TECH SHEET

PEM® - REF / FASTENERS FOR USE IN STAINLESS STEEL SHEETS

SUBJECT: Installing PennEngineering® fasteners into stainless steel sheets

Engineers, designers, and manufacturers often choose clinch fasteners to eliminate the need for loose hardware or to provide a method to include threads in thin sheets. Self-clinching fasteners are able to "grip" the sheet metal into which they are installed by deforming the sheet metal. Utilizing the ductility of the sheet metal and its ability to cold flow, the fastener will move the sheet metal into its "clinch features," which include an undercut and either lugs or knurls. Together, these mechanical features prevent axial and radial movement of the fastener. Those familiar with self-clinching fasteners understand that the fastener itself must be considerably harder than the sheet metal to ensure that the sheet metal flows, and the fastener does not deform. That is, there must be an adequate hardness differential to guarantee an appropriate clinch. While clinching is a favorable option for captivating fasteners in many cases, some may choose non-clinch options for stainless steels sheets. This Tech Sheet will discuss these options as well.

PennEngineering® offers clinch fasteners for stainless steels with three different sheet hardness maximums: HRB 88, 90, and 92. The hardness maximum depends on the geometry of the part and the material the fastener is made from. Based on ASTM A240, Table 1 shows which sheet material, based on UNS designation, falls under each respective hardness maximum. The PennEngineering parts in Table 1 are inclusive, meaning parts that can clinch into HRB 90 maximum sheets can also clinch into HRB 88 maximum sheets, and parts that can clinch into HRB 92 maximum can also clinch into sheets that are HRB 90 and 88 maximum. Table 2 at the end of the document compares PennEngineering part types by installation method and maximum sheet hardness.

Table 1. Sheet hardness maximum by UNS designation.

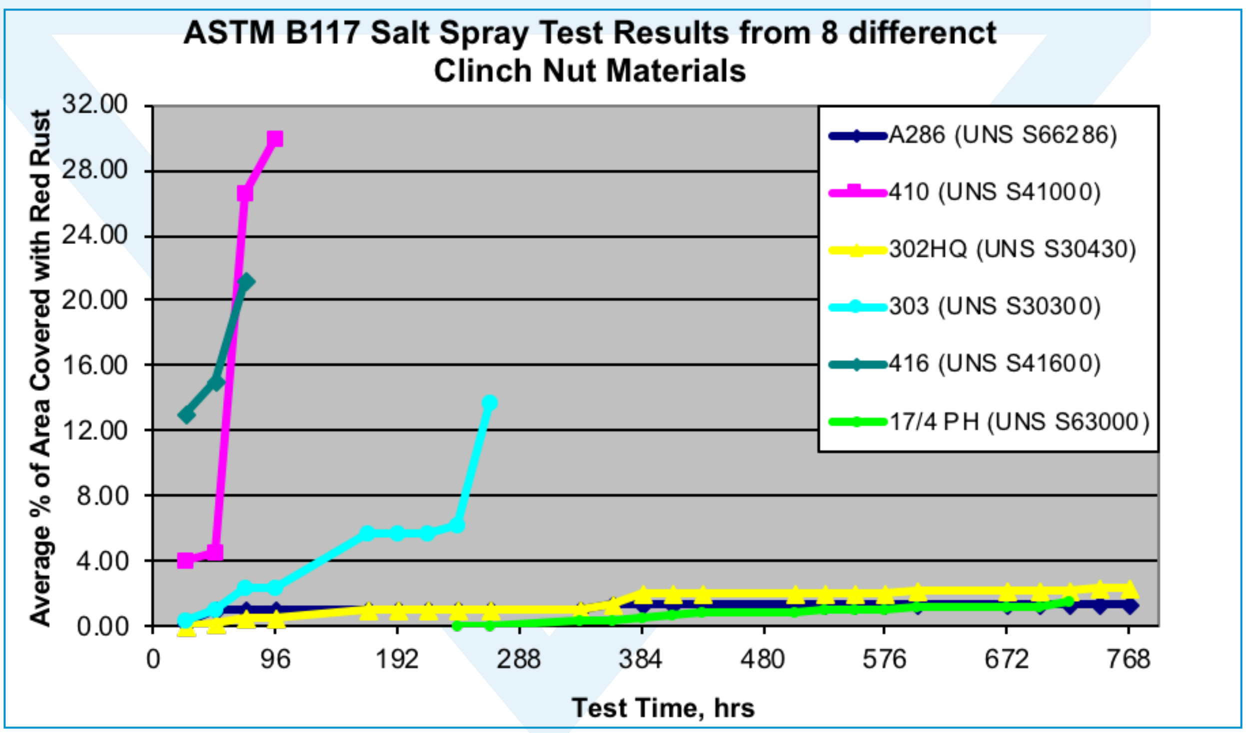
UNS Designation Maximum Sheet Hardness per ASTM A240		
HRB 88 Maximum	**HRB 90 Maximum**	**HRB 92 maximum**
S30500, S40500, S40910, S40920, S40930, S40945 S40977, S41045, S42035	N08700, N08904, S30435, S41050, S41008, S42900, S43000 S43035	S20432, S30200, S30400, S30403 S30409, S30441, S30530, S34700 S34709, SS34751, S34800, S34809, S40975
Corresponding PennEngineering® Parts		
A4™, LA4™, F4™, SO4™, BSO4™, TSO4™, PFC4™, SFP™	SP™, SMPP™	FH4™, FHP™, TP4™

