

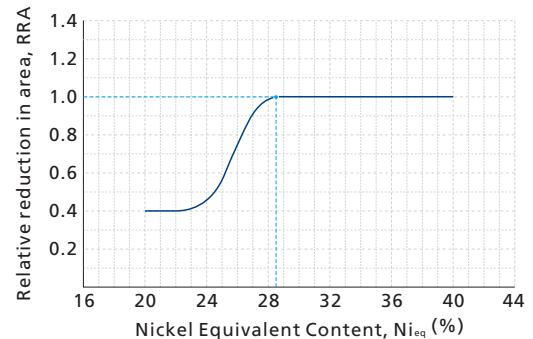
## Tips for Hydrogen Applications

### ▶ 316 SS with $Ni_{eq} \geq 28.5\%$ is a better choice than normal 316 SS in critical hydrogen applications

Normal 316 SS is acceptable for hydrogen applications. While 316 SS with  $Ni_{eq} \geq 28.5\%$  has better performance of hydrogen embrittlement resistance.

Material Grade	Composition %			$Ni_{eq}$ %
	Ni	Cr	Mo	
ASTM A479 316 SS	10-14	16-18	2-3	>22.4
FITOK Tailor-Made 316/316L SS	12-14	17-18	2.6-3	$\geq 28.5$

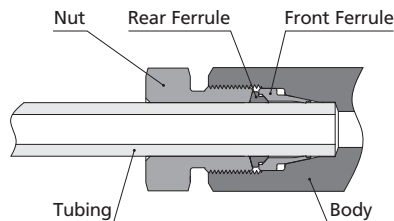
Hirayama's equation:  $Ni_{eq} = 12.6C + 0.35Si + 1.05Mn + Ni + 0.65Cr + 0.98Mo$



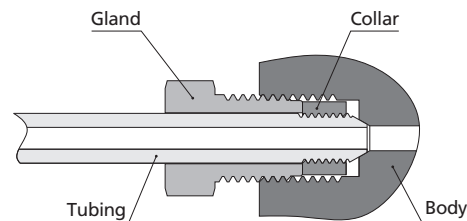
RRA is a quantitative description of hydrogen embrittlement

### ▶ Double ferrule fittings perform better than cone & thread fittings in hydrogen applications

Cone & thread connection can hold liquid at high pressure, while double ferrule fittings are more reliable than cone & thread fittings in hydrogen applications.



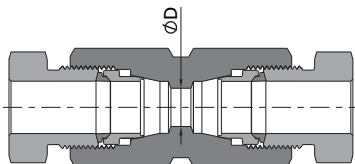
Double ferrule fittings



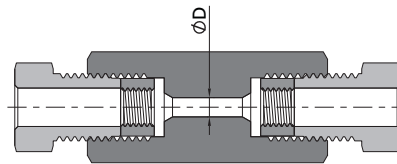
Cone & thread fittings

### ▶ Double ferrule connections are more cost-effective than cone & thread connections

Double ferrule connections have better flow capacity compared to cone & thread connections of the same size, which means double ferrule connections are cost-effective to achieve the desired flow rate.



Double ferrule fittings



Cone & thread fittings

Union Size	Double ferrule fittings Dia. D /mm	Cone & Thread fittings Dia. D /mm
3/4"	14.3	11.1
1"	17.5	14.3

➤ **Medium pressure tubing for double ferrule connection and for cone & thread connection should be distinguished**

	Tubing for Double Ferrule Connection		Tubing for Cone & Thread Connection	
Series	FITOK T20D		FITOK T20M	
Manuf. Process	Cold-Drawn 1/8-hard		Cold-Drawn	
Yield Strength /MPa	517-758		600-758	
Tensile Strength /MPa	724-965		724-965	
Elongation	≥25%		≥25%	
Hardness	≤26 HRC		≥98 HRB	
Size & Tolerance Standard	ASTM A269		ASME B1.1	
OD	OD Tolerance	WT	OD Tolerance	WT
1/4"	±0.005"	0.065"	-0.002"/-0.007"	0.071"
3/8"		0.083"	-0.005"/-0.01"	0.086"
1/2"		0.109"		/
9/16"		/		0.125"
3/4"		0.165"	0.156"	

➤ **Leakage rate standard shall be stricter than EC79 and HGV 3.1**

The leakage rate accepted by EC79 and HGV 3.1 is about 10 ml/hour. The leakage is too much for hydrogen applications. It's not difficult for competent manufacturers to reach stricter leakage rate standard. FITOK leakage rate standard is as follows:

Products	Leakage Rate Standard		
	FITOK	EC79	HGV 3.1
Valves	≤1x10 <sup>-6</sup> Ncm <sup>3</sup> /s	≤10 Ncm <sup>3</sup> /h	≤10 Ncm <sup>3</sup> /h
	11.6 days/Ncm <sup>3</sup>	6 minutes/Ncm <sup>3</sup>	6 minutes/Ncm <sup>3</sup>
Tube Fittings	≤1x10 <sup>-9</sup> Ncm <sup>3</sup> /s	≤10 Ncm <sup>3</sup> /h	≤10 Ncm <sup>3</sup> /h
	32 years/Ncm <sup>3</sup>	6 minutes/Ncm <sup>3</sup>	6 minutes/Ncm <sup>3</sup>

**Products Portfolio for Hydrogen Applications**

