Astralloy
a NUCOR company

Astralloy 8000®

Advanced Technology in Wear

Chemical Composition* – % Weight						
C	Mn	P	S	Ni	Cr	Mo
.28	1.60	.015	.002	≈.40	1.60	.20

Physical Properties – Typical Values at 68°F				
BHN Hardness	Tensile Strength	Yield Strength	Elongation in 2"	Charpy Test Toughness index
430 – 470	236 ksi	156 ksi	12%	22 ft. lbs. @ RT

Physical Properties	
Expansion Coefficient — Average (x 10-6.°C-1)	
20° – 100°C (68°–212°F)	11.2
20° – 200°C (68°–392°F)	12.0
20° – 300°C (68°–572°F)	12.5
20° – 400°C (68°–752°F)	13.2
20° – 500°C (68°–932°F)	13.8

Astralloy 8000® is an advanced abrasion-resistant steel with a better compromise, in extreme applications, between abrasion resistance and toughness (crack resistance). It has a wear life which is over 50% higher than 500 HB conventional water quenched steels.

Astralloy 8000 capitalizes on an innovative metallurgical concept, based on a specific chemical analysis. This chemical analysis is combined with a dedicated heat treatment conducted by oil quenching.

The successful use of Astralloy 8000 for wear parts in various industries is a result of:

* a superficial hardening following a very efficient work hardening capability in service, governed by a metallurgic phenomenon called TRIP effect (Transformation Induced by Plasticity).
* a very fine and homogeneous dispersion of hard particles in steel (mainly chromium, molybdenum and titanium microcarbides) giving the material its extremely high abrasion resistance.

In addition to its high wear resistance, Astralloy 8000 is able to process (forming, machining) much better than the existing 500 HB resistant steels.

Astralloy 8000 is known as the best compromise for severe applications where exceptional abrasion, impact, heat and moderate corrosion are requested in service.

Astralloy 8000 is currently used in industries such as: mining, quarries, cement and concrete, iron making, steel processing, recycling, earthmoving (public works), and dredging.

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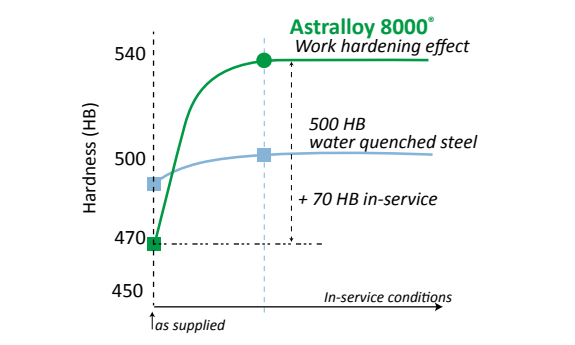
METALLURGICAL CONCEPT

Wear resistance depends not only on the hardness of the steel in the delivered state, but also on the other properties, such as crack resistance, work hardening, strength, ductility, softening resistance, etc. The in-service performance of any given wear resistant steel is strongly influenced by the microstructure obtained after thermal processing. In the case of Astralloy 8000, a significant improvement of the in-service wear resistance is mainly due to the following properties:

"TRIP effect": Transformation Induced by Plasticity.

Due to its initial structure which is not fully martensite (a mix of martensite, bainite and retained austenite), Astralloy 8000 has the ability to work-harden when submitted to local plastic deformation while in service. Plastic deformation induces a surface hardening phenomenon by transformating retained austenite into fresh and very hard martensite while the material remains ductile underneath. This makes it extremely effective in withstanding both abrasion and heavy impact while in service.



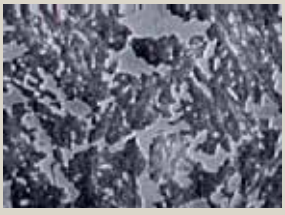
In addition, the advanced ductility of the retained austenite contributes to the improved in-service lifetime by allowing larger micro shearing which delays the ultimate tearing of metal particles from the surface of the material exposed to the abrasive.

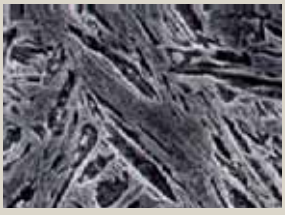
On this typical microstructure of Astralloy grades, the retained austenite grains are revealed by means of Klemm. Reactive etching appear in white.

When subjected to plastic deformation in service (impact or high pressure), Astralloy 8000 takes advantage of a surface hardening of about 70 HB, whatever the applied strain level.

Fine dispersion of micro carbides

The fine microstructure of Astralloy 8000 is a result of a specific chemical composition combined with a controlled cooling rate performed by oil quenching.