Corrosion Requirements

Material selection is crucial when using self-clinching fasteners with stainless steel sheets. The two most important factors to consider when clinching into stainless steel sheet are hardness and corrosion resistance. Steel fasteners and 300 series stainless steel fasteners will not be hard enough, relative to the stainless steel sheet, for the sheet to cold flow into the clinch features of the fastener. For that reason, 400 series stainless steel fasteners as well as precipitation hardening (PH) grade material fasteners are chosen to clinch into stainless sheet. In addition to hardness, the environment in which the system will be exposed needs to be considered. People typically choose to use stainless steel sheets in corrosive environments. 400 series stainless steels typically have corrosion resistance similar to that of zinc-plated steel. For that reason, they have limited corrosion resistance compared to 300 series stainless steel or PH grade material. 400 series stainless steel fasteners should only be used when corrosion resistance is not a priority.

Figure 1 below displays the results of a salt spray test conducted in accordance with ASTM B117 by PennEngineering™ for different clinch nut materials. It is clear that the two 400 series stainless steels (grades 416 and 410) are not as corrosion resistant as the PH grades (17-4 and A286). For this reason, PH grade material is preferred over 400 series stainless steel when corrosion resistance is a priority.

Figure 1. Salt Spray results for common stainless steels and A286 material.



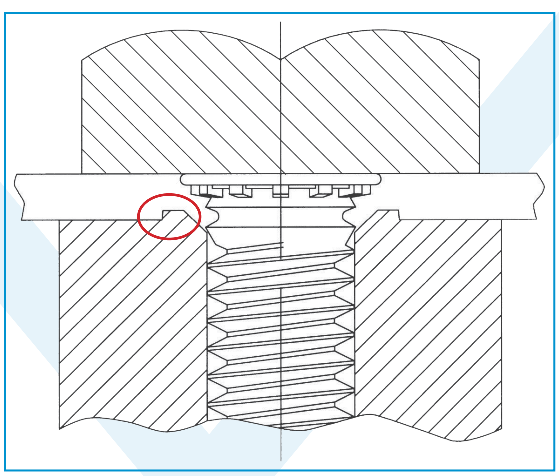
Magnetism

Magnetism is often a crucial property to consider when selecting a fastener. It is important to understand the differences in magnetic properties when discussing stainless steels and PH grade materials. All austenitic stainless steels are non-magnetic. However, they may become slightly magnetic after cold working. So, a cold formed 300 series fastener may actually be slightly magnetic. Additionally, martensitic stainless steels are magnetic. Many 400 series stainless steels are martensitic, and therefore, magnetic. Some PH grade materials are magnetic, while some are not. A286, for example, is non-magnetic. Material traceability is important for one to understand the magnetic properties of a given stainless steel.

