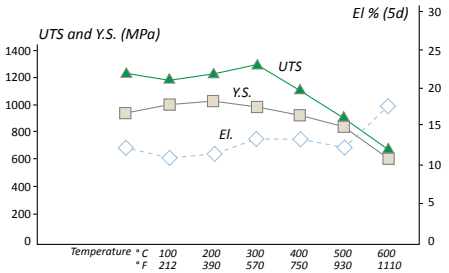
Astralloy
a NUCOR company

Astralloy 4800®

Advanced Technology in Wear

Chemical Composition* – % Weight							
C	Mn	P	S	Ni	Cr	Mo	Other
≤ .20	≤ 1.60	≤.018	≤ .005	≈ .20	≤ 1.90	≤ .40	≤ .20

Physical Properties – Typical Values at 68° F				
BHN Hardness	Tensile Strength	Yield Strength	Elongation in 2”	Charpy Test Toughness Index
370	174 ksi	130 ksi	12 %	27 ft. lbs. @ RT



Astralloy 4800® is a wear resistant steel offering up to 50% additional in service life compared with a 400 HB water quenched steel. The steel combines several modern metallurgical concepts which, depending on thickness, use different combinations of an enriched chemical analysis (Cr, Mo, Ti) and controlled quenching rate. Astralloy 4800 is designed to provide the optimum combination of wear resistance, controlled hardness and ease of processing.

Rather than just using a high hardness level, it achieves this state by using proven and controlled metallurgical mechanisms, which are more complex but more efficient than the simple effect of hardness alone:

* Work-hardening and Cr Mo micro-carbides
* TRIP(*) effect originally developed with Astralloy 8000
* Reinforcement of the structure with titanium carbides

The limited hardness of Astralloy 4800 makes processing operations like cutting, machining and forming no more difficult than processing 400HB water quenched steel.

Astralloy 4800 is ideal for applications in mines and quarries, cement and the steelmaking industries, publics works and agricultural machinery. It is suitable for all types of abrasion, sliding or impact, dry or wet media, including high temperature abrasion up to 350°C (660°F).

(1) Transformation induced by plasticity

Physical Properties Expansion Coefficient — Average (x 10-6.°C-1)	
20° – 100°C (68°–212°F)	12.4
20° – 200°C (68°–392°F)	13.1
20° – 300°C (68°–572°F)	13.9
20° – 400°C (68°–752°F)	14.4
20° – 500°C (68°–932°F)	14.7
20° – 600°C (68°–1112°F)	15.0

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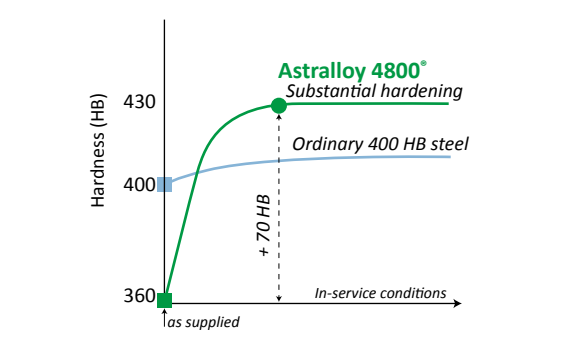
ABRASION RESISTANCE

Abrasion resistance is not exclusively associated with the hardness of the steel in the supplied condition. Its composition and structure strongly influence the actual in-service performance. The chemical composition and the manufacturing process of Astralloy 4800 develops a metallurgical structure which greatly contributes to the improvement in its wear resistance through effects from the following:

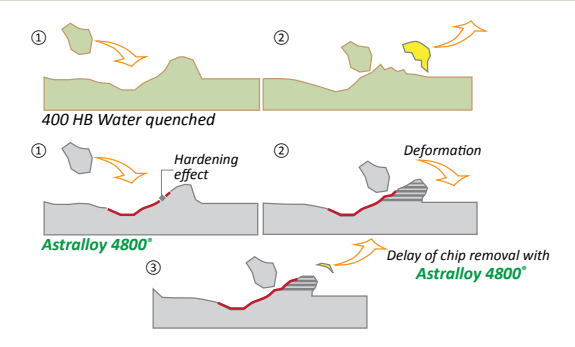
Work hardening in service

When entering into service, Astralloy 4800 takes advantage of a surface hardening of about 70 HB depending on the applied strain (impact, pressure):



Delay of chip removal

Astralloy 4800 has the advantage of a higher capacity for plastic deformation caused by impact. This extra-ductility induces a delay in the chip removal, ensuring a slower wear rate (weight loss) than on 400HB water quenched steels.



