come into salt water or hydrochloric - it doesn't work like that::

PITTING CORROSION

The passive film breaks down locally allowing corrosion pits to form on the surface.

CREVICE CORROSION

Not really corrosion in itself but usually a design that allows material to pool and promote pitting corrosion. Incredibly, even everyday dirt covering the stainless can cause corrosion, not because dirt is necessarily corrosive in itself but because the passive film can be starved of oxygen by the smother of the "dirt" and salts present in the dirt attack surface of the stainless. Again, in practice we have not experienced this extreme situation with fasteners bought from us and fixed to a motorcycle!

Both examples are of oxygen deprivation - the bike is left standing, water pools, the oxygen concentrations in the water fall and the passive film is eventually broken. Heat accelerates the process rapidly. Unless your fasteners are sitting in a crevice "pool" they are extremely unlikely to corrode!

People who live on the coast will be aware that they are probably regularly bombarded with lots of saltwater spray. In general terms the best advice to people living by the sea who are concerned about this potential is simply if in doubt, to specify A4 fasteners.

GALVANIC CORROSION

If two different metals are connected and placed in an electrolyte, an electric current flows but a result of this is that the less noble material is eaten away - the old torch battery principal.

Imagine your Engine outer cover screws - lovely and shiny but still being lashed by rain and salt water. The alloy castings exposed to the elements will corrode more quickly in the exposed areas in contact with the Stainless Steel. This is known as Galvanic Corrosion - in this instance Galvanic corrosion will not affect the stainless itself

but could create serious problems in removing the fastener if the build up of Oxide from the casting is allowed to accumulate sufficiently.

The areas for potential stainless corrosion have been pretty well covered, precautions can be taken if needed. Remember though, whilst the machine with its lovely new fasteners looks great and that you know about pitting and crevice corrosion and all about the Swedish guy, the engine castings and steel throughout the machine is still trying it's damndest to rot, stainless steel will not stop Japanese cast alloy crankcase and gearbox covers from corroding, quite the opposite, because of the nobility of stainless it is possible that it could actually accelerate the process.

An illustration of the relevant metal nobility table – assume blue is the most 'noble'



Of course there is an answer you always knew there was going to be and it is incredibly simple - make sure you ALWAYS use quality COPPER anti seize during installation. Copper anti seize grease is essential because it sits between alloy and stainless in the nobility table - do not under any circumstances use cheap copper grease because it will run out of the threads as 3 in 1 oil would and NEVER use Aluminium assembly grease even if it can be blagged from the nearest motor car tyre depot because over time it will wreck your castings.