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British thread standards

Screw thread standards were a real pain point back in the day when everyone was doing their own thing. It wasn't until Joseph Whitworth came along in 1841 with his BSW (British Standard Whitworth) that things started to get standardized. His genius idea specified a 55-degree thread angle and other crucial measurements, which eventually became the world's first national screw thread standard. The Whitworth thread was so revolutionary that it paved the way for other standards like BSF, BSP, BSCon, and BSCopper. Even the Royal Navy took notice, using the Whitworth thread in their Crimean War gunboats, a testament to its reliability and efficiency. In fact, the construction of these gunboats was a marvel of mass-production techniques that left European powers stunned. As time went on, British railway companies adopted the BSW standard, making it the go-to choice for manufacturing specifications across the country. The Whitworth thread (BSW) was replaced by American Unified Coarse (UNC) threads, which were based on similar Imperial fractions, in the mid-20th century. However, BSW continued to be used for some aluminum parts as late as the 1960s and 1970s. The Whitworth thread form is characterized by a fundamental triangle with an angle of 55° at each peak and valley, and a flank angle of 27.5° perpendicular to the axis. The actual depth of thread is approximately two-thirds of the height of this triangle. Here are some key differences between Whitworth and UNC threads: * Thread pitch: For bolts up to 1+1/2 inches in size, thread pitch is the same for both systems (except for a single exception). However, from 1/2 inch up to 1+1/2 inches, the BSW thread pitch is 12 threads per inch (tpi) compared to 13 tpi for UNC. * Thread angle: The Unified thread angle is 60° and has flattened crests, while Whitworth crests are rounded. Here's a historical table of Whitworth thread sizes: | Nominal size | Major diameter | Thread density | Thread pitch | Minor diameter | Tap drill size | | --- | --- | --- | --- | --- | --- | | 1/16 in | 1.588 mm | 60 tpi | 0.423 in | 0.0412 in | #56 | | ... | ... | ... | ... | ... | ... | Note that this table shows the historical thread sizes for Whitworth threads and is not to be confused with G-threads, which are used in British Standard Pipe (BSP) systems. The Whitworth thread system was widely used in the UK and other countries, but it has largely been replaced by American Unified Coarse (UNC) threads. In this section, a hexagon is used to denote either a bolt head or nut, with two spanners of different sizes being shown side by side to demonstrate that they can both be considered nominal size 5/8 in despite their actual differences. The across-flats definition is the standard today, which measures the distance between the flats of the hexagon. The Whitworth and BSF standards for fasteners are distinct from one another, with Whitworth spanner markings referring to the bolt diameter rather than the distance across the flats. However, due to the original size difference between the two standards (Whitworth was originally 1/2 inch larger), there can be confusion when using Whitworth and BSF spanners. To address this issue, a new series of standards was introduced in 1929 by the British Engineering Standards Association, which standardized the sizes for both Whitworth and BSF fasteners. The smaller size hexagon was adopted during World War II to save metal and has remained popular ever since. Today, it's common to encounter Whitworth fasteners with non-standard spanners, especially those marked "Auto-Whit" or with a jaw size of 0.710 in, which can accommodate either the 7/16 BSW or BSF hexagon. The original sizes for Whitworth fasteners are often referred to as "pre-war" sizes, although this term is not strictly accurate. The table shows various screw thread sizes and their corresponding dimensions. The British Standard Fine (BSF) standard has a similar thread angle to the BSW, but features finer thread pitches and shallower threads. This is more akin to the modern "mechanical" screw and was used for fine machinery and steel bolts. In contrast, the British Standard Cycle (BSC) standard uses a 60° thread angle and fine thread pitches. It was commonly employed on British bicycles and motorcycles. The British Association screw thread (BA) standard is often grouped with Whitworth standards due to its presence in similar machinery, but it's actually a metric-based system with its own head sizes and a 47.5° thread angle. BA threads have diameters ranging from 6 mm (0BA) to smaller sizes and are frequently used in precision machinery. The Whitworth 55° angle remains widely utilized today in various forms, including the 15 British standard pipe threads defined in ISO 7, which are commonly found in water supply, cooling, pneumatics, and hydraulic systems. Other threads that employed the Whitworth 55° angle include Brass Threads, British Standard Conduit (BSCon), Model Engineers' (ME), and British Standard Copper (BSCopper). The widely used British Standard Pipe thread, as defined by the ISO 228 standard, also employs the Whitworth standard thread form. Even in countries where it's not commonly used, such as the US, personal computer liquid cooling components often utilize the G1⁄4 thread from this series. The Leica Thread-Mount, used on rangefinder cameras and enlarging lenses, features a 1+17⁄32 in by 26 turns-per-inch Whitworth design. This is due to its development by a German company specializing in microscopes, which was equipped with tooling capable of handling threads in inches and in Whitworth. The 5⁄32 in Whitworth threads have been the standard Meccano thread for many years and are still used by the French Meccano