

Bolts for flange connections

Types of bolts

In Petro and chemical industry for flange connections stud bolts and hex bolts are used. The stud bolt is a threaded rod with 2 heavy hexagon nuts, while the hex bolt has a head with one nut. Nuts and head are both six sided.

Stud bolts general

Stud bolt length are defined in ASME B16.5 standard. The length in inches is equal to the effective thread length measured parallel to the axis, from the first to the first thread without the chamfers (points). First thread is defined as the intersection of the major diameter of the thread with the base of the point.

Image of the effective thread length of Stud and Hex bolts.

Note: The length of metric stud bolts measured parallel to axis, is the distance from each stud bolt, including the point.

The quantity of bolts for a flange connection will be given by the number of bolt holes in a flange, diameter and length of bolts is dependent of flange type and Pressure Class of flange.



To allow the use of hydraulic tensioning equipment, larger dimension studs shall be often one diameter longer than "standard". That bolts to have plastic end cap protection.

Bolts threading are defined in ASME B1.1 Unified Inch Screw Threads, (UN and UNR Thread Form). The most common thread is a symmetrical form with a V-profile. The included angle is 60°. This form is widely used in the Unified thread (UN, UNC, UNF, UNRC, UNRF) form as the ISO / metric threads.

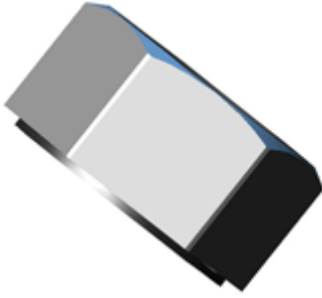
The advantage of a symmetrical threads is that they are easier to produce and inspect compared with non-symmetrical threads. These are typically used in general-purpose fasteners.

Thread series cover designations of diameter/pitch combinations that are measured by the number of threads per inch (TPI) applied to a single diameter.

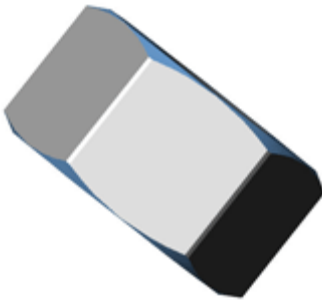
Standard Thread Pitches

- Coarse thread series (UNC/UNRC) is the most widely used thread system and applied in most of the screws, bolts and nuts. Coarse threads are used for threads in low strength materials such as iron, mild steel, copper and softer alloy, aluminium, etc.. The coarse thread is also more tolerant in adverse conditions and facilitate quick assembly.
- Fine thread series (UNF/UNRF) is commonly used in precision applications and in there where require a higher tensile strength than the coarse thread series.
- 8 - Thread series (8UN) is the specified thread forming method for several ASTM standards including A193 B7, A193 B8/B8M, and A320. This series is mostly used for diameters one inch and above.

Hex nuts (dimensional data) are defined in ASME B18.2.2, and even as bolts the threading in ASME B1.1. Depending on a customer specification, nuts must be both sites chamfered or with on one side a washer-face. The height of a nut for stud bolts are the same as the diameter of the thread rod.



Nut with on one side a
washer-face



Both sites
chamfered

Materials for stud bolts

Dimensions from stud bolts are defined in the ASME B16.5 standard. The material qualities for studs are defined in the different ASTM standards, and are indicated by Grade. Frequently used grades are A193 for thread rods and A194 for the nuts.

ASTM A193 covers alloy and stainless steel bolting material for pressure vessels, Valves, flanges, and fittings for high temperature or high pressure service, or other special purpose applications.

ASTM A194 covers a variety of carbon, alloy, and martensitic and austenitic stainless steel nuts. These nuts are intended for high-pressure or high-temperature service, or both.

Below you will find as an example a table with materials and grades for flanges, thread rods (bolts) and nuts, arranged on design temperature, flanges, thread rods and recommended nuts.