Installation and Mounting Holes

When installing into stainless steel sheets, cold working is an important phenomenon to understand. Local hardening of the material when pressure is applied to an area is the result of cold working. The installation of clinch fasteners involves cold working the sheet metal into the clinch features of the fastener. As this happens, the stainless steel sheet hardens locally around the fastener. This actually makes it harder for the fastener to install because, as discussed earlier, the fastener must be hard enough to clinch into the sheet. Thin stainless steel sheets are especially of interest in this case, because they have been rolled more than thicker sheets, and therefore have more cold work. In some cases, such as FH4™ and FHP™ studs in the PEM® SS Bulletin, a raised-ring anvil is recommended for installation. See Figure 2 below.

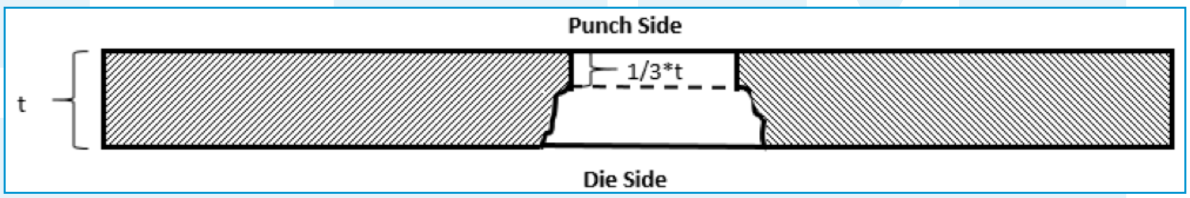
Figure 2. Installation tooling for FH4™ and FHP™ studs with a raised-ring anvil (raised-ring circled).



The purpose of the raised-ring is directly related to cold working of the sheet. As the sheet gets harder in the region close to the clinch features of the stud, the sheet could become too hard and actually deform the lugs. Since the anvil is made from hardened tool steel, it will always be harder than the sheet. The raised ring cold works the sheet and helps material flow into the clinch features of the stud, without yielding the clinch features. PennEngineering™ recommends measuring the height of the raised-ring, dimension "P" in PEM® Bulletin SS™, every 5000 installations to ensure it remains within specification.

Mounting holes are typically created by punching. Punching mounting holes is a quick and easy method. However, care must be taken when installing a fastener into a punched mounting hole. As the punch goes through the sheet, it first shears the material. Then, it begins to fracture approximately 1/3rd of the way into the sheet. See Figure 3 for example.

Figure 3. Punched-hole diagram



The fracture on the die side of the sheet causes not only a slightly larger mounting hole than on the punch side, it also creates a burr. For both of these reasons, it is recommended to install fasteners on the punch side of a punched hole.

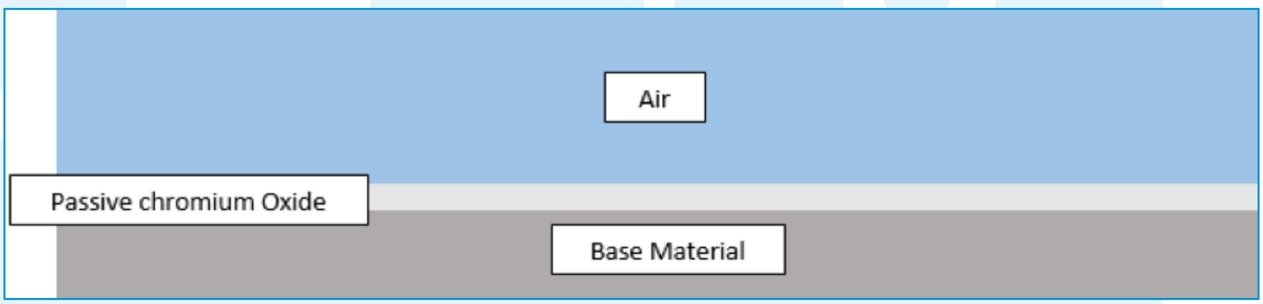
Galling

Assembling stainless steel fasteners can lead to thread binding issues, known as galling. There are a number of factors which may increase the likelihood of galling, including fine threads, high speed tightening, and mating part misalignment. Fortunately, there are a variety of methods available to prevent galling. PennEngineering has published a detailed tech sheet defining galling and discussing many ways to prevent it. It can be found on the PennEngineering website.

