Tech Note 21:
Comparing Stainless & Copper Press-Fit

TN.21

Applicable Products:
- AusPress Stainless Press-Fit, diameters 15 – 168.3mm.
- AusPress Copper Press-Fit, diameters DN15 – 108.

Stainless as a material has many advantages and was an obvious choice for us to distribute as our first press-fit range in 1995 to the hygiene sensitive projects we originally specialised supply to including food & beverage and pharmaceutical. Copper is renowned for its use in plumbing for over 4,000 years reaching wide spread acceptance in the mid-1900's for water supply pipework and continues today despite the evolution or plastics and other materials developed since.

Stainless press-fit is a more technical product than the copper version, with the following information outlining how to approach working with stainless press-fit for those familiar with copper press-fit systems already.

Q: Explain why stainless press-fit is different than copper press-fit?

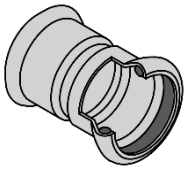
<u>As a Material</u>
It depends on the situation to determine which material is best suited for an application and often both can be found viable for an installation. However, there are some key attributes to consider where the materials differ:

Key Attributes	Ref	Stainless 316	Copper
Mechanical Strength [1]		Higher	Lower
Corrosion Resistance [2]	TN.01	High	High
Thermal Conductivity [3]	TN.04	Low ~15 W/(m.k)	High ~320 W/(m.k)
Thermal Expansion	TN.27	Equal	Equal
Contains Lead		Nil	Nil
Plumber Familiarity		Low	High
Reaction with Galvanised (Zinc) Metals [4]	TN.33	Some	Yes
Embodied Energy		Lower	Higher
Recyclability		High	High
Theft Risk & Perceived Theft Value		Low	High

Notes: 1- Stainless work hardens, copper work softens. Wear from cleaning and water velocities; 2- No material is resistant in all situations, for example stainless is susceptible to chlorides, copper to high or low pH levels. Protecting and maintaining the material passive oxide layer is critical; 3- Relates to heat loss, insulation considerations; 4- Corrosion process between dissimilar metals in the presence of water; cathodic vs anodic.

Use in Press-Fit

AusPress stock both ranges of material and understand both are used across Australia and considered standard in their respective industries. We've seen a steady increase in the acceptance of stainless in more industries as the cost difference between the two metals decreases and the need for specialised welding experience no longer required to install.

Use in Press-Fit	AusPress Stainless 316	AusPress Copper
Socket Profile	 **M-Profile** - The original design from 1962 that provides the best combination of joint strength, fitting length and sealing for all diameters.	 **V-Profile** - Used by majority of copper systems available in Australia, identified by the tail extending beyond the fitting seal; large diameters feature a grab ring & ring seal.
Range of Diameters	15mm to 168.3mm (metric)	DN15 to DN100 (AU imperial)
Working Pressure ‡	Max 6,000 kPa‡ (up to 35mm)	Max 1,600 kPa‡ (all diameters)
Temperature Rating	Equal	Equal
Installation Process	Equal	Equal
Bracket Spacing	Equal	Equal
System (dry) Weight	Less (8,000 kg/m3)	More (8,940 kg/m3)
Surface Roughness Coefficient (Average)	Equal	Equal
Warranty/Design Life *	25 years / 50 years	25 years / 50 years
Water Velocity ᵅ (max)	12.0 m/s	3.0 m/s

‡ Values depend on the application (ie potable water), the relevant standard(s), diameter, fitting and the press tool used. Refer to AusPress technical information including Tech Note TN.03.
ᵅ Refer to Tech Note TN.30.
* Terms and conditions apply, refer to our warranty documents.

Q: Details on the operation conditions of the system such as but not limited to temp, pressure, oxidising agent levels, water quality?

System Temperature

The limit is determined by the ring seal type fitted to each press socket…

Material	Colour	Range‡	Common Application‡
EPDM ethylene propylene diene monomer	Black	-20°C to 100°C	Standard ring seal for potable water, hot water, dry compressed air.
NBR nitrile butadiene rubber	Yellow	-20°C to 70°C	Selected for natural gas and LPG installations.
FKM fluoro-elastomer	Green	-20°C to 180°C (200°C short peak)	Selected for chemical, oil and fuels, wet compressed air and high temperature applications (excluding steam).

