VALVE AND FLOW CONTROL SPECIALISTS
SERVICE AND RELIABILITY

DK-Lok Tubing

No. TS-05-S
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Stainless Steel Instrumentation Fractional / Metric Tubing

Tubing benefits

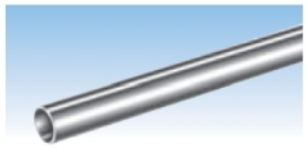
Tubing has many benefits against piping

- Pipe threading or welding is difficult to disassemble and re-assemble.
- Piping requires skilled worker for welding & threading.
- Piping is bulky.
- Tubing is assembled by simple wrench make-up on DK-Lok Tube Fittings reducing assembly time and the overall cost of installation.
- Tubing is bendable, allowing lower pressure drop with fewer connections. This in turn reduces costs with less fabricating manpower.

For safe, reliable and leak-free tubing system for use with DK-Lok Fittings , tubing should be considered as one of fitting components.

The following parameters should be considered when ordering instrumentation bright annealed seamless and welded tubing.

1. Tubing Selection
2. Tubing Handling
3. Tubing Installation
4. System Pressure
5. Welded Tubing Working Pressure



DK-Lok Tubing Features

For the best performance with DK-Lok fittings, DK offers ASTM A269 and A213 bright annealed DK-Lok tubing 1/8 in. to 1 in. OD with the following features:

- Seamless and suitable for bending and flaring.
- Free of scratches, drawing, dirt, and dust and other contamination.
- Chemically cleaned and passivated surface.
- Cold drawn and bright annealed.
- Hardness 80 HRB or less.

DK-Lok Tubing marking and packaging

- Marking on tubing includes OD, wall thickness(WT), material grade, specification, heat code, and country of origin.
- Tubing ends to be capped.
- A certain quantity to be packaged in a protective cover and then packed in a wooden crate.

DK-Lok Tubing standard length

6 meter tubing cut length variations as per the requirement of ASTM A450 standard.

DK-Lok Tubing ovality in OD and variations in WT

ASTM A269 specifies permissible variation in tubing OD and WT, reads:

Tube O.D. In	Permissible variation in OD, In. (mm)	Permissible variation in WT, %
Up to 1/2	+/- 0.005 (0.13)	+/- 15%
1/2 to 1 1/2, excl	+/- 0.005 (0.13)	+/- 10%

Tubing ovality variation in OD as per the requirements of ASTM A269. For tubing OD 1/8 in. and smaller, DK supplies +/- 0.003 inch variations for the leak-free performance with stainless steel 316 DK-Lok Fittings.

Tubing WT variations as specified in the ASTM A269 standard. See Table 4 and 5.

Heat Treatment

Solution annealed.

Surface Condition

Bright annealed with thermocouple clean level on the inside surface as per ASTM A632 S3.

Tubing Selection

Hardness

1. Tubing must be softer than fitting material. The metal tubing must be fully annealed and suitable for bending and flaring.
2. Tubing hardness must be selected according to the information in the table 4 and 5.

Surface

3. Tubing must have a surface free from scratches, draw mark, dirt, durst and flat spots.

Ovality

4. Tubing in oval or out-of-roundness may not fit into the fitting. Do not force the tubing into the fitting; it may damage the fitting sealing system on the nut, ferrules, and body.

5. Material

Using like tubing and fitting material is essential for the thermal compatibility and corrosion resistance. Different materials have different hardness level that may adversely affect the fitting seal on tubing. The only exception is copper tubing with brass DK-Lok Fittings.

6. Wall thickness

The table 4 and 5 show tubing working pressure ratings in a wide range of wall thickness. A too thin of a wall may collapse and too thick wall may not properly be deformed by the ferrule action. DK-Lok Fittings are not recommended for tube wall thickness not listed in the table 4 and 5.

7. Wall thickness for gas application

Gases such as nitrogen, air, hydrogen and helium, can escape even the most minute leak path due to their small molecules. Heavy wall tubing resists ferrule action by coining out minor defects of the tube surface whereas a thin wall may collapse with little resistance to ferrule action. For gas service, use heavy wall in white in table 4 and 5.

