



# ATT 2316 MOD

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V2316MOD

## SIMILAR STANDARDS

ATT 2316 MOD is a modified version of the following grades: DIN X38CrMo16 and X36CrMo17, W.Nr. 1.2316, UNS S42010.

## GENERAL INFORMATION

ATT 2316 MOD is a martensitic stainless steel with high chromium and molybdenum. The main application for this steel is manufacturing of plastic molds that work in corrosive environments.

## MAIN CHARACTERISTICS

ATT 2316 MOD presents the following properties:

- ⇒ Excellent corrosion resistance
- ⇒ Excellent polishability
- ⇒ Good wear resistance
- ⇒ Good machinability

ATT 2316 MOD has special chemical composition and homogeneity, which prevents delta ferrite formation.

## CHEMICAL COMPOSITION

Typical Analysis (Weight Percent)

C	Si	Mn	Cr	Mo	Ni	N
0.25	0.35	0.9	14.0	0.90	0.50	+

## STANDARD PRODUCTION RANGE

Production Route	Production Range	Finishing
Rolled Products	Thickness between 8 to 152 mm with width between 38.10 to 320mm Round 12.70-152.40mm	Centerless ground Peeled Turned
Forged Products	Round 152.40 – 570 mm Thickness up to 300mm with width up to 760mm	Turned Peeled Milled

\*Other dimensions and conditions are available upon inquiry.

## DELIVERY CONDITION

ATT 2316 MOD is usually available pre-hardened to 265-310 HB. Other hardness ranges or annealed condition can also be supplied upon request.

## HEAT TREATMENT

### Soft Annealing

Soft annealing should be carried out by slow heating to 780 and 840°C for 1 hour for each inch of thickness, followed by slow cooling at 30°C per hour until 600°C and, then, by air cooling. In this treatment, the use of protective atmosphere is important to avoid surface oxidation and decarburization.

### Stress Relief

In case of high removal during machining, a stress relief heat treatment shall be applied in order to avoid distortions during quenching and tempering heat treatments. The indicated procedure is slow heating to 650°C or 50°C lower than the tempering temperature in case of hardened tool, holding until complete homogenization, and cooling inside the furnace at least down to 200°C.

### Hardening

Preheat the part to 600-750°C in two steps, until the temperature from center to surface is equal in each step. The austenitizing temperature should be between 1000 and 1040°C holding the temperature until complete homogenization of the part,

Surface decarburization cause decrease in hardness and may cause polishing problems named “overpolishing”. Therefore, the use of protective atmosphere (or vacuum) is important during heating to hardening.

After austenitization, the quenching can be performed in different quench media as:

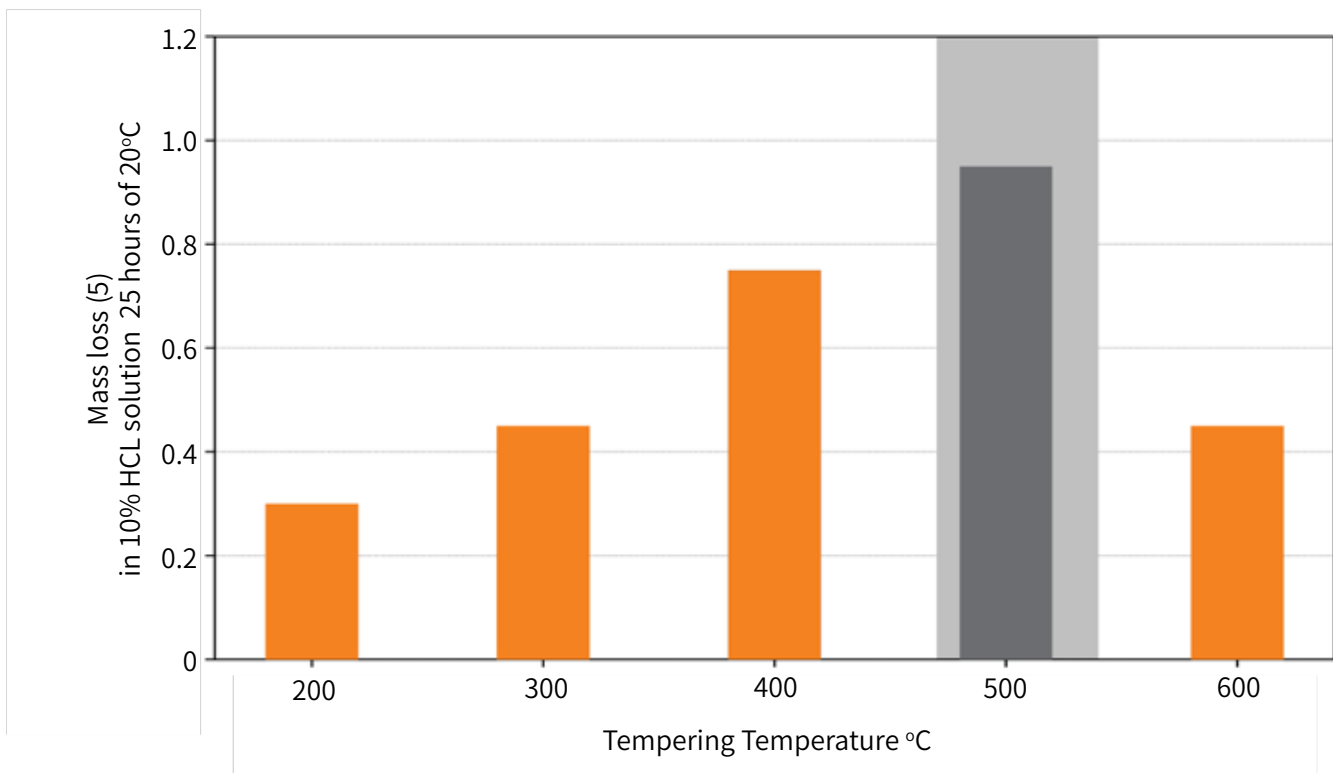
- ⇒ Pressurized vacuum furnace with pressure higher than 5 bar
- ⇒ Warm oil, 40 - 70°C
- ⇒ Salt or fluidized bed between 400 - 450°C

