outokumpu
stainless steel & high performance alloys

North American Version
Imperial Units

PRODEC® Type 304, Type 304L

A special quality of standard Type 304 UNS S30400/ 304L UNS S30403 with composition and processing for enhanced machinability.

Description

PRODEC® 304/304L is an improved version of standard Type 304/304L. With advanced ladle metallurgy techniques, the steel is processed for improved machinability and outstanding uniformity. PRODEC 304/304L offers faster machining speeds, longer tool life, improved part quality, and lower total cost of machined parts.

PRODEC 304/304L is nonmagnetic in the annealed condition but may become slightly magnetic as a result of cold working or welding.

Dual Certification

It is common for PRODEC 304L to be dual certified as PRODEC 304 and PRODEC 304L when the material meets both the lower carbon limit of Type 304L and the slightly higher strengths of Type 304. The producer of the steel must certify the material as Type 304 if it is to be used asType 304 instead of Type 304L.

Specifications

PRODEC 304/304L meets the same AMS, ASTM, ASME, QQS, and MIL-S specifications as standard Type 304/304L.

Product Forms Available

Plate
Bar

Corrosion Resistance

PRODEC 304/304L is a versatile, general purpose stainless steel with good resistance to atmospheric corrosion, to many organic and inorganic chemicals, and to foods and beverages. It has also been used in vacuum processing equipment and specialized instruments where high integrity is essential.

Although improvements in machinability in the past have been associated with reduced corrosion resistance, PRODEC 304/304L has been shown to have corrosion resistance within the range typically expected of Type 304L stainless steel. Because of its low carbon content, PRODEC 304/304L retains this corrosion resistance in the as-welded condition.

Machinability

PRODEC 304/304L is melted to a closely controlled chemistry and ladle-treated to achieve control of the composition, amount, size, shape, and distribution of the nonmetallic inclusions (sulfides and oxides) normally occurring within a standard stainless steel. These inclusions provide for chip breaking and for reduced wear of carbide tooling at high machining speeds. PRODEC 304/304L permits higher machining speeds, longer tool life, and superior part quality with reduced total cost for finished parts.

Turning

Table 1

Feed (in/rev)	Cutting depth (in)	Cutting speed, sfm: Cemented carbides C7	C6	C5	High speed steel
< 0.012	0.08	820	650	—	130
0.012-0.020	0.08-0.20	—	590	490	115
0.020-0.040	0.20-0.40	—	330	295	65

Threading

Table 2

Tool	Speed (sfm)
Cemented Carbide (C6-C5)	295-425
High Speed Steel	50-65

Reaming

Table 3

Ream diameter (in)	Cutting Speed (sfm) Cemented carbide	High speed steel	Feed (in/rev)
< 0.40	165	33-50	0.004-0.008
0.40-0.80	165	33-50	0.012
> 0.80	165	33-50	0.012-0.016

Coolant/lubricant: emulsion or cutting oil

Cut Off

Table 4

Tool	Speed (sfm)	Feed (in/rev)
Cemented Carbide (C5)	330-490	0.004-0.008
High Speed Steel	80	0.002

Drilling — High Speed Steel Twist Drills

Table 5

Drill diameter (in)	Speed rpm	Speed fm	Feed (in/rev)
0.04	3200-3800	33-38	0.002
0.12	1600-1800	50-57	0.004
0.20	1080-1270	57-66	0.008
0.40	540-640	57-66	0.012
0.60	360-430	57-66	0.014
0.80	270-320	57-66	0.016
1.20	180-220	57-66	0.018

Notes:

1. Cutting Fluid: Ample flow of 10% emulsion coolant.
2. With short NC drills, feed can be increased about 40%.
3. When hole depth exceeds 4x diameter, clear chips from hole.
4. With TiN-Coated HSS drills, speed can be increased 10%.
5. For rotating drill and fixed workpiece, as in drilling a hole in a plate, the maximum speed should not exceed 50 sfm.

Drilling — Indexable insert drills, cemented carbides

Table 6

Drill diameter (in)	Speed sfm	Feed (in/rev)	Type of carbide Center	Periphery
0.80	655-820	0.004	C6	C7
1.20	655-820	0.005	C6	C7
1.60	655-820	0.006	C6	C7
2.00	655-820	0.008	C6	C7

The following tables give some speeds and feeds obtained in tests for PRODEC 304/304L, providing guidelines for possible adaptation to particular machining programs. The data provided are based on achieving tool lives of 15 minutes for cemented carbides and 60 minutes for high speed steel tools.

Heat Treatment

Annealing

PRODEC 304/304L should be heated to 1900°F minimum, then water quenched or rapidly cooled by other means.

Mechanical Properties at Room Temperature

Table 7

	Typical*	ASTM 304	ASTM 304L
Ultimate Tensile Strength, ksi	99	80 min	70 min
0.2% Offset Yield Strength, ksi	48	35 min	25 min
Elongation in 2 inches, %	52	40 min	40 min
Reduction in Area, %	61	—	—
Hardness, Rockwell B	85	96 max	92 max

*0.375 inch plate

Chemical Composition, wt. pct.

