

UGI® 4057 AIR

Chemical composition (wt %)	C	Si	Mn	Ni	Cr	Cu	Mo	P	S
	0.12 - 0.20	≤ 1.0	≤ 1.0	2.0 – 3.0	15.0 – 17.0	≤ 0.5	≤ 0.3	≤ 0.025	≤ 0.005

29-05-2015 – REV 01

General presentation:

UGI® 4057 AIR is a martensitic stainless steel with Ni addition. Its 15% Cr content ensures a higher corrosion resistance than classical martensitic stainless steels like AISI 410 or 420. The balance between alloying elements, Cr, Ni and C, in UGI® 4057 AIR has been carefully chosen to obtain an almost fully martensitic structure after austenitization (with limited amounts of retained austenite and delta ferrite) to develop full strength. This grade is employed preferentially in quench and tempered condition that offers a wide range of mechanical properties depending on the tempering temperature.

Classification:

Carbon martensitic stainless steel with Ni addition for aerospace applications

Designation and general standards

Europe	USA	Japan	France	Germany	UK	Sweden
EN	ASTM	JIS	AIR	WL	BS	SIS
EN 10088-3 EN 3490	ASTM A276, A479, A314		9160C		BS 7S 80	
1.4057 X17CrNi16-2 X15CrNi17-3	UNS S43100 AISI 431	SUS431	Z15CN17-03	1.4044	S80	2321

Heat treatments

Heat treatments carried out on UGI® 4057 AIR are composed of two steps:

- Austenitization, whose purpose is to dissolve carbon and obtain a hard supersaturated martensite
- Tempering, whose purpose is to adjust mechanical for the application (strength / toughness compromise). A single or double tempering treatment can be performed depending on the customer specification.

Austenitization

Austenitization is performed in the range 950°C to 1030°C, for a dwell time of 30 min minimum. Cooling must be fast enough to avoid grain boundary precipitation that would be detrimental for toughness, but not too fast to avoid quench cracking. Oil quenching (with a moderate drasticity fluid) or air cooling can be performed depending on the size of treated parts.

Tempering

Tempering conditions may vary depending on customer's specifications. Some specifications demand a double tempering treatment (to relax fresh martensite formed after the 1st tempering) whereas other are requiring a single tempering. Thanks to its low retained austenite content after austenitization, UGI® 4057 AIR can indifferently be tempered by double or single treatment. For the QT900, the recommended tempering treatment routes are:

- 640 °C / 4h / AC + 610 °C / 4h / AC (double tempering)
- 650 °C / 4h / AC (single tempering)

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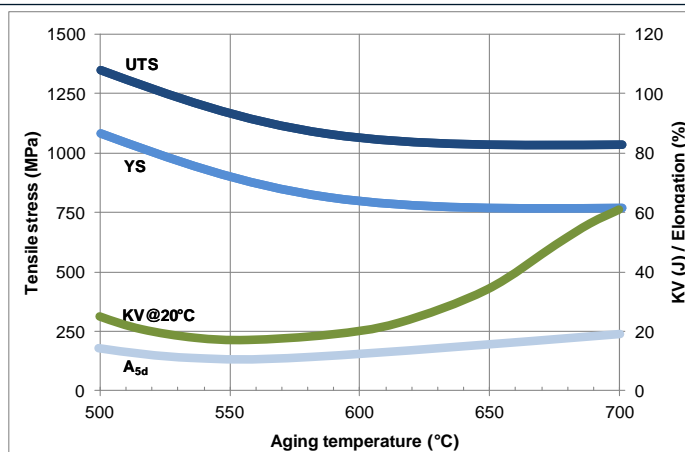
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Evolution of mechanical properties with single tempering temperature on UGI® 4057 AIR austenitized at 1015°C

Annealing/softening

Full annealing is impracticable because of long cooling time required. Instead, the following semi-anneal procedure can be employed:

- austenitization at rather low temperature to form globular carbides, typically at 800°C for a dwell time of 2 hours followed by furnace cooling until 600°C and air cooling below.
- high temperature tempering at 680-700°C for 4 hours followed by air cooling.

Average mechanical properties obtained after this two steps semi-anneal procedure are the following:

Rm	Rp0.2	A%	KV	HRC	HB
900	700	20	60-80	26	275

Guaranteed mechanical properties on UGI® 4057 AIR

Condition	Specifications	Diam	Heat treatments QT		Rm	Rp0.2	A5d	KV-L	KU-L	HBW
		[mm]	Aust.	Temper.	[MPa]	[MPa]	[%]	@20°C [J]	@20°C [J]	
A	EN 10088-3 EN 3490 WL 1.4044.2	-								≤ 293
QT800	EN 10088-3 WL 1.4044.5	≤ 100	950°C /3h/ AC	700°C/4h/AC + 650°C/4h/AC	800 - 950	≥ 600	≥ 14	≥ 25	≥ 25	235 - 285
QT900	EN 10088-3	≤ 100	950 to 1020°C / AC or OQ	Single tempering 620-650 / 4h /AA	900 - 1080	≥ 700	≥ 12	≥ 20		270-321
QT900	EN 3490 WL 1.4044.6 BS80 (*)	≤ 100	950 to 1020°C / AC or OQ	Double tempering 640 + 610	900- 1080	≥ 700	≥ 12	≥ 20	≥ 20	270-321

(*) special heat treatment to comply with Impact Izod requirements

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Microstructure

The microstructure in quench and tempered condition is fully martensitic with fine chromium carbides. The delta ferrite is nearly totally eliminated by hot rolling and austenitization (δ fraction < 5 % is guaranteed).