## Tempering

The parts shall be tempered immediately after quenching, i.e. as soon as they reach 60°C. It is necessary, at least, double tempering. After each tempering, parts shall be slowly cooled to room temperature.

Tempering temperatures between 470 – 540°C cause excessive loss on corrosion resistance and toughness (figure below) and must be avoided.

For parts with thickness larger than 70 mm, the time at temperature should be calculated according to their size, being a reference for calculation about one hour for each inch of thickness.

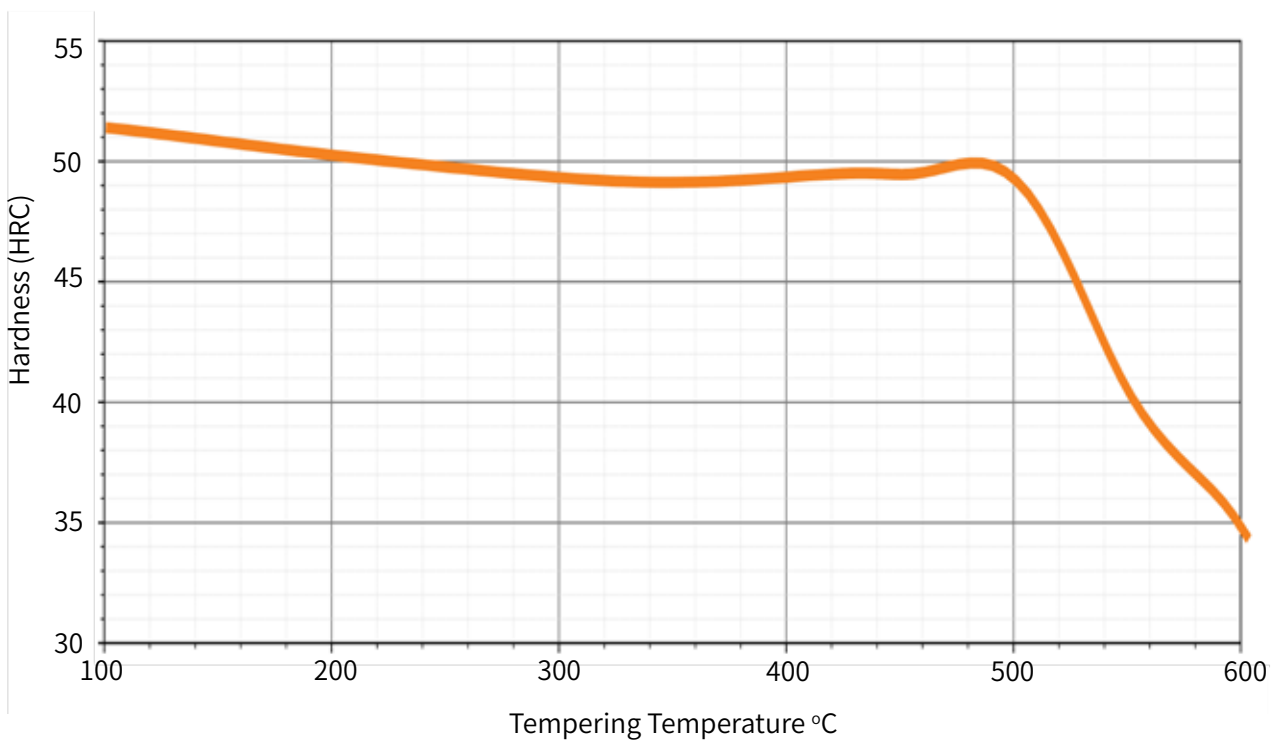


Effect of tempering temperature on corrosion resistance

## Surface Treatment

Nitriding or nitrocarburizing might be applied when higher levels of surface hardness or wear resistance are required. ATT 2316 MOD has a good nitriding response in terms of hardness, but it is important to highlight that nitriding impairs corrosion resistance.

PVD (especially DLC) and CVD coatings are also suitable to be applied if desired. Same precautions in terms of tempering temperature must be observed for all coating processes in order to avoid excessive loss of corrosion resistance.



Tempering curve of ATT 2316 MOD after hardening at 1020°C. Tempering time: 2 hours  
Curve obtained from specimens with 20 mm x 20 mm x 20 mm

## MAIN APPLICATIONS

ATT 2316 MOD is applied in molds that work in corrosion conditions or need to be stainless for other reasons. Typical applications are:

- ⇒ Molds for Injection or extrusion of chlorinated thermoplastic polymers, such as PVC
- ⇒ Molds that work or are storage in corrosion environments or wet conditions
- ⇒ Molds for glass industry
- ⇒ Other applications where high mechanical strength and high corrosion resistance are necessary

## MACHINABILITY

Due to its refined structure ATT 2316 MOD presents good behavior in grinding operations. This contributes to reduce the risk to surface overheating and cracking.

Care needs to be taken in the selection of the tool and the speed in order to allow a good machinability. Electro-erosion process can be employed in heat treated dies or molds. After electro-erosion machining it is recommended to remove the superficial layer thru fine grinding wheel and perform a tempering heat treatment in temperatures not higher than 500°C.

## WELDING

In exceptional cases and always considering that welding would be a temporary solution ATT 2316 MOD might be welded using special procedures to minimize the HAZ.

