

Technical Data Sheet

UGI® 4418 AIR

Chemical analysis (%)

C	Si	Mn	Ni	Cr	Mo	Cu	N	P	S
≤ 0.060	≤ 0.6	≤ 1.5	4.0- 5.0	15.0 - 17.0	0.8 - 1.2	≤ 0.5	≥ 0.020	≤ 0.030	≤ 0.005

16-04-2015 – REV 00

General presentation

UGI® 4418 AIR stainless steel is a low-carbon super-martensitic grade with the addition of nickel. It is specifically designed for the aerospace market. It combines high mechanical strength with excellent resilience and very good corrosion resistance, considerably higher than those of conventional high-carbon Fe-Cr-C martensitic steels. This grade exhibits excellent cryogenic properties.

Classification

Martensitic stainless steel

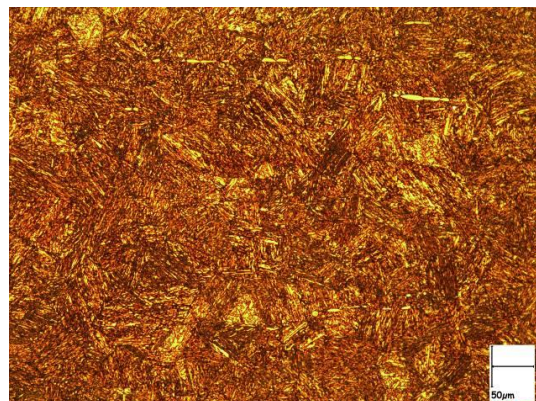
Designation

Material No. or designation

Europe	USA	Japan	ISO	Others
ISO EN 10088-3 EN 4631; EN 4628	UNS	JIS	ISO 15510	Ex AIR 9160-C standard
1.4418 (X4CrNiMo16-5-1)	-	-	4418-431-77-E	Z8CND17-04

Microstructure

In the quenched and tempered state, the UGI® 4418 AIR microstructure consists predominantly of tempered martensitic. It may contain traces of ferrite (less than 5%) and residual austenite, depending on the diameter and the heat treatments used.



Microstructure of UGI® 4418 AIR in the QT900 quenched and tempered state (longitudinal direction x200)

The microcleanliness guarantees are as follows (rating as per ASTM E45/method A):

Inclusion type	Sulphides A	Alumina B	Silicates C	Globular oxides D
Fine	≤ 2.0	≤ 2.0	≤ 2.0	≤ 2.0
Thick	< 2.0	< 2.0	< 2.0	< 2.0

UGI® 4418 AIR is also available in an electro-slag-remelted (ESR) version.



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Mechanical properties

Quenched and tempered turned bars

Heat treatment	Diameter	Direction	Temperature	Tensile strength	Yield strength	Ultimate elongation	Resilience	Hardness
	Ø		T	Rm	Rp _{0.2}	A	KV	HBW
	(mm)		(°C)	(MPa)	(MPa)	(%)	(J)	
Annealed	≤ 200		20					≤ 293
QT900 *	≤ 75	L	20	900 to 1050	≥ 700	≥ 16	≥ 120	269 to 331
		L	-40				≥ 70	
	> 75	T	20	900 to 1050	≥ 700	≥ 12	≥ 60	269 to 331
		T	-40				≥ 35	
QT1100	≤ 75	L	20	1100 to 1250	≥ 900	≥ 14	≥ 100	337 to 380
	> 75	T	20	1100 to 1250	≥ 900	≥ 8	≥ 50	337 to 380
QT1150 **	≤ 75	L	20	1150 to 1300	≥ 900	≥ 14	≥ 100	341 to 401
		L	-30				≥ 60	
	> 75	T	20	1150 to 1300	≥ 900	≥ 8	≥ 50	341 to 401
		T	-30				≥ 20	

* : to EN 4631; ** : to EN 4628

Physical properties

Temperature	Density	Elasticity modulus	Thermal conductivity	Expansion coefficient between 20°C and T	Electrical resistivity	Specific heat	Magnetizable
(°C)	(kg/dm³)	(GPa)	(W.m ⁻¹ .K ⁻¹)	(10 ⁻⁶ .K ⁻¹)	(μΩ.mm)	(J.kg ⁻¹ .K ⁻¹)	
20	7.7	200	15	-	800	430	Yes
100		195		10.3			
200		185		10.8			
300		175		11.2			
400		170		11.6			

Corrosion resistance

Due to its high percentage of nickel, chromium and molybdenum and its low carbon content, UGI® 4418 AIR has good corrosion resistance.

Localized corrosion

— Pitting corrosion

The pitting potentials were measured as specified in ISO 15158-2014 in a solution containing 0.02M NaCl at 23°C. UGI 4418 AIR also has far better pitting corrosion resistance than a 13% Cr martensitic (type 1.4006). The results show that the pitting corrosion resistance of UGI® 4418 AIR is similar to that of 1.4542 and 1.4307 (containing 0.020% of sulphur).



