



## Plate

### MTD<sup>®</sup> and Tool Steels: for Mold, Tool and Die Applications

#### Introduction

##### *ArcelorMittal USA MTD<sup>®</sup> Steels*

ArcelorMittal USA MTD steels comprise a family of four pre-hardened alloy plate steels developed for a variety of mold, tool and die applications. These steels have been available for over 20 years and possess the flexibility of the AISI 41XX steels. They are available in the 262-321 Brinell range\* (unless otherwise noted) for optimum balance between machinability and hardness. The use of pre-hardened MTD<sup>®</sup> steels eliminates the need for and risk associated with heat treating molds, holder blocks and other parts after machining. MTD plates are routinely saw cut.



*ArcelorMittal USA MTD plates are routinely saw cut into bar stock and mold base plates.*

##### *ArcelorMittal USA Tool Steels*

ArcelorMittal USA produces the tool steels A2, A8 Mod., D2, O1, S5, S7, and 52100\*\* for use in applications where an air-hardening, oil-hardening or shock-resisting tool steel is required. These steels are available from ArcelorMittal USA in full-sized, annealed plates suitable for saw cutting and/or finishing. Parts can subsequently be machined and heat treated to a range of hardness requirements. For improved internal cleanliness, all ArcelorMittal USA tool steels are produced with maximum sulfur levels of 0.010%, using Finline<sup>®</sup> processing. These steels are also available as ArcelorMittal USA Finishline<sup>™</sup>, a prefinished plate product with decarb-free top and bottom surfaces ground to a maximum 125 RMS.

\* Brinell hardness (HB) readings are taken from standard test locations on the plate surface after the decarburization layer is removed. This range of HB converts to 27-34 Rockwell "C". ArcelorMittal USA uses HB measurement as its official test.  
\*\* Check with ArcelorMittal USA plate offices for the availability of other grades.



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## Production

All of ArcelorMittal USA MTD and tool steels are produced\* in the former Lukens Steel facilities in Coatesville and Conshohocken, PA. The modern electric melt shop includes a 165-ton electric arc furnace, a ladle furnace for steel refining and a tank degasser for vacuum treatment. These facilities allow the production of quality alloy steels with consistent chemistry heat-to-heat and plate-to-plate.

When specified, very clean steels with sulfur levels as low as 0.001% maximum can be produced using ArcelorMittal USA Fineline processing. For improved machinability, higher levels of sulfur can be maintained through ArcelorMittal USA Clean-Cut® processing.

Depending on grade and final plate thickness, ArcelorMittal USA steels are cast into slabs via continuous casting, which includes electromagnetic stirring and argon shrouding or bottom-poured into ingots.

The slabs or ingots are rolled to plate on one of two rolling mills (Coatesville and Conshohocken, PA), depending on finished plate size. Both mills have hydraulic gauge control to produce plates with uniform thickness end-to-end and side-to-side with “mill-edge” quality available.

MTD plates are pre-hardened and tempered in one of three continuous heat-treating facilities or in carbottom heat treating furnaces, all with the latest process control features.

Two additional heat treating facilities, also with full process control, are available for annealing the tool steels. Heat treatment cycles have been designed to produce MTD and tool steels with consistent machinability and minimal internal stresses.

*Note: For those who prefer to have material heat treated locally after cutting or machining, all MTD® chemistries can be purchased in stress-relieved or annealed condition. However, due to variations in processing, the hardness values certified by ArcelorMittal USA will not necessarily apply when heat treatment is performed outside of ArcelorMittal USA control.*

*\* Some tool steels may be melted at outside facilities.*



*MTD 1 and MTD 2 are available with Clean-Cut processing for improved machinability.*



*MTD steels comprise most of the components of this mold base.*



*This mold is made possible by Fineline® process, an advanced technique for sulfur removal.*