Passivation

Stainless steel is an inherently corrosion resistant material because of the passive chromium oxide layer on the outer surface of the material. This passive layer acts as a barrier between the base material and the surrounding environment. Figure 4 shows an illustration of the passive layer. Forming and machining operations can introduce free iron to the surface of stainless steel. As cutting tools wear, free iron may stick to the stainless steel, making the surface no longer passive. PennEngineering® stainless steel parts are tested and/or passivated per ASTM A380 before they are packaged. A copper sulfate test is used to determine if any free iron is on the surface of the stainless steel parts. If free iron is on the surface, copper will plate to the parts. When this happens, the parts will be sent to a passivation line, which will ensure a passive layer is formed in the presence of air. Parts which pass the passivation test, having no free iron on the surface of the parts, have a passive surface and are adequate to be packaged.

Figure 4. Passive layer of stainless steel.



Non-Clinching Fasteners

In some cases, a design may require a fastener to be captivated using a method other than clinching. This section discusses a number of those options. Swaging collar stud (SGPC) parts can install into most panel material, including 300 series stainless steel, as long as the maximum sheet thickness is not exceeded. In this case, the fastener is deformed by the punch. This product is made from 302HQ (UNS S30430) stainless steel, giving it corrosion resistance similar to that of PH grade materials. See PEM® Bulletin SS™ and Panel Design Sheet for installation instructions.

Captive panel screws, also known as access hardware, include non-clinching options capable of use with stainless steel sheets. Specifically, flare-mounted captive panel screws are adequate in stainless steel sheets. PF7MF™ Flare-mounted captive panel screws for installing into stainless steel, PF11MF™ large knob, spring loaded flare-mounted captive panel screws, and PF11MW™ large knob, spring-loaded flare-mounted, floating captive panel screws are captive panel screws available for use in stainless steel sheets.

PennEngineering® offers internally threaded fasteners for use in stainless steel sheets, which include weld nuts and ATLAS® blind threaded inserts.

Stainless steel weld nuts are made from 302HQ (UNS S30430) material, feature a round head design, a self-locating shank and three engineered projections which act as contact points for the weld. More information on weld nuts can be found in PEM® Bulletin WN.

ATLAS® inserts are blind threaded rivet-style inserts. These parts are especially useful when only one side of a panel or wall can be accessed, and they do not require a hardness differential between the fastener and mating panel. When galvanic corrosion resistance is required of the fastener, ATLAS® AESS™ and AENM™ inserts are available. AESS™ inserts are made from 430 stainless steel (UNS S43000), which is a ferritic, magnetic grade. AENM™ inserts are non-magnetic and made from 316 stainless (UNS S31600), which is an austenitic grade with excellent corrosion resistance. See the ATLAS® catalog for more details.

Overview of Captive Fastener Options for Stainless Steel Panels

Captivation Method	Captivation Method							
Features/Benefits	PEM Brand Self-Clinching		PEM Brand Swaging/Flaring		PEM Brand Weld Nuts		Atlas Brand Bulbing	
Flush shank/thread:	Yes		No		Yes		No unless hole is countersunk	
Installation Method:	Press to Force - Need Acces to Both Sides		Press to Force - Need Acces to Both Sides		Resistance Welding (Squeeze-Weld-Hold)		Spin-Pull Tool - Need Access to One Side	
Major Benefits:	Clean, simple Install/Good Captivation		Low cost fastener w/ high corrosion		Low fastener cost/High strength captivation		Available in type 316 - high corrosion	
Potential Issues:	Insufficient Hardness Differential		Mating part must clear swaging shoulde		Thermal discoloratrion/Sensitization		Limited torsional captivation unless hex	
Functionality	Type	Max Panel Hardness	Type	Max Panel Hardness	Type	Max Panel Hardness	Type	Max Panel Hardness
Internal Threads	SP, SMPP	HRB 90 /HB 192			WNS	No Limit	AESS or AENM	No Limit
Internal Threads (cont.)	A4, LA4, F4	HRB 88/HB 183						
External Threads	FHP, FH4	HRB 92/HB 202	SGPC	No Limit			AESS (Steel)	No Limit
Pins	TP4, MPP	HRB 92/HB 202						
Standoff	BSO4, SO4, TSO4	HRB 88 / HB 183	MSOFS	No Limit				
Panel Fastener	PFC4	HRB 88 / HB 183	PF7MF or PF11MW	No Limit				
Sheet to Sheet	SFP, T4, TS4	HRB 88 / HB 183						

Table 2. PennEngineering part by type with corresponding maximum sheet hardness.