METRIC FASTENERS

The U.S. is the last country in the world to not be exclusive users of the metric system in everything. We have been using the metric system for decades in pharmaceuticals, photography, chemical industry, optics and even spark plugs.

by Guy Avellon

As a unit of length measurement, everything is based on the meter, with a shift in the decimal point to the left or right depending upon whether the value goes up or down.

So, if a meter is 1.00, a tenth of a meter is a decimeter at 0.1m, a centimeter (cm) is one-hundredth of a meter at 0.01m and a milli-meter (mm), or one-thousandth of a meter is 0.001m. Therefore, 1,000mm = 100cm = 1m. The numbers stay the same, only the decimal point shifts. This is actually like counting change. Going larger, the next unit is 1,000 expressed as a kilometer (km), or 1,000m.

An interesting fact that occurs with metric units; all units of weight, length and volume are related. A cube which measures 10cm on each side has an area of 1,000 cc (cubic centimeters). If the cube was filled with water, it would hold 1 liter (1 l, or 1,000ml for milliliter) and weigh 1,000 g (grams) or 1 kg (kilogram).

Metric Standards

Until a few decades ago, there was no agreement to standards regarding metric fasteners from France, Italy, Germany, England or Japan. The DIN (Deutsche Industries Norman) devised the most complete standards of any country, but there was still a need for unification. The ISO (International Standards Organization) was formed.

The DIN standards have been modified to follow ISO recommendations. The United States coordinates their efforts with ISO through ANSI, the American National Standards Institute although there are still some slight differences.

Fastener Designation

First, when ordering or identifying the dimensions of a metric fastener, all metric fasteners are preceded by the capitalized letter 'M'. Then, similar to how inch series fasteners are identified, the diameter is listed with the thread pitch, length and property class. For example: M12 x 1.5 x 50, 10.9 Hex Cap Screw.

This tells us the diameter is 12mm, the thread pitch is 1.5mm and the length is 50mm. The property class is a 10.9.

Thread Pitch

Users must be aware that there are three types of thread pitches available: the Standard thread, which is similar to the UNC; the Fine thread, similar to the UNF; and the Japanese thread which is in between but is used only on the M10 and M12 fasteners. For example; an M10 fastener can have a thread pitch of 1.0mm, 1.25mm and 1.50mm.

Identification is extremely important because many metric sizes are very close to the inch series that the nut or fastener may be started but additional tightening may result in thread stripping. For example, a 1/4"-28 fastener has a diameter of 0.250" compared with an M6 which measures 0.236". The difference is 0.014". The thread pitch on the M6 is 1.0, which is roughly equivalent to 25.6 threads-per-inch Vs the 28 TPI for the inch fastener. Not much difference and easy to confuse.

The following chart cites other examples, which illustrate the potential danger of mixing an inch with a metric fastener. The resultant assembly will produce clamp loads from 25 to 60% less than expected, providing the threads haven't stripped or have begun to strip, in which case the loads will be close to 100% lost.

INCH THREADS VS METRIC THREADS

Inch Bolts	Metric Nuts
10-32	M5 x 0.8
1/4"-28	M7 x 1.0
5/16"-18	M8 x 1.0
3/8"-16	M10 x 1.5
7/16"-14	M12 x 1.75
1/2"-13	M14 x 2
3/4"-10	M20 x 2.5
3/4"-16	M20 x 1.5
Inch Nuts	**Metric Bolts**
1/2"-20	M12 x 1.25
3/4"-10	M18 x 2.5
3/4"-16	M18 x 1.5
1"-8	M24 x 3
1"-12	M24 x 2

Property Class

Metric fastener strengths are named 'Property Class', not 'Grade'. Even so, the Property Classes are roughly equivalent to the SAE Grade system. The following provides some examples.The easiest way to tell a metric fastener's Property Classis by looking at the fastener for a numeric designation. These decimal numbers will be marked on the hex head or on the top or side of a socket head fastener.

METRIC GRADES

Property Class	SAE Grade
4.6	Grade 1
4.8	Grade 1
4.8	Grade2
8.8	Grade 5
9.8	9% stronger
10.9	Grade 8
11.9	none
12.9	ASTM A574

The fasteners will have the decimal point designation, nuts will not. For example, a 10.9 fastener's matching nut will have the marking of '10', not 10.9.

The US automotive industry developed the 9.8 because there were some sizes of the 8.8 fastener that would not provide the same strength as an SAE Grade 5. It was a combination of fastener strength and head dimension geometry for stress distribution.

One of the largest areas of confusion lies with the property class 8.8 designation. Many have confused this for the equivalent of the SAE Grade 8. The tensile strength difference between 120 ksi and 150 ksi can be catastrophic in a critical application.

Another part to look closely at for proper identification is the metric socket head cap screw. Unlike the US socket head products, which come in only one strength grade of 180ksi up to 1/2" and 170 ksi over 1/2", metric socket head products come in three property classes; 8.8, 10.9 and 12.9. So be very aware of this when repairing European machinery, so the proper strength of socket product is replaced with the same type as was designed by the factory.

Thread Length

The DIN 931 and DIN 960 are essentially the same as the ISO requirement for thread length; two diameters plus 6mm for fasteners up to 125mm in length.

With the DIN 933 and DIN 961, however, the fastener is fully threaded to the head regardless of length.

Wrench Sizes

Many mechanics have complained about the fact that they have had to use two wrenches to tighten the head and nut of the same sized fastener. Fortunately, this only occurs in a couple of sizes. It is due to a basic disagreement between DIN and ISO. The width across the flats (WAF) of DIN fasteners is 1mm larger on the M10, M12 and M14, while it is 2mm smaller on the M22.

Both types are available and sold in the US. So it depends what specification the manufacture uses and who distributes them. A company buying from several distributors may end up with different sized nuts and bolt heads in the same storage bin.

Metric Torque

Metric torque is expressed as a Newton - meter (N-m). The Newton is a commonly used term in physics for force, named after the scientist Sir Isaac Newton. A Newton equals 0.2248 pounds of force. Shifting the decimal point three places to the right, we have a kilo-Newton (KN) or 224.81 pounds.

Fastener Strength

We have learned what the different property class designations are, but how do they relate? Instead of using 'pounds-per-square-inch' (psi), metric terminology uses the term Pascal for its strength unit. Since these units become large, they use a prefix 'Mega' to form 'Mega Pascal' or MPa.

Therefore, 1 MPa is equal to 145 psi.

MPa x 145 = psi

Psi x 0.0069 = MPa

It is also interesting to note that the property class numbers actually relate to the strength of the fastener. For example; an 8.8 fastener has the strength of 830 MPa and the 10.9 is 1040 MPa. The metric designation number is actually its tensile strength.

It should also be noted here that while there are still nuts on the market with an '8' on it for use with the 8.8 fastener, ASTM A563M is only recognizing the property class 9 nut for use with the 8.8 and 9.8 fasteners. Naturally, it has a minimum proof load stress of 900 MPa.