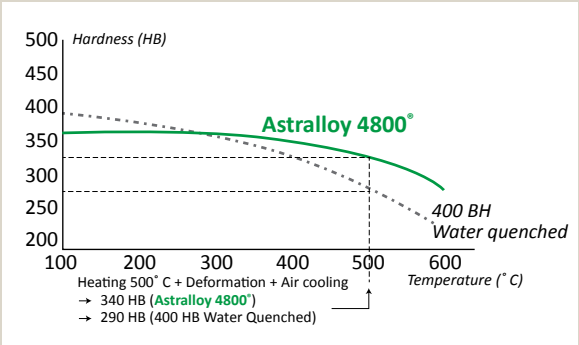
Titanium carbides

In addition to the fine and homogeneous distribution of chromium and molybdenum carbides (1500 HV and 1800 HV respectively), Astralloy 4800 is a new generation steel in the field of wear resistance steels with a significant addition of titanium resulting in the formation of a structure with very hard and fine particles of titanium carbide (TiC), reaching a hardness level of 3200 Hv. These carbides provide increased wear resistance to the steel.

	400 HB Water Quenched	Astralloy 4800®
	* Conventional route * Passive material * PASSIVE STEEL	* Innovative route * Active material * REACTIVE STEEL
Wear Resistance	* Just connected to supplied hardness	Combining: * In service hardening * TRIP effect * Micro-carbides + Titanium effect
Process	* Low alloyed steel (C. Mn. B) * Water quenching	* Specific addition of alloying elements (Cr, Mo B, Ti...) * Controlled cooling rate
Structure	* 100 % martensitic structure	* Structure + bainite/martensite + retained austenite + micro-carbides * Transformation of retained austenite into fresh martensite under abrasive effect * Fine micro-carbides homogeneously dispersed + very hard Titanium carbides

PROPERTIES AT HIGH TEMPERATURE

Astralloy 4800's chemical composition, consisting of chromium and molybdenium, provide a high resistance to softening in hot conditions, which is superior to that of 400 HB water quenched steel.



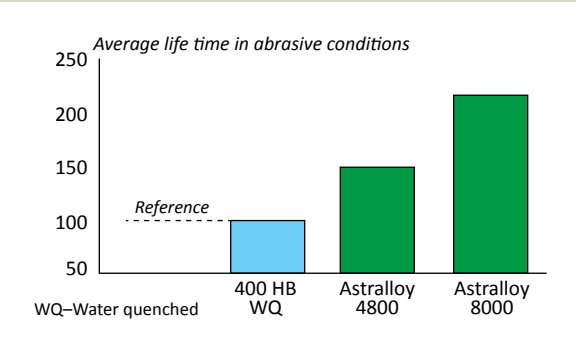
These properties enable the steel to be processed in the hot condition (450/500°C- 840/930°F): One example is the forming of thick plates followed by a slow cooling without inducing any significant drop in hardness.

The heat resistance of Astralloy 4800 is ideal for use in hot environments where pieces are heated up to 350°C (660°F).

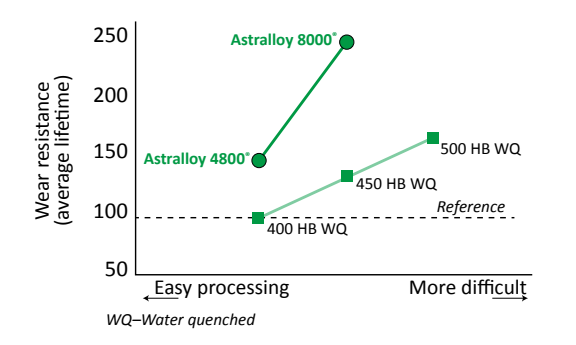
Astralloy 4800®

SERVICE LIFE

Astralloy 4800's metallurgical content improves its wear resistance when compared to other anti-abrasion grades available in the market, and in all service conditions.



Astralloy 4800 benefits from the optimum compromise between wear resistance and ease of processing.



CUTTING

All classical thermal processes (oxy-fuel, plasma, laser) can be used. Plasma/laser processes are specially recommended, they provide a better precision and cutting aspect and produce a narrower Heat Affected Zone (HAZ).

The following conditions are sufficient to avoid any cold cracking, independent of the process used:

Plate Temperature	Thickness ≤ 60 mm (2.4")	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 may also be used.

MACHINING

Drilling can be done with high speed tools, HSSCO type (ex. AR 2.9.1.8 according to AFNOR, M42 according to AISI). Lubrication with soluble oil diluted to 20% is recommended.