8. Weld tubing

The weld bead should not be noticeable visually on the outside of the tube.

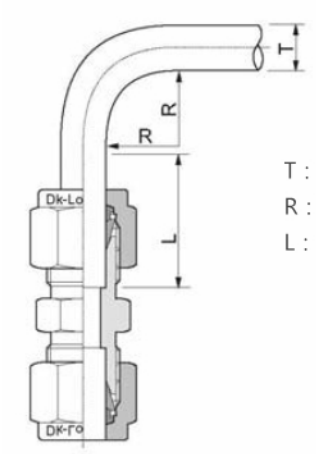
Note:
Tubing of ornamental, structural or mechanical grade should not be used for fluid system.

Tubing Handling

Careful handling and storage practices will protect tubing from unnecessary scratches, nicks and or degrading good tubing surface finish

- Tubing ends should be capped so any foreign materials will not fall inside during transportation and storage.
- Do not drag across tubing rack, cement, gravel or any rough surface.
- Do use correct tube cutter for tube material. The wrong cutter may result in excessive deformation of the tube end.
- Do not cut deep with each turn of cutter.
- Tube cutters and hacksaws should be sharp enough.
- Hacksaw blades should have at least 32 teeth per inch.
- Deburring tube ends before inserting in the tube fittings helps prevent against system containments.

Tubing Installation



T : Tube OD
R : Radius
L : Straight tube length

When tube bend is too close to a fitting, the bend section shall enter the fitting. This may not allow the tube to be bottomed out in the fitting, and may result in leakage.

Keep the proper straight length of tube as shown in table 1 below.

- Do not bend a tube in the fitting. Use tube bender.

Table 1.

Fractional tube, in.	
T	L
1/16	1/2
1/8	23/32
3/16	3/4
1/4	13/16
5/16	7/8
3/8	15/16
1/2	1 3/16
5/8	1 1/4
3/4	1 1/4
7/8	1 5/16
1	1 1/2
1 1/4	2
1 1/2	2 13/32
2	3 1/4

Metric tube, mm	
T	L
3	19
6	21
8	23
10	25
12	31
14	32
15	32
16	32
18	32
20	34
22	34
25	40
28	46
30	50
32	54
38	63
50	80

System pressure

DK-Lok Fitting pressure ratings are governed by the connective tubing pressure rating. To determine allowable working pressure at elevated temperature, multiply the working pressure at ambient temperature shown in table 4 and 5 by the factor shown in table 2.

Example:
SS316 seamless tubing 1/2 in. O.D. x 0.065 in.WT
at 700 F. 4700 psig x 0.82 = 3854 psig.
Therefore 3854 psig is the maximum allowable working pressure
at 700 oF for SS316 seamless 1/2 in. O.D. x 0.065 in. wall thickness tubing.

Table 2. Temperature De-rating Factors

Temperature		Stainless steel ASTM A269	
°F	°C	SS304	SS316
100	38	1	1
200	93	1	1
300	149	1	1
400	204	0.94	0.97
500	260	0.88	0.9
600	316	0.82	0.85
700	371	0.8	0.82
800	427	0.76	0.8
900	482	0.73	0.78
1000	538	0.69	0.77
1200	649	0.3	0.37

Table 3. Elastomer seal working temperature

Elastomer Seals	Working Temperature
NBR	-40 to 110C (-40 to 230°F)
FKM	-20 to 200°C(-4 to 392°F)
FFKM (Kalrez®)	-30 to 275°C(-22 to 527°F)

When Elastomer seal is used in the system, care must be taken for allowable working temperature. See Table 3

* Kalrez®: TM Dupont

Welded Tubing Working Pressure

As per ASME B31.3 Code for weld tubing working pressure, de-rating factors below must be applied. For double butt weld tubing multiply by 0.85 and for single butt weld tubing multiply by 0.80.

Example:
SS316 single butt weld tubing 1/2 in. O.D. x 0.065 in.
4700 psig x 0.80 = 3760 psig at -20 to 100°F (-28 to 37°C).