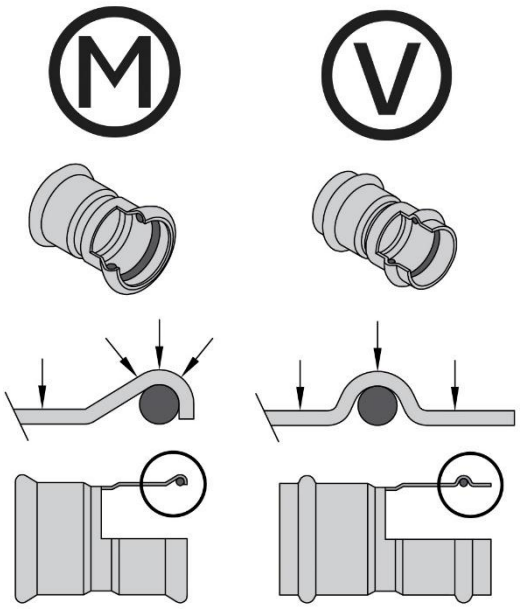
‡ Values depend on the application (ie potable water) and the relevant standard(s).

System Pressures

Maximum working pressure depends on a combination of the press tool used to install, the fitting profile, fitting diameter, the system material, operating temperature and the application.

The press profile is the socket design of the fitting, engineered as a permanent connection between the fitting and the tube/pipe using a press tool and sealed with an internal elastomer ring seal.

In the Australian market, both profiles M & V exist for both materials, stainless & copper – **it is critical to ensure the matching press jaw profile is used with the matching profile fitting.**



Some applications are limited to a lesser pressure despite the system able to achieve higher; in these cases, the lesser pressure is used (ie AS 5601 limits natural gas pressure to 200 kPa):

- Working Pressure – 'normal' operating pressure, designed for and in accordance to relevant standards and our Tech Note TN.03.
- Test Pressure – 1.5x the working pressure, during site test conditions only (refer AusPress Test Protocol Form for details).

Fitting Material	Fitting Profile	Jaw/Collar Type	Diameter (mm)												
			15	18	22	28	35	42	54	66.7	76.1	88.9	108	139.7	168.3
AusPress Stainless	**M Profile**	Standard Pressure‡	6,000 kPa*			2,500 kPa		2,500 kPa			1,600 kPa			2,000 kPa*	1,600 kPa*
		High Pressure (HP)‡	N/A			6,000 kPa*		4,000 kPa		N/A	2,500 kPa*			N/A	

Fitting Material	Fitting Profile	Jaw/Collar Type	Diameter (DN)								
			15	20	25	32	40	50	65	80	100
Copper	**V Profile**	Standard Pressure‡	1,600 kPa						1,600 kPa		

‡ Values depend on the press tool, press heads, application, fitting, and method used – refer to AusPress "Select A Press Tool" page in the catalogue for details.
* Higher pressures possible only with written confirmation by AusPress on a project specific basis.

Size & Pressure Comparison Chart

Pressure ratings for systems illustrating the higher inherent rating for stainless tube joined with press fittings versus the derating of copper tube when installed with brazed joints (temperatures < 75°C):