Table 8

	PRODEC 304	PRODEC 304L
Carbon	0.030 max	0.030 max
Manganese	2.00 max	2.00 max
Phosphorus	0.045 max	0.045 max
Sulfur	0.030 max	0.030 max
Silicon	0.75 max	0.75 max
Chromium	18.0-20.0	18.0-20.0
Nickel	11.0-15.0	11.0-15.0
Nitrogen*	0.10 max	0.10 max

*flat-rolled products only

Physical Properties

Table 9

Density, lb/in^3	0.285
Modulus of Elasticity, psi	29×10^6
Coefficient of Thermal Expansion, 68-212°F, /°F	8.9×10^{-6}
Thermal Conductivity, Btu/ft hr°F	8.7
Heat Capacity, Btu/lb°F	0.12
Electrical Resistivity, Ω-inch	33.5×10^{-6}

Milling

Table 10

Operation	Cemented carbide			High speed steel	
	Speed (sfm)	Feed (in/tooth)	Type of carbide	Speed (sfm)	Feed (in/tooth)
Face Milling	490-820	0.006-0.012	C7-C6	80-100	0.005-0.008
Side Milling	590-790	0.010-0.012	C7-C6	80-100	0.005-0.008
End Milling	490-720	0.004-0.008	C7-C6	80-100	0.001-0.006
End Milling (Solid cemented carbide)	165-330	0.002-0.008	C5	—	—

Lowest Temperature (°F) at Which the Corrosion Rate Exceeds 5 mpy

Table 11

Corrosion Environment	654 SMO®	254 SMO®	904L	Type 316L (2.7 Mo)	Type 304	Outokumpu 2507	2205 Code Plus Two®	Outokumpu 2304
0.2% Hydrochloric Acid	>Boiling	>Boiling	>Boiling	>Boiling	**>Boiling**	>Boiling	>Boiling	>Boiling
1% Hydrochloric Acid	203	158	122	86	**86p**	>Boiling	185	131
10% Sulfuric Acid	158	140	140	122	—	167	140	149
60% Sulfuric Acid	104	104	185	<54	—	<57	<59	<<55
96% Sulfuric Acid	86	68	95	113	—	86	77	59
85% Phosphoric Acid	194	230	248	203	**176**	203	194	203
10% Nitric Acid	>Boiling	>Boiling	>Boiling	>Boiling	**>Boiling**	>Boiling	>Boiling	>Boiling
65% Nitric Acid	221	212	212	212	**212**	230	221	203
80% Acetic Acid	>Boiling	>Boiling	>Boiling	>Boiling	**212p**	>Boiling	>Boiling	>Boiling
50% Formic Acid	158	212	212p	104	**≤50**	194	194	59
50% Sodium Hydroxide	275	239	Boiling	194	**185**	230	194	203
83% Phosphoric Acid + 2% Hydrofluoric Acid	185	194	248	149	**113**	140	122	95
60% Nitric Acid + 2% Hydrochloric Acid	>140	140	>140	>140	**>140**	>140	>140	>140
50% Acetic Acid + 50% Acetic Anhydride	>Boiling	>Boiling	>Boiling	248	**>Boiling**	230	212	194
1% Hydrochloric Acid + 0.3% Ferric Chloride	>Boiling, p	203ps	140ps	77p	**68p**	203ps	113ps	68p
10% Sulfuric Acid + 2000ppm Cl^- + N_2	149	104	131	77	—	122	95	<55
10% Sulfuric Acid + 2000ppm Cl^- + SO_2	167	140	122	<<59p	—	104	<59	<<50
WPA1, High Cl^- Content	203	176	122	≤50	**<<50**	203	113	86
WPA2, High F^- Content	176	140	95	≤50	**<<50**	167	140	95

ps = pitting can occur
ps = pitting/crevice corrosion can occur

WPA	P_2O_5	Cl^-	F^-	H_2SO_4	Fe_2O_3	Al_2O_3	SiO_2	CaO	MgO
1	54	0.20	0.50	4.0	0.30	0.20	0.10	0.20	0.70
2	54	0.02	2.0	4.0	0.30	0.20	0.10	0.20	0.70

1053EN, Itasca, USA, August 2013.

Hardening

PRODEC 304/304L cannot be hardened by heat treatment. However, PRODEC 304/304L can be hardened by cold working.

Corrosion Performance of Stainless Steels

Table 11 compares several Outokumpu steels in a variety of common corrosive environments. The lowest temperature at which the corrosion rate exceeds 5 mpy was determined. All testing was done in accordance with the requirements of the Materials Technology Institute of the Chemical Process Industries (MTI).

Workability
Cold Working

PRODEC 304/304L is readily formed and fabricated through a full range of cold working operations. It can be used in heading, drawing, bending, and upsetting. Any cold working operations will increase the strength and hardness of the material, and may leave it slightly magnetic.

Hot Working

PRODEC 304/304L can be forged in the 1700-2200°F range. For maximum corrosion resistance, forgings should be annealed at 1900°F minimum and water quenched or rapidly cooled by other means after hot working operations.

Welding

PRODEC 304/304L is readily welded by a full range of conventional welding procedures (except oxyacetylene). AWS E308L/ER308L filler metal should be used with PRODEC 304/304L steel, but the low carbon molybdenum-containing austenitic stainless steel filler metals may also be considered.

Technical Support

Outokumpu assists users and fabricators in the selection, qualification, installation, operation, and maintenance of PRODEC 304/304L stainless steel. Technical personnel, supported by the research laboratory of Outokumpu, can draw on years of field experience with PRODEC 304/304L to help you make the technically and economically correct materials decision.

Outokumpu is prepared to discuss individual applications and to provide data and experience as a basis for selection and application of PRODEC 304/304L.

Outokumpu works closely with its distributors to ensure timely availability of PRODEC 304/304L in the forms, sizes, and quantities required by the user. For assistance with technical questions and to obtain top quality PRODEC 304/304L, call Outokumpu at 1-800-833-8703.

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