Cryogenic Service

- SS316 DK-Lok Fittings provide highly reliable performance from cryogenic to high temperature.
- SS316 DK-Lok Fitting and tubing temperature Rating: -425 to 1200°F (-253 to 649 oC)
- Cryogenic temperature are considered temperatures below -100°F (-73 oC)

Table 4. Tubing Material Grade and Chemical Requirements

Material Grade	ASTM	A269		A213 (a) / A249	
	UNS	S31600	S31603	S31600	S31603
	Grade	TP316	TP316L	TP316	TP316L
Chemical %	Chromium	16.0 to 18.0			
	Nickel	10.0 to 14.0		11.0 to 14.0	10.0 to 15.0
	Molybdenum	2.00 to 3.00			
	Manganese	2.00 max			
	Silicon	1.00		0.75 max	0.75 max (b)
	Carbon	0.08 max	0.035 max (c)	0.08 max	0.035 max (c)
	Phosphorus	0.045 max		0.040 max	
	Sulfur	0.030 max			

ASTM Standards

(a) Nominal wall thickness, not minimum wall thickness.

(b) For seamless TP316L tube, the silicon maximum shall be 1.00%.

(c) For smaller diameter or thin walls, or both, where many drawing passes are required, a carbon maximum of 0.040% is necessary in grade TP316L. This is applicable tubing size less than 1/2 in. OD and less than 0.049 in. (1.2 mm) in WT.

Stainless Steel Tubing

Fully annealed austenitic Type 304 or 316 seamless tubing ASTM A269 or A213, or equivalent. Tubing to be free from scratches, draw mark, dirt, durst and flat spots. Suitable for bending and flaring.

Table 5. Seamless Stainless Steel Fractional Tubing (Recommended hardness: 80 HRB (180 HV) or less.)

Tube OD In.	Tube Wall Thickness, in.														
	0.012	0.014	0.016	0.02	0.028	0.035	0.049	0.065	0.083	0.095	0.109	0.12	0.134	0.156	0.188
1/16	6800	8100	9400	12000											
1/8					8500	10900									
3/16					5400	7000	10200								
1/4					4000	5100	7500	10200				Working Pressure in PSIG			
5/16						4000	5800	8000							
3/8						3300	4800	6500	8600						
1/2						2400	3500	4700	6200						
5/8							2900	4000	5200	6000					
3/4							2400	3300	4200	4900	5800	6400			
7/8							2000	2800	3600	4200	4800	5400	6100		
1								2400	3100	3600	4200	4700	5300	6200	
1 1/4									2400	2800	3300	3600	4100	4900	
1 1/2										2300	2700	3000	3400	4000	4900
2											2000	2200	2500	2900	3600

Table 6. Seamless Stainless Steel Metric Tubing (Recommended hardness: 80 HRB (180 HV) or less.)

Tube OD mm	Tube Wall Thickness, mm												
	0.8	1	1.2	1.5	1.8	2	2.2	2.5	2.8	3	3.5	4	4.5
3	710												
6	330	420	520	670									
8		310	380	490									
10		240	300	380						Working Pressure in Bar			
12		200	240	310	380	430							
14		180	220	280	340	390	430						
15		170	200	260	320	360	400						
16			190	240	300	330	370						
18			170	210	260	290	320	370					
20			150	190	230	260	290	330	380				
22			130	170	210	230	260	300	340				
25					180	200	230	260	300	320			
28						180	200	230	260	280	330		
30						170	190	210	240	260	310		
32						160	170	200	230	240	290	330	
38							140	170	190	200	240	280	310

- ASTM A269 tubing allowable working pressure is calculated at -20 to 100°F (-28 to 37°C) using allowable stress value of 20,000 psi according to ASME B31.3 Code.
- Pressure calculations are based on maximum O.D. and minimum wall thickness and no allowance is made for corrosion and erosion. i.e., ASTM A269 1/2 in. OD x 0.035 in.: OD tolerance ± 0.005 in., WT tolerance ± 15%. Calculations are based on 0.505 in.OD x 0.0298 in. WT.
- Safety Factor is 3.75 to 1, considering ultimate tensile strength of 75,000 psi.
- For working pressure according to ASME B31.1, multiply the ASME 31.3 rating by 0.94.