Nominal Size		Copper Brazed (Type "B")				Stainless Press-Fit (Metric Tube)			
DN	**Imperial**	**OD**	Wt	ID	SWP (kPa)	**OD**	Wt	ID	SWP (kPa)
15	**1/2"**	**12.7**	0.91	10.88	5,250	**15**	1.0	13	6,000
18	**5/8"**	**15.88**	1.02	13.84	4,668	**18**	1.0	16	6,000
20	**3/4"**	**19.05**	1.02	17.01	3,847	**22**	1.2	19.6	6,000
25	**1"**	**25.4**	1.22	22.96	3,431	**28**	1.2	25.6	6,000
32	**1.1/4"**	**31.75**	1.22	29.31	2,717	**35**	1.5	32	6,000
40	**1.1/2"**	**38.1**	1.22	35.66	2,250	**42**	1.5	39	4,000
50	**2"**	**50.8**	1.22	48.36	1,673	**54**	1.5	51	4,000
65	**2.1/2"**	**63.5**	1.22	61.06	1,332	**66.7**	2.0	62.7	2,500
80	**3"**	**76.2**	1.63	72.94	1,486	**76.1**	2.0	72.1	2,500
90	**3.1/2"**	**88.9**	1.63	85.64	1,270	**88.9**	2.0	84.9	2,500
100	**4"**	**101.6**	1.63	98.34	1,108	**108**	2.0	104	2,500
125	**5”**	**127.0**	1.63	123.74	884	**139.7**	2.0	135.7	2,000
150	**6"**	**152.4**	2.02	148.36	913	**168.3**	2.0	164.3	1,600

Notes: DN= Nominal Diameter; OD= Outside diameter; Wt= Wall thickness; ID= Internal diameter; SWP (kPa)= Safe Working Pressure (kilopascal) for copper vales from The Plumbers Handbook 10th edition, The Australia Copper Tube Industry “Safe Working Pressure Calculations For Copper Tubes” *and* Safe Working Pressure (kilopascal) for stainless press-fit taken from AusPress using suitable Novopress tooling.

Product Batch Numbers

Our AusPress stainless fittings, stainless tube and copper fittings are marked with batch numbers identifying the batch date, material and process manufactured as a 3.1 certification. This means we can provide certificates from the material source the items were manufactured from to prove stainless material composition.

Oxidising Agents

AusPress offer technical chemical assessment for applications and chemicals to confirm suitability and ring seal selection. **When requesting assessment, both the chemical concentration and temperature are required.** Send this information, plus the SDS to technical@auspress.com.au.

- Stainless has a very high resistance to corrosion across a broad range of the pH spectrum however, chemicals and additives high in chlorides (and chlorine) can have a detrimental effect to the protective oxidation layer of 316 stainless steel – refer our Tech Note TN.01.
- Copper has a lesser range of pH tolerance, where high acidic or high alkaline conditions can cause issues – refer our Tech Note TN.03.

Water Quality
Potable water complying to the values nominated in the Australian Drinking Water Guidelines (ADWG) are suitable for both grade 316 stainless and copper press-fit systems.

As opposed to copper material, 316 stainless is suitable for low and high pH waters and purified waters up to a purity of < 0.1µS/cm (such as ultra-pure waters).

Testing waters for the chloride and free chlorine levels is required to confirm if within the acceptable levels of 316 stainless is required for sources including (but not limited to):

- Bore water,
- Additives (such as for disinfecting activities),
- Treated water,
- Batch or Recycled water.

Refer to our Tech Note TN.01 Chlorides, Chlorine & Stainless Steel for suitable levels, contact time and temperature considerations.

Q: Any know failures where and root cause?
Supplying stainless press-fit for over 25 years, we know that failures do happen and take any failure seriously. Each reported case is assessed with “installer error” easily the highest cause by numbers.

Installation Error: Insufficient insertion depth and incomplete tool pressing are the top reasons with press-fit, common to both stainless and copper systems. These two faults are easily identified by marking the required fitting insertion depth and pressure testing at the time of commissioning with both steps part of our recommended installation procedures.

Surface damage is the next common error in practice to the material from either:

- Stagnant water is left, for example after pressure testing as part of an extended construction schedule, and not drained or flushed or,
- Excessive dosing where the chemical(s), concentration and/or contact time is not suitable and damages the material.
- Incorrect insulation is specified and/or installed to the pipework.

Through our onsite training and knowledge of our staff, installation errors are a minority and fortunately easily avoided through best practice, explaining the risks and concise specifications.

Q: Constraints to the installation?
In general, the constraints for copper and stainless press-fit are the same however, we recommend both specifiers and installers are familiar with the Technical Section of the AusPress Press-Fit Catalogue and our suite of Tech Notes that cover specific installation situations for our products.