Tool	Ø mm	Cutting Speed (m/min)	Revolution Speed (rev/min)	Feed (mm/rev)
HSSCO AR.2.9.1.8 (M42)	5	15 - 20	950 -1250	.07
	10	13 - 17	415 - 540	.09
	15	12 - 15	255 - 320	.10
	20	11 - 14	175 - 220	.12
	25	9 - 12	115 - 150	.15
	30	8 - 10	85 - 105	.20

Milling can be done with a cutting tool equipped with a F40M insert. Lubrication with soluble oil is recommended.

Tool	Cutting Speed (m/min)	Revolution Speed (rev/min)	Feed (mm/rev)
F40M Ø 12mm	1 - 5	70 - 200	.12 - .35

COLD FORMING

Cold forming Astralloy 4800 can be done under the following conditions:

* No marks or scratches in shaped zones, edges and external face
* Beveling by grinding sharp edges, especially on rough edges from cutting
* Minimum internal bending radius (table below)
* Plate temperature above 50°F (10°C)

BENDING

Perpendicular to rolling direction	$r_i \geq 3th$
Parallel to rolling direction	$r_i \geq 4th$
Die opening V (mini)	$r_i \geq 12th$

th = thickness

* The strength necessary to bend depends on UTS and plate thickness as well as bended length and die opening V.

Indicative values, for die opening V = 12th (V bending)	
Plate Thickness (mm)	Bending Strength L = 1m (ton/m)
5	70
10	130
20	250

* Spring back: Allows for a tight bending angle to compensate spring back effect. Example: For r_i / th = 5, anticipate an angular correction of about 10°.
* ***Safety: Due to the high elastic energy of the steel, it is recommended not to stand in front of the machine, but at the side.***

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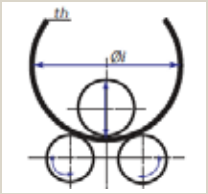
Rolling has to be done using the following conditions:
$Ø_i \geq 30$ th (plate temperature > 10°C (50°F):
The force necessary to roll a plate will be about double that of a S355 type steel.



Astralloy 4800 can be hot formed at a temperature of 450°– 500°C (840°– 930°F) without any further heat treatment. At this temperature, the force necessary to deform the plate will be lower than at room temperature, and the deformation capability of the steel will be higher (smaller forming radius).

It is possible to deform an Astralloy 4800 plate thicknesses ≤ 20mm (.78”) within a temperature range of 870°– 1000°C (1600°– 1830°F) followed by air cooling without impacting the steel properties.

This process is beneficial in reducing bending/rolling forces and increasing the deformation capability of the steel.

WELDING

Astralloy 4800 can be welded with all traditional welding processes: manual, semi-automatic under gas, automatic under fluxes. For welds that are unexposed to wear, the following welding rods can be used:

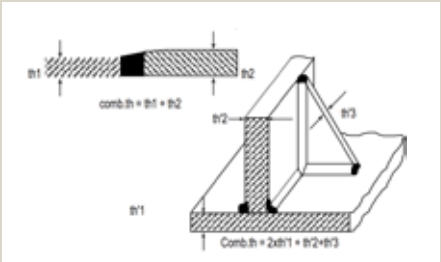
Processes	AWS	Class
Manual Stick Electrode	AWS 5-1	E7016 or E7018
Semi-automatic under Gas	AWS A-5-18	ER70S4 or ER 70S6
	AWS-5-20	ER 71T5

For welds exposed to wear, please ask for recommendation on the choice of welding products, processes and parameters. The welded area must be free of grease, water, and oxide. Electrodes and flux shall be stoved according to supplier’s recommendations.

The following preheating conditions shall be met (weld without excessive stresses).

		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 75°C (167°F)
Pre-postheating at 125° C (257° F)



SIZES - TOLERANCES

Thickness	Standard Sizes (mm)	Flatness
3 –150 mm (.12” – 5.9”)	1500 x 3000 (59” x 118”)	5mm/m (.2”)
	2000 x 6000 (79” x 236”)	
	2500 x 8000 (98” x 315”)	

APPLICATIONS

* Quarries - Public works
  Blades, Bucket liners, crushers, lateral stiffeners, screens, dumper bodies and trommels.
* Mining
  Extraction equipment, conveyor bottom plates, hoppers, helical gravity and screw conveyors, skips, ventilators, discharge plates.
* Cement
  Wheel excavators, buckets, crushers, lateral shields, clinker chutes, buckets, ventilators, dust separators, bagging machines.
* Steelmaking
  Guiding plates, hoppers, chutes, discharge plates, scrap containers/ charging boxes.

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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