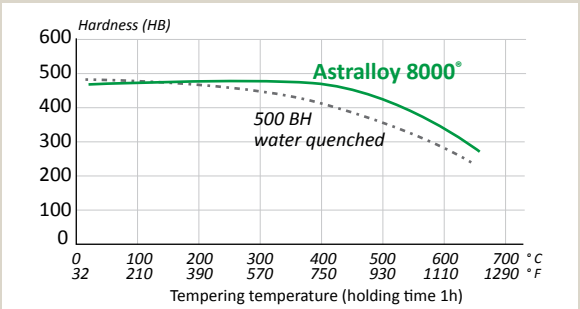
This microstructure differs from the rough acicular lamellar structure which is typical of the fully martensite steels (conventional 500 HB water quenched steels).

Moreover, the fine and homogeneous dispersion of micro carbides significantly contributes to the improvement of the reinforcement of the matrix by increasing the in-service sliding wear resistance.

500 HB Water Quenched	Astralloy 8000®
* Conventional route * Passive material	* Alternate route * Active steel
* Restricted alloy elements (mainly C, Mn, B) * Drastic water quenching * Fully martensitic structure	* Specific chemical composition * Controlled cooling (oil quenching) * Mix macro-structure: martensite + bainite + retained austenite * Perfect balance: high wear resistance + improvement workability * Wear resistance in service is a combination of: → work-hardening effect (TRIP phenomenon) → Presence of micro-carbides (chromium, molybdenum, titanium) → Delayed tearing of metal particles (super-ductility of the retained austenite).
In-service wear resistance is a result of the hardness in the delivered state. It is an answer to common applications.	Astralloy 8000 is the solution for certain applications.

PROPERTIES AT HIGH TEMPERATURE

The chemical composition of Astralloy 8000, and specifically chromium, molybdenum and titanium contents, confer a high softening resistance to the material. This allows for the use of Astralloy 8000 in hot service conditions, at a maximum of 450°C (840°F), while conventional 500 HB water quenched steels are limited to 250°C (480°F).



Softening resistance according to tempering temperatures

It is also possible to process the steel at high temperatures 500° – 550°C (930° – 1020° F) (hot forming: bending, rolling) followed by a slow air cooling without inducing any significant drop of hardness (about 30 – 50 HB).

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SERVICE LIFE

Independent of the service conditions, the original metallurgical concept of Astralloy 8000 confers to the material an improvement of its performance in terms of wear resistance and workability, compared to other conventional 500 HB water quenched steels. This is especially useful in extreme applications when severe abrasion conditions are combined with huge impact, heat or moderate corrosion.

FIELD TESTS

Multiple tests were performed in various industries which confirm the higher performance of Astralloy 8000 compared to 500 HB water quenched steels.

Service Life Versus 500 HB Steels

Areas of industries	Applications	Thickness Piece	Service Life
Mines *(gold ore)*	Wear parts - External liner of bucket excavator	30 mm (1.2")	+ 100%
Foundry *(handling hot agglomerate)*	Extracting plates	12 mm (.47")	+ 36%
Iron making *(iron ore + coal)*	Wear parts - Internal chute liner	15 mm (0.6")	+ 35%
Fertilizer industry	Crushing hammers	15 mm (0.6")	+ 58%
Wood industry	Pneumatic chip handling (pipe elbows)	12 mm (.47")	+ 38%
Glass recycling *(calcin)*	Belt conveyor (guide plate)	15 mm (0.6")	+ 69%
Quarry (granite)	Wear parts (internal side of a jaw crusher)	40 mm (1.6")	+ 50%

CUTTING

All classical thermal processes (gas-plasma-laser) can be used, however plasma/laser processes are recommended. These provide a better precision and cutting aspect and induce a thinner Heat Affected Zone (HAZ).

The following conditions are enough to avoid cold cracking:

Plate Temperature	Thickness ≤ 40 mm (1.57")	Thickness > 60 mm (2.4")
≥ 10° C (50°F)	No Preheating	Preheating 150 °C (302° F)
< 10° C (50°F)	All thicknesses: Preheating 150° C (302°F)	

Water jet cutting can be used. Shearing of thin plates is not recommended.

MACHINING

Drilling must be done with high speed steels HSSCO type (ex. AR 2.9.1.8. according AFNOR, M42 according to AISI) taper shank.

In medium to large production, carbide tip drills (K10 or K20 according to ISO) eventually coated (TiN) shall significantly improve drilling performances.

Quality	Ø mm (in)	Drilling Speed (m/min)	Revolution Speed (rev/min)	Feed (mm/rev)
HSSCO AR.2.9.1.8 (M42)	10 (0.39")	4 – 6	125 – 190	0.07
	20 (0.79")		65 – 95	0.10
	30 (1.18")		40 – 65	0.12
Carbide K20	10 (0.39")	18 – 22	575 – 700	0.07
	20 (0.79")		285 – 350	0.10
	20 (0.79")		190 – 235	0.12

Milling shall also be done with HSSCO tools (AR.6.5.2.5. according to AFNOR, M35 according to AISI or AR.12.0.5.5/T15). A better efficiency will be obtained with carbide tips P10/P30 (rough machining) or K10/K20 (finishing).