Underground joints are not recommended but if unavoidable, to be limited in number and protected by wrapping each join using a sealing product (such as Denso). Refer to our Tech Note TN.07 “Using AusPress Underground” for more information.

Insulating with low-chloride content material is recommended as alternatives can damage the external stainless surface, increasing in speed and severity with the increase in temperature. Refer to our Tech Note TN.04 “Insulation & Stainless Steel (Lagging)” for more information.

Q: Any risks to mitigate?
Press-fit installation offers the obvious advantages of flame-free install, lighter equipment and faster installation times plus:

- With the connection, the M-Profile join offers a higher-pressure rating than the V-Profile in the same material, with a safety margin beyond the 1.5x test pressure for commissioning.
- The permanent join is formed at the time of pressing with no drying or cooling time required by other systems and modifications can be made easily in the future for additions.

At the time of supply/purchase is a great opportunity to ask some basic questions of the installer.

The assumption that copper and stainless are the same to install is misleading. Asking the right questions at the start will often avoid post-installation problems and faults.

1) Tooling – ability, jaws/collars, press-profiles.
2) Installation – tool lubrication, deburring & cutting, bracketing, insulation, commissioning.
3) Handling – surface protection, contamination, scratches.
4) Media – ring seal selection, chlorides, pressures.

Installation risks are as per other plumbing activities with common traps including:

- Insulation applied before hot water pipework is at temperature, resulting in 'short' insulated segments and not a continuous insulated surface.
- Not using two spanners to tighten threaded joints putting undue rotational force on the pressed socket join.
- Using dis-similar metals (such as brackets) causing bi-metal reactions.
- Installation errors nominated above; stagnant water, excessive dosing, not marking insertion depths, poor tool use and incorrect insulation selection.
- Stagnant water and dead legs in pipework is discouraged for all materials and stainless is no different to help avoid forms of microbial issues.
- Stainless and copper are colloquially considered compatible but best practice recommends separating the materials to prevent direct contact using a suitable separation material such as brass. Flow from stainless to copper is preferred; the reverse direction may lead to copper oxide coating the internals of the stainless pipework without detriment to the stainless.

Q: How one would destroy this pipe type?
With all products of metal, assessing the suitability of any chemical additives to the system is critical. Stainless has excellent resistance properties to most acids and alkaline solutions however, chemicals with unsuitably high levels of chlorides or chlorine are detrimental to grade 316 stainless. High dosing (ie 16x) beyond the 0.3ppm limit identified in the Australian Drinking Water Guidelines (ADWG) are detrimental to stainless steel, as they are for copper. Resistance for stainless is further covered in our Tech Note TN.01 "Chlorides, Chlorine & Stainless Steel" and Tech Note TN.33 Bimetallic Corrosion.

The location for installation is important to consider too. Exposure to sea and marine conditions can be detrimental to both copper and stainless, as noted in Tech Note TN.11 where the external surfaces need protection and/or maintenance (Tech Note TN.29 Cleaning & Maintaining Stainless). This includes before installation storage and freight with exposure to mild steel and aluminium dust damaging too.

Q: Whether blue water is a problem with stainless steel (it is with copper)?
No, blue water, the release of copper from copper pipe from corrosion from high or low pH, cannot occur with stainless steel.

FAQ

1. Q: Can I press stainless M-Profile fittings with a Rothenberger copper jaw?
   A: No, the diameters are different and the profile is different.

2. Q: Can stainless and copper pipework be mixed?
   A: Yes – refer to Tech Note TN.33 Bimetallic Corrosion for more information.

3. Q: Can I use galv brackets on stainless tube?
   A: Not in direct contact; use a 3mm rubber lining to separate the different metals.

4. Q: Can any insulation be used with stainless tube?
   A: No, only low-chloride products are to be installed – refer to Tech Note TN.04 Insulation & Stainless Steel (Lagging).

5. Q: Any special requirements for fuel, oil or diesel lines?
   A: Yes, refer to Tech Note TN.02 for information including changing the ring seal.

END