Company. Fixings for garden gates traditionally employed Whitworth carriage bolts, and these are still supplied as the standard in UK and Australia. British Morris and MG engines from 1923 to 1955 utilized metric threads with bolt heads and nuts dimensioned for Whitworth spanners and sockets. In 1919, Morris Motors took over the French Hotchkiss engine works, which had moved to Coventry during the First World War. The Hotchkiss machine tools featured metric threads, but metric spanners were not readily available in Britain at the time, so fasteners were made with metric thread but Whitworth heads. In the 2011 movie Cars 2, a British Morris engine is depicted being used by Mater's friend, Finn McMissile. Pixar's clue to discovering Sir Miles Axlerod's true nature lies in his use of Whitworth bolts. Although Axlerod doesn't resemble any real car, he bears a striking resemblance to the original Range Rover Classic. Early Range Rovers used imperial dimensions, while the photograph of the villain's engine closely resembles the later 3.5-litre single plenum Rover V8 design. The article delves into various thread standards, including British Association screw threads (BA), British Standard brass thread, and Unified Thread Standard (UTS). It also explores the history of Whitworth threads, tracing their development from Joseph Whitworth's initial paper to the modern-day specifications. The text provides a comprehensive overview of Whitworth / BSF Hex Sizes, Old & New Standards, as well as additional information on spanner jaw size tables and Machinery's Screw Thread Book. Moreover, it discusses British Standard Pipe (BSP), a widely used pipe thread system outside North America. Despite being a British standard with nominal pipe sizes in inches, the dimensions are defined in millimeters. The article explains the difference between BSP threads and other metric and inch threads, providing insights into calculating and defining basic dimensions and tolerances for each series. Standard Symbol Description ISO 7-1 pipe threads have mechanical sealing on the thread, eliminating the need for O-rings. There are four types: Internal and external tapered threads (BSPT-Rc and BSPT-Rp) for use with BSPT-R external threads, and parallel internal and external threads (BSPP) that require an O-ring for a seal. Rc(Rounded threads), the diameters are measured on the gauge plane Capital D's designates internal threads.Small d's designates an external thread. (R) d1 / D1 Minor Diameter d2 / D2 Pitch Diameter The thread charts define d and p. They are the same for the 3 sub-groups.α & ß are constant (See above chart).The rest of the common parameters can be calculated by the below formulas.The formulas are the same of d (external) and D (internal) \(\begin{array}{l} P= \frac{25.4}{TPI}\\ d_2=d\,-\,0.640327\times\,P\\ d_1=d\,-\,1.280654\times\,P\\ h=0.640327\times\,P\\ \\ \text {For R and Rc Threads:}\\ H=0.960237\times\,P\\ r=0.317278\times\,P\\ \\ \text {For Rp Threads:}\\ H=0.960491\times\,P\\ r=0.137329\times\,P\\ \end{array} \) Quick video explaining BSP threads Definition of parameters that are used for tapered threadsGauge Length: Because of the taper angle, the diameters (major, minor, and pitch) change as we move along the thread’s axis. The gauge length is an arbitrary distance from the thread’s end at which the measurements of diameters are made. This location may also be referred to as “Gauge Plane”. The thread standard also defines the tolerance for the gauge length.Useful Thread: A thread that is fully formed at the root but can be truncated at the crest by its intersection with the cylindrical surface of the product.Length: the distance from the thread’s end to the last useful thread.Washout (Vanished threads): The part of the thread which is not fully formed at the rootFitting Allowance: Length of useful thread beyond the gauge plane of an external thread required to provide for assembly with an internal thread at the upper limit of the tolerance. The fitting allowance is used to calculate the minimum required length for eternal and internal threads.BSPT R (External)BSPT Rc (Internal) Symbol Description Remark Lg Gauge Length The distance from the reference plane to the point where the diameters (Major, Minor, and pitch are measured) T1 Lg Tolerance -External The tolerance can be defined by number of turns or distance T2 Lg Tolerance - Internal F Fitting allowance The length of useful threads beyond the gauge plane of an external thread required for proper assembly with an internal thread at the upper limit of the tolerance. L Overall Thread Length Dimensions are in millimeters. To view Inch values, click the Thread Description.The below chart shows only the main dimensions. To view all the dimensions, click the thread description or use the BSPT Thread Calculator. BSPP stands for British Standard Pipe Parallel, a group of threads defined by ISO 228-1 & ISO 228-2 standards. According to ISO-228, pipe threads where pressure-tight joints are not made on the threads are known as BSPP. This means that the thread will not seal without the aid of an O-ring or sealant. The basic profile of a BSPP G thread is similar to the BSPT Rp series thread, but with different tolerances on Pitch, Major and Minor diameters. BSPP G threads can be classified into three classes: No class (internal thread), Class A (external high-precision thread) and Class B (external low-precision thread). The tolerance field width of class B is twice that of class A. The dimensions of a BSPP G thread are defined in millimeters, except for the nominal pipe thread which is listed in Inch fractions. The charts below provide only the main dimensions, while all the dimensions can be viewed in detail using the BSPT Thread Calculator or by clicking on the thread description.