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Grade	Pitting potential (mV/ECS at ± 20 mV)
1.4006 (410)	185
1.4307 (304L)	400
1.4542 (17-4PH)	380
UGI 4418 AIR	375

— Intergranular corrosion

Its structure and composition make UGI® 4418 AIR insensitive to intergranular corrosion.

Hot forming

Forging

Heating between 1150°C and 1200°C is recommended. Hot forming (forging) must preferably be carried out at a temperature of between 1200°C and 900°C, followed by air cooling. The behaviour of UGI® 4418 AIR during forging is equivalent to that of a type 1.4301 austenitic grade.

Full heat treatment, austenitizing/quenching followed by tempering, is recommended after hot forming.

Cold forming

UGI® 4418 AIR can be cold formed by conventional cold-working processes (bar drawing, wire drawing, forming, profiling, etc.). Its high mechanical properties require particular attention. After or during cold-forming operations, quenching may be necessary to soften the grade. In the event of high levels of deformation, a complete quenching and tempering process is recommended.

Welding

UGI® 4418 AIR can be welded by electric arc (GMAW, GTAW, SMAW, etc.) and by most other processes (spot welding, seam welding, LASER, etc.). Due to its low percentage of carbon and its nickel content, UGI® 4418 AIR is easier to weld than most martensitic stainless steels.

Low-carbon martensite combined with finely dispersed residual austenite gives the heat-affected zones (HAZ) of UGI® 4418 AIR

excellent toughness in the as-welded condition. UGI® 4418 AIR is therefore only slightly susceptible to cold cracking after welding and it is not normally necessary to preheat the parts, unless the parts to be welded are very thick or their geometry is liable to generate high stress concentrations at the welds after cooling (in this case, preheating at 100-120°C is recommended). If the Weld Metal (WM) does not require the mechanical properties of UGI® 4418 AIR, an austenitic grade such as A316LM or A316LT can be used as filler metal. Post-weld heat treatment is then generally not necessary.

Where the WM must have the same mechanical properties as those of UGI® 4418 AIR, a homogeneous filler metal must be used (such as "16 5 1"). In this case, post weld heat treatment at 580-600°C is recommended.

For GMAW with homogeneous filler metal, a slightly oxidizing shielding gas such as Ar + 1-2% CO₂ will be chosen to avoid too high a percentage of oxygen in the WM, thus ensuring good impact properties for these WMs.

Heat treatment

Softening

UGI® 4418 AIR is difficult to soften due to its chemical composition leading to a very low transformation point (Ac₁). Soft annealing is generally carried out between 600 and 650°C.

Quenching

UGI® 4418 AIR quenching heat treatment consists of austenitizing between 1010°C and 1060°C, followed by oil quenching (or air quenching for smaller sections). To limit the risks of quenching cracks, tempering must be carried out as soon as possible after the quenching operation, after returning to the ambient temperature.



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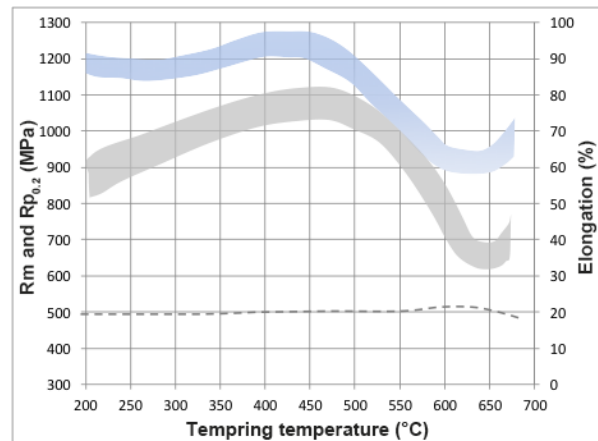
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Tempering

The tempering temperature must be adjusted according to the mechanical properties required.

- QT 900 level: tempering between 550°C and 620°C
- QT 1100 and QT1150 levels: tempering between 375°C and 405°C

The tempering period is generally between 2 h and 4 h and is followed by air or oil cooling. Double tempering can be used to soften the grade further. The temperature range between 400°C and 450°C should be avoided, as it can lead to excessive metal embrittlement.



UGI® 4418 AIR tempering graph (for information only)

Available products

Product	Profile	Finish	Tolerance	Dimensions
Bars	Round	hot rolled descaled	K13 – K12	22 -115 mm
		turned	h11 - h10	22-115 mm
		turned polished	h11 - h10 h9	22-115 mm 22-55 mm
		ground	h9 - h8 - h7	5-115 mm
		drawn	h9	5-30 mm

For others: please contact us

Applications

- Rotating parts
- Fasteners
- Brake pistons
- Fittings and connectors
- Shaft and pins
- Structural parts
- Tanks



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