As a general guideline, it is recommended to: (a) preheat, (b) weld with appropriate filler metal, (c) perform a stress relief heat treatment, (d) machine, (e) quench and temper if in the annealed condition or stress temper if already hardened and (f) grind to final dimensions. The qualification of a specific welding procedure for repair is the key point to obtain the desired quality. The skill and experience of the welder is also a vital factor in obtaining satisfactory results.

## PHYSICAL PROPERTIES

### Density

Temperature	g/cm <sup>3</sup>	lb/in <sup>3</sup>
20°C (68°F)	7.70	0.278

### Thermal Conductivity

Temperature	W/(m·K)	Btu.in/(h.ft <sup>2</sup> .°F)
100°C (212°F)	23.5	163

### Specific Heat

Temperature 20 °C to (68°F to)	J/kg.K	Btu/lb.°F
100°C (212°F)	460	0.110

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Advanced Tooling Tek (Shanghai) Co. Ltd. (ATT), established in 2001, is a trusted supplier of premium mold steel for China's manufacturing sector. With more than two decades of industry experience, ATT has built a strong reputation for reliability, technical expertise and customer-focused service.

Serving a wide range of industries, including automotive, electronics, home appliances and packaging, ATT offers a comprehensive portfolio of premium tool steels, including hot work tool steel, cold work tool steel and primarily plastic mold steel. To meet diverse customer requirements, ATT provide processing services such as sawing, milling, grinding, and heat treatment, ensuring efficient turnaround and consistent quality.

To further enhance its product range and technical strength, ATT collaborates closely with its group mill, Villares Metals. Headquartered in Sumaré, São Paulo, Brazil, Villares Metals has been a leader in specialty steels and alloys since 1944, supplying high-performance solutions to industries such as automotive, railway, energy, medical, oil and gas, aerospace and agriculture across the Americas and globally.

Through this collaboration, ATT offers customers access to world-class materials, international metallurgical expertise and innovative steel technologies. From mold manufacturers to component users and end product producers, ATT supports every stage of the value chain with dependable products, technical guidance and responsive service.

ATT is dedicated to being your preferred partner for high-performance tool steel solutions.

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