Quality	Depth mm (in)	Cutting Speed (rev/min)	Feed (mm/rev)
HSSCO AR 12.0.5.5 (T15)	1 (0.4")	10 – 12	0.08
	4 (0.16")	8 – 10	0.12
	8 (0.31")	5 – 8	0.12

FORMING

Cold forming can be done under the following conditions:

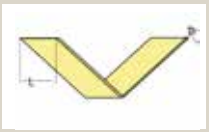
* edge preparation by grinding to remove flame cutting heterogeneities
* minimum internal bending radius (table below)
* plate temperature at 10°C (50°F) minimum.

Perpendicular to rolling direction	$r_i \geq 5th$
Parallel to rolling direction	$r_i \geq 4th$
Die opening V (mini)	$r_i \geq 14th$

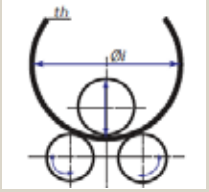
th = thickness

According to the parameters above, bending strength depends on bending length, thickness, and die opening.

The table found below provides the indication of the power needed to bend for a die opening of 14 times the thickness.



Thickness (mm)	Bending strength per m (ton/m)
10 (0.39")	200
20 (0.78")	430



Rolling shall be performed under the following conditions: $Ø_i \geq 40th$ (temperature of the piece ≥ 10°C - 50°F)

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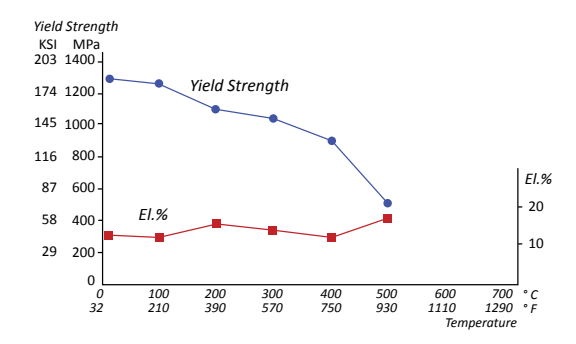
Astralloy 8000 can be hot formed at temperatures of 500°– 550°C (930-1020°F) without any further heat treatment. At this temperature, forming requires lower power (according to the reduction of the yield strength YS 0.2) than the expected value at room temperature.



WELDING

Astralloy 8000 can be welded using all standard processes: manual, semi-automatic under gas protection, and automatic under flux.

For welds which are not subjected to wear, the following welding products can be used:

Processes	AFNOR	DIN	AWS
Manual coated electrode	A81-309 e5 14/3 B	DIN 1913 Class E5 14/3 B10	AWS 5-1 Class E7016 or E7018
Semi-automatic under gas	A81311 GS2	DIN 8559 SG2	AWS A5-18 Class ER 70S4 or ER 70S6
	A81350 TGS 51BH TSG 47BH	DIN 8559 SGB1 CY 4255	AWS-5-20 Class ER 71T5

For welds subjected to wear, please call us for a recommendation on the best choice of welding consumables. Surfaces to be welded must be clean and free of rust, heat scale, dirt, grease and water. Electrodes and flux shall be stoved according to supplier's recommendations.

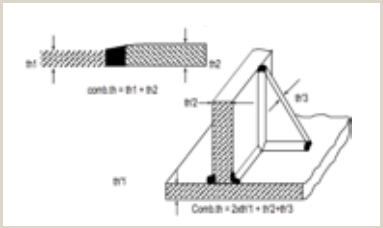
The following preheating conditions shall be respected (for welded structure without excessive stresses).

		0.39»	0.78»	1.18"	1.57"	1.96"	2.36"	2.75"	3.14"	3.54"
Semi-automatic under gas	5.9 kJ/in									
	11.8 kJ/in									
Manual welding stick electrode	3.9 kJ/in									
	7.9 kJ/in									
Automatic under solid flux	7.9 kJ/in									
	11.8 kJ/in									

Without preheating

Pre-postheating at 100°C (212°F)

Pre-postheating at 150° C (302° F)



SIZES AND TOLERANCES

Product	Thickness	Tolerance
Coils	4 –15 mm (.16" – .6")	5mm/m (.20")
Plates	5 –60 mm (.20" – 2.36")	

Other sizes - please consult

APPLICATIONS

Astralloy 8000 may be used in a wide range of applications:

* Bucket liners for excavators, shovels, loaders, dozers
* Cutting edges or stiffeners for various bucket types
* Truck tray body liners
* Wear parts for primary and secondary crushers
* Vibratory feeder liners
* Chute liners
* Hopper liners
* Screens
* Trommels
* Pipe elbows
* Cyclones
* Deflectors
* Grinder liners (SAG Mill)
* Demolition tools (recycling)
* Pipes for dredging
* Blade liners for heavy duty fans

Note: The data contained in this document is accurate at time of printing, and intended for use as a general guide.
* Typical maximum values. Mill certifications are available upon request.

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