Microstructure of UGI® 4057 AIR in quench and tempered condition, observed under light microscope

Microcleanliness

The following microcleanliness, according to ASTM E45/A is guaranteed on UGI®4057 AIR:

Type	A		B		C		D	
rating	Thin	Heavy	Thin	Thick	Thin	Thick	Thin	Thick
	< 2	< 2	≤ 2	< 2	≤ 2	< 2	≤ 2	< 2

For applications requiring an improved microcleanliness UGI®4057 AIR also exists in ESR refined version.

Physical properties

The following values are reported for information purpose. They are dependent on the metallurgical condition, please contact us for precise information.

Temperature	Density	Weight of round bars	thermal expansion between 20°C and T	Young's modulus	Thermal conductivity	Electrical resistivity	Specific heat	Magnetic properties
[°C]	[kg/dm³]	[kg/m]	[10 ⁻⁶ K ⁻¹]	[GPa]	[W/(m.K)]	[μΩ.cm]	[J/(kg.K)]	
20	7.71	0.0061xD[mm]²		215	25	70	460	ferromagnetic
100	7.69		10.6	212				
200	7.66		11.2	205				
300	7.64		11.7	200				
400	7.60		12.1	190				

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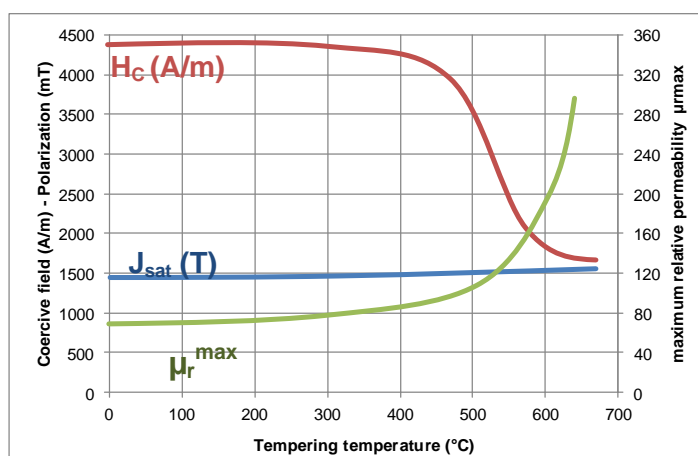
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Magnetic properties

UGI® 4057 AIR is a ferromagnetic grade at room temperature until 727°C (Curie transition). Its magnetic properties are semi-hard, and are significantly changed by tempering. The evolution with tempering is reported below:



Corrosion resistance

This alloy has a good atmospheric corrosion resistance and is one of the best standard martensitic grades for corrosion resistance; only structurally hardened grades such as UGIMA® 4542 have a higher resistance (among martensitic grades). It is also resistant to certain petroleum and organic products.

Environment	Behaviour/ Use
Nitric acid	GOOD
Phosphoric acid	Restricted use
Sulphuric acid	Restricted use
Acetic acid	Restricted use
Sodium carbonate	Average
NaCl (fog test)	Average
Humidity	GOOD
Sea water	Restricted use

N.B. : the corrosion resistance of a stainless steel depends on many factors related to the composition of the corrosive atmosphere (chloride concentration, presence or absence of oxidizing agents, temperature, pH, agitation or no agitation, and so on), as well as to the preparation of the material (surfaces free from metal particles, surface finish, such as hardening, polishing, and so on). Precautionary measures should be taken for certain tests such as the sodium chloride fog test (ISO 9227): for example marking labels (that might cause corrosion run-outs and reduce the test resistance time) should not be used on the sample.

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Forging

UGIMA® 4057 is suitable for forging. It is heated slowly to 850°C, then more quickly to 1150/1180°C for forging between 1180°C and 950°C. Forging must be followed by a stress relief heat treatment at 200°C or softening at between 750 and 850°C or hardening and tempering.

Welding

Provided certain precautionary measures are taken, UGIMA® 4057 can be subjected to most arc welding or resistance welding techniques in tempered, hardened or softened condition.

To prevent any risk of cold cracking after welding, UGIMA® 4057 must be preheated to between 200 and 300°C and the temperatures between passes maintained at a minimum of 200°C. A tempering heat treatment at 650°C is also required after welding.

If a filler metal is needed, a filler wire with a similar composition to that of UGIMA® 4057 is recommended, especially if the mechanical properties of the weld metal have to be the same as that of the base metal. If not, AWS E/ER310 austenitic wire can be used.

Ar + 1 to 3% CO₂ or O₂ shielding gases are recommended for MIG welding. Gas containing H₂ should not be used. Coated electrodes must be oven dried before welding.

Products available

Product	Profile	Surface Finishing	Tolerance	Size (mm)
Bar	Round	Hot rolled descaled	k13 – k12	22 - 115
		Turned		
		Smooth Turned	h11 - h10	22 - 115
		Peeled and polished	h9	
		Centerless Ground	h9 - h8 - h7	5 - 115
		Cold Drawn	h9	5 - 21

For other profiles, please contact us.

Applications

UGI® 4057 AIR is frequently used in highly stressed parts where good corrosion resistance is important in design, such as aircraft fittings, pump shafts and valve parts.

It also meets the requirements of EN10272 with respect to pressure vessels.

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