DESIGN TEMPERATURE	FLANGES	GRADE THREAD RODS	GRADE NUTS
-195° to 102°C	ASTM A 182 Gr. F304, F304L, F316, F316L, F321, F347	A320 Gr. B8 Class 2	A194 Gr. 8A
-101° to -47°C	ASTM A 350 Gr. LF3	A 320 Gr. L7	A 194 Gr. 7
-46° to -30°C	ASTM A 350 Gr. LF2	A 320 Gr. L7	A 194 Gr. 7
-29° to 427°C	ASTM A 105	A 193 Gr. B7	A 194 Gr. 2H
428° to 537°C	ASTM A 182 Gr. F11, F22	A 193 Gr. B16	A 194 Gr. 2H
538° to 648°C	ASTM A182 Gr. F11, F22	A 193 Gr. B8 Class 1	A 194 Gr. 8A
649° to 815°C	ASTM A182 Gr. F304 H, F316 H	A 193 Gr. B8 Class 1	A 194 Gr. 8A

Note: materials in the table above are being provided for guidance purposes

Marking of stud bolts

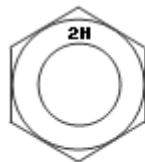
Thread rods and nuts must be marked by the manufacturer with a unique identifier to identify the manufacturer or private label distributor, as appropriate. Below you will find a number of ASTM examples.



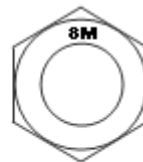
A193
Grade B7



A193
Grade B8M



A194
Grade 2H

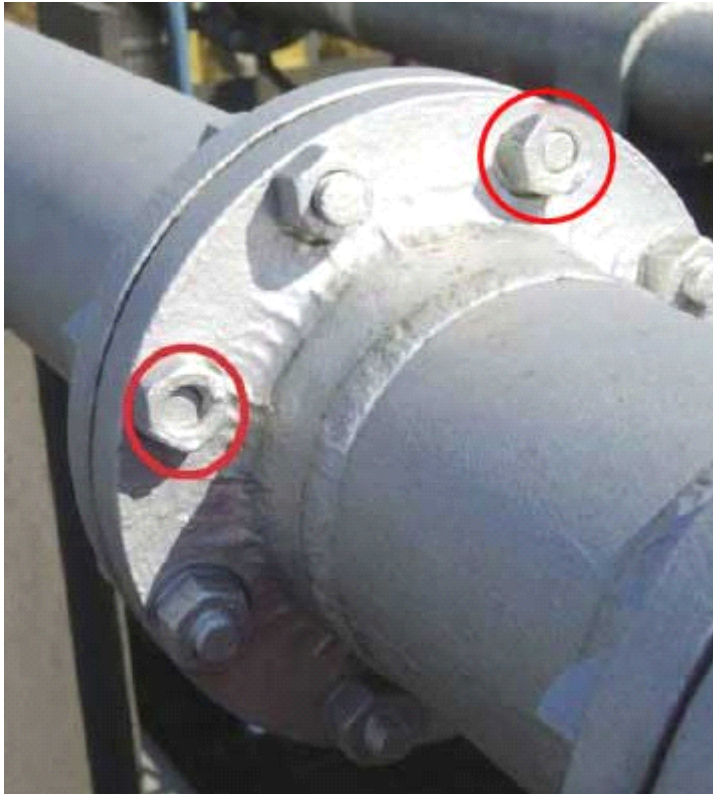


A194
Grade 8M

Remark(s) of the Author...

Improper flange connections - the bolts are too short !

What can you do?



- The picture shows an improperly bolted flange, because two bolts are too short, and the nuts are not completely on the bolts. This means that the joint may not be as strong as it should be. Flanges are designed so that the entire nut-bolt combination holds the forces on the flange. If the nut is only partially screwed onto the bolt, the connection may not be strong enough.
- If your job includes putting equipment together, assembling flanged pipe, bolting manhole covers or other bolted connections on equipment, or other equipment assembly, remember that the job is not complete until all of the bolts are properly installed and tightened.
- Some equipment requires special bolt tightening procedures. For example, you may have to use a torque wrench to correctly tighten the bolts to the specification, or tighten the bolts

in a special order. Make sure that you follow the correct procedure, use the correct tools, and that you are properly trained in the equipment assembly procedure.

- Check pipes and equipment for properly bolted flanges as part of your plant safety inspections. As simple guidance, bolts that do not extend beyond the nuts should be reviewed by a plant piping craftsman or engineer.
- If you observe improperly bolted flanges in your plant, report them so they can be repaired, and make sure the required repairs are completed.
- Inspect new equipment, or equipment which has been re-assembled after maintenance, to make sure it is correctly assembled and properly bolted before starting up.

What is the proper length of a bolt?

As a rule, you can use: The free threads of the bolt above the top of the nut is equals to $1/3$ times the bolt diameter.