## Chemistries – MTD Steels

SPECIFICATION	MTD 1	MTD 2	MTD 3	MTD 4
<b>Thickness (inches)</b>	½ to 6½	½ to 12	¾ to 12	½ to 6½
<b>Chemical Composition (%)</b>				
<b>Carbon (Max.)</b>	.38/.46	.27/.33	.24/.35	.48/.53
<b>Manganese</b>	.70/1.00	.90/1.30	.75/1.00	.75/1.10
<b>Phosphorus (Max.)</b>	.035	.035	.025	.035
<b>Sulfur (Max.)</b>	.040	.040	.005	.040
<b>Chromium</b>	.80/1.15	.60/.90	.90/1.20	.80/1.10
<b>Molybdenum</b>	.15/.25	.15/.25	.45/.65	.15/.25
<b>Silicon</b>	.15/.40	.15/.40	.15/.40	.15/.40
<b>Vanadium (Min.)</b>	.03	.02	.04	
<b>Heat Treatment Required</b>	N&T	Q&T	Q&T	N&T
<b>Surface Brinell Hardness (HB)*</b>	262/321 to 3" Incl.; 241/321 Over 3-6½" Incl.	262/321	262/321	262/321 to 3" Incl.; 241/321 Over 3-6½" Incl.
<b>Melting Practice</b>	FGP**	FGP**	FGP, F/L	FGP**

\* Brinell hardness (HB) readings, taken from the standard test locations on the plate surface after the decarburization layer is removed. These ranges of HB convert to 27-34 and 23-34 Rockwell "C". ArcelorMittal USA uses HB measurement as its official test.

\*\* May also be specified as Clean-Cut where improved machinability is desired.

FGP	=	Fine Grain Practice
F/L	=	Fineline Double-O-Five or Better Available
N&T	=	Normalized and Tempered
Q&T	=	Water Quenched and Tempered

### Applications of MTD Steels

**MTD 1** is a 4140 plate steel modified with slightly higher carbon and a vanadium addition. Vanadium improves grain refinement and, coupled with the higher carbon, promotes hardness and wear resistance. Another advantage of this steel is its excellent response to flame hardening. It is widely used in a number of applications including holder blocks. MTD 1 steel is normalized and tempered to 262-321 HB in thicknesses to 3 inches and 241-321 HB over 3 inches to 6½ inches.

**MTD 2** is a mold base quality, Mn-Cr-Mo plate steel. It is commonly used in holder blocks, clamping plates and support plates. The typical .29% carbon content of this steel permits water quenching and tempering to 262-321 HB up to 12 inches thick.

**MTD 3** is Mn-Cr-Mo-V plate steel used in cavity molds. Its excellent internal quality is made possible by ArcelorMittal USA Fineline process, an advanced technique for sulfur removal. Reducing the sulfur level to a maximum of .005% through Fineline Double-O-Five processing results in fewer inclusions. Those that remain resist elongation during rolling and tend to remain spherical. This "shape control" contributes to improved mechanical properties and good polishing characteristics. High levels of internal quality can be verified by ultrasonic testing, when specified. Available in thicknesses to 12 inches, MTD 3 is quenched and tempered to a hardness range of 262-321 HB.

**MTD 4** is a 4150 plate steel for applications such as press brake dies, machinery parts and short-run tools and dies where abrasion is a concern. This steel is normalized and tempered to a hardness of 262-321 HB in thicknesses to 3 inches. In thicknesses over 3 inches to 6½ inches, it is offered at 241-321 HB.

## Chemistries – Tool Steel \*\*\*

SPECIFICATION	A2	A8 Mod.	D2 ****	O1	S5	S7	52100
<b>Thickness (Max. In.)*</b>	6½	2¼	6½	6½	2¼	6½	6 ½
<b>Chemical Composition (%)**</b>							
<b>Carbon (Max.)</b>	.95/1.05	.48/.55	1.40/1.60	.85/1.00	.50/.65	.45/.55	.98/1.10
<b>Manganese</b>	.40/1.00	.20/.50	.25/.60	1.00/1.40	.60/1.00	.20/.90	.25/.45
<b>Phosphorus (Max.)</b>	.030	.030	.030	.030	.030	.030	.030
<b>Sulfur (Max.)</b>	.010	.010	.010	.010	.010	.010	.010
<b>Chromium</b>	4.75/5.50	7.50/8.40	11.00/13.00	.40/.60	.10/.50	3.00/3.50	1.30/1.60
<b>Molybdenum</b>	.90/1.40	1.30/1.60	.70/.25	-	.20/1.35	1.30/1.80	-
<b>Silicon</b>	.10/.50	.75/1.05	.10/.60	.10/.50	1.75/2.25	.20/1.00	.15/.30
<b>Vanadium (Min.)</b>	.15/.50	.30/.55	.50/1.10	.30 Max.	.15/.35	.35 Max.	-
<b>Tungsten</b>	-	-	-	.40/.60	-	-	-
<b>Surface Hardness – HB Max. in Annealed Condition</b>	235	241	235	212	235	223	235

\* Refer for size availability

\*\* Nickel plus Copper: .75% max., unless otherwise specified.