Ordering information

DK-Lok A269/A213 seamless bright annealed stainless steel grade TP316/316L tubing.

Tube OD in.	Nominal Wall Thickness (in.)	Ordering Number
1/8	0.028	TL2-028-x-S
	0.035	TL2-035-x-S
1/4	0.028	TL4-028-x-S
	0.035	TL4-035-x-S
	0.049	TL4-049-x-S
	0.065	TL4-065-x-S
3/8	0.035	TL6-035-x-S
	0.049	TL6-049-x-S
	0.065	TL6-065-x-S
	0.083	TL6-083-x-S
1/2	0.035	TL8-035-x-S
	0.049	TL8-049-x-S
	0.065	TL8-065-x-S
	0.083	TL8-083-x-S
3/4	0.065	TL12-065-x-S
	0.083	TL12-083-x-S
	0.095	TL12-095-x-S
	0.109	TL12-109-x-S
	0.120	TL12-120-x-S
1	0.083	TL16-083-x-S
	0.095	TL16-095-x-S
	0.109	TL16-109-x-S
	0.120	TL16-120-x-S
	0.134	TL16-134-x-S
	0.156	TL16-156-x-S

Tube OD mm	Nominal Wall Thickness (mm)	Ordering Number
6	1.00	TL6M-1.0-x-S
	1.20	TL6M-1.2-x-S
	1.50	TL6M-1.5-x-S
8	1.00	TL8M-1.0-x-S
	1.20	TL8M-1.2-x-S
	1.50	TL8M-1.5-x-S
10	1.00	TL10M-1.0-x-S
	1.20	TL10M-1.2-x-S
	1.50	TL10M-1.5-x-S
12	1.20	TL12M-1.2-x-S
	1.50	TL12M-1.5-x-S
	1.80	TL12M-1.8-x-S
	2.00	TL12M-2.0-x-S
20	1.80	TL20M-1.8-x-S
	2.00	TL20M-2.0-x-S
	2.20	TL20M-2.2-x-S
	2.50	TL20M-2.5-x-S
	2.80	TL20M-2.8-x-S
25	1.80	TL25M-1.8-x-S
	2.00	TL25M-2.0-x-S
	2.50	TL25M-2.5-x-S
	2.80	TL25M-2.8-x-S
	3.00	TL25M-3.0-x-S

To order tubing in 6 meter length, insert "6M" into the ordering number. Example: TL8-035-6M-S
To order tubing in 20 feet length, insert "20" into the ordering number. Example: TL8-035-20-S

To order weld tubing remove "L" after T in the ordering number. Example: T8-035-6M-S
To order annealed & pickled A269 seamless SS316 tubing, insert "AP" in the ordering number. Example: TL8-083-6M-AP-S

Reference Documents

- ASTM A213 Seamless Ferritic and Austenitic Alloy-Steel Boiler, Super heater, and Heat-Exchanger Tubes
- ASTM A249 Welded Austenitic Steel Boiler, Super heater, Heat Exchanger, and Condenser Tubes
- ASTM A269 Seamless and Welded Austenitic Stainless Tubing for General Service.
- ASTM A450 General Requirements for Carbon, Ferritic Alloy, and Austenitic Alloy Steel Tubes
- ASTM A632 Seamless and welded Austenitic Stainless Steel Tubing (Small-Diameter) for General Service
- DIN 2391/EN10305 Precision Seamless Tubes
- DIN 17458/2462 Seamless Circular Tubes of Austenitic Stainless Steels with Special Quality Requirements

DK-LOK Fittings & Valves
www.dklok.com

DK-LOK Corporation
Mailing Address
7, Golden root-ro 129beon-gil, Juchon-myeon, Gimhae-si, Gyeongsangnam-do, South Korea 621-842

DK-Lok contact information
Tel. (82) 55-338-0114
Fax. (82) 55-901-0143
E-mail : sales@dklok.com

For International customers
Tel. (82) 55-338-0031/2
Fax. (82) 55-901-0142
E-mail : dklok@dklok.com