\*\*\* Check with ArcelorMittal USA for the availability of other grades

\*\*\*\* Inquiry basis

### Applications of Tool Steels

**A2** is an air hardenable 1.0% carbon, 5% Cr–Mo–V tool steel with high wear resistance, even at high working temperatures and deep hardening capability. It is popular in a variety of tooling and plastic molding applications including wear inserts, blanking dies and forming tools.

**A8 Mod.** is an air hardenable 0.50% carbon, 8% Cr–Mo–V tool steel with excellent toughness, deep hardening and high resistance to tempering. It is principally used in chipper knives for saw mill, waste wood and paper and pulp mill chippers.

**D2** is an air hardenable 1.5% carbon, 12% Cr–Mo–V tool steel with excellent wear resistance, even at higher working temperatures, and extremely deep hardening capability. It is most often used in long run and/or thicker components in forming, blanking and drawing dies and plastic injection and compression molds.

**O1** is an oil hardenable 0.90% carbon, Mn–Cr–W tool steel with a high resistance to wear at normal working temperatures and moderate hardening capability. It is used in a variety of plastic injection molding applications and in tools and dies of small to moderate sections.

**S5** is an oil hardenable 0.55% carbon, 2% Si–Mn–Mo tool steel designed for high toughness and tempering resistance. It has moderate wear resistance and hardening capability with good edge retention for use in hand tools, shear blades and punches.

**S7** is an air hardenable 0.5% carbon, 3% Cr–Mo–V tool steel designed for toughness and shock resistance. It has moderate wear resistance and deep hardening capability and is used in punches and dies subject to high impact shear blades and plastic injection and compression molds.

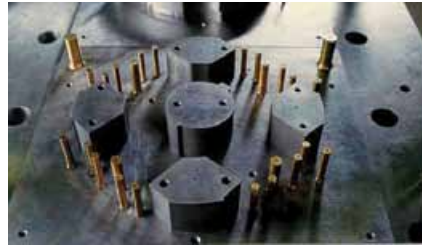
**52100** is an oil hardenable 1.0% carbon, 1.5% chromium tool steel with good wear resistance and moderate hardening capability. It is used in a variety of tool applications, including dies, mandrels and bearings.

## Processing Guidelines

**Machining** – These steels are usually machined by grinding, milling and drilling. To improve machinability, MTD 1, 2 and 4 can be ordered with Clean-Cut processing. For more details on the benefits of this processing, see Item 1 under “Additional Information.”

**Thermal Cutting** – As with any steel having high carbon and alloy levels, MTD steels, if thermally cut, should be preheated and then stress relieved as detailed in the table below. More details on this processing are provided in Item 3 under “Additional Information”. The tool steels are not intended to be thermally cut and are almost exclusively saw or abrasive cut.

**Welding** – MTD and tool steels, as other steels having high carbon and alloy levels, are difficult to weld. However, when proper precautions are taken and low hydrogen practices followed, they may be welded. Contact ArcelorMittal USA Customer Technical Service Department for more detailed recommendations.



MTD and tool steels used for mold, tool and die applications.



Die shoe, holder block and punches.

ArcelorMittal USA Specifications	Thickness (Inches)	
	Preheat 300°F Gascut Hot	Preheat 300°F – Gascut Hot Immediately Heat Treat Edges (a,b)
<b>MTD 1</b>	1 and Under	Over 1
<b>MTD 2</b>	1 and Under	Over 1
<b>MTD 3</b>	-	All Thicknesses
<b>MTD 4</b>	-	All Thicknesses

### Notes:

Recommended practices are based on Tables 10 and 11, Iron and Steel Society Steel Products Manual-Plates, and/or ArcelorMittal USA experience.

- (a) must be heat treated immediately after cutting to soften edges. If unable to heat treat edges immediately, material must be kept hot until heat treated
- (b) Heat to 1050°F+25°F, hold ½ hr./in., air cool

## Further Information

Contact John Kross at ArcelorMittal USA at T +1 610 383 2306 or email [john.kross@arcelormittal.com](mailto:john.kross@arcelormittal.com).

Continuing updates of this information can be found on our website at: [www.arcelormittal.com](http://www.arcelormittal.com).

## Additional Information

- [Free Machining Steels](#)
- [Fineline Steels](#)
- [Guidelines for Fabricating and Processing Plate Steel](#)

All information in this brochure is for the purpose of information only. ArcelorMittal USA reserves the right to change its product range at any time without prior notice.

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