



## W 1.2343 – AISI H11

### 2343 - H11: Hot work tool steel for die casting dies

#### Material properties

Standard hot work tool steel grade suitable for die casting dies and forging applications  
 Good softening resistance, good polishing properties after hardening.  
 Good toughness  
 Good dimensional stability during heat treatment

#### For which applications

Die casting dies (Sn, Pb, Zn, Al, Mg)  
 Forging dies (short series)  
 Moulds for plastic injection

### PROPERTIES

#### STANDARDS

|               |             |
|---------------|-------------|
| > JIS         | SKD6        |
| > EURONORM    | X37CrMoV5.1 |
| > WERKSTOFF   | W1.2343     |
| > ASTM A681-9 | AISI H11    |
| > AFNOR       | X38CrMoV5   |

#### CHEMICAL ANALYSIS

|     | C    | S     | Si   | Cr   | Mo   | V    |
|-----|------|-------|------|------|------|------|
| Min | 0.33 | -     | 0.80 | 4.80 | 1.10 | 0.30 |
| Typ | 0.37 | 0.001 | 1.05 | 5.10 | 1.25 | 0.35 |
| Max | 0.41 | -     | 1.20 | 5.50 | 1.50 | 0.50 |

Typical Industeel analysis is in accordance with international standards

#### MECHANICAL PROPERTIES

2343 grade is delivered in annealed condition with a hardness <230HB. It has to be heat treated after rough machining.

Typical mechanical performances of W1.2343/AISI H11 after hardening are :

| Hardness (HRC) | Temperature of hardening | Rm (MPa) | Rp0,2 (Mpa) |
|----------------|--------------------------|----------|-------------|
| 44             | 20°C                     | 1380     | 1600        |
| 48             | 20°C                     | 1140     | 1370        |

## PHYSICAL PROPERTIES

Typical values of 2343 after hardening

| Thermal conductivity<br>W.m-1.K-1 | Thermal expansion Coefficient (10-6.K-1) |          |          |          |          | Specific heat J/kg.°C |
|-----------------------------------|--|----------|----------|----------|----------|-----------------------|
|                                   | 20°C                                     | 20-100°C | 20-200°C | 20-300°C | 20-400°C |                       |
| 25                                | 11.7                                     | 11.8     | 12.4     | 12.8     |          | 460                   |

## METALLURGICAL PROPERTIES

### Internal soundness

All plates & blocks are 100% UT tested and meet following standards:

- > Euronorm EN 10228-3 class 4
- > SEP1921Gr4 Class E/e

### Grain size

Uniform 6/7 grain size according to ASTM E 112 method.

### Cleanliness

Due to the steelmaking process, the content of nonmetallic inclusions is reduced to an extremely low level. Nonmetallic inclusions content is measured in accordance with ASTM E45 A method ("worst field").

| A (sulfide) |       | B (alumina) |       | C (silicate) |       | D ( Globular oxides) |       |
|-------------|-------|-------------|-------|--------------|-------|----------------------|-------|
| Thin        | Heavy | Thin        | Heavy | Thin         | Heavy | Thin                 | Heavy |
| 2           | 1     | 1           | 1     | 1.0          | 0.5   | 1.5                  | 1     |

### Annealed microstructure

Standard 2343 is delivered without any guarantee on the structure.

For applications requiring higher performances, an improved 2343 grade meeting the following requirements is available:

- Structure fine and homogeneous without carbides at the grain boundaries
  - Structure in accordance with NADCA, SEP 1614-1 pictures: A5-B4-C2-D2-E1 or CNOMO max image D.
- Please consult for more information.

2343 grade is delivered in a soft annealed condition for easier machining. When machining is completed, it can be hardened with a heat treatment procedure including preheating, austenitizing, quenching and double tempering. Heat treatment should be done under vacuum or under gas protection to avoid surface oxidation and decarburization. Surface and core temperature ( $T_s/T_c$ ) should be controlled by thermocouples.

**Soft annealing**

- Heating at 850°C (1560°F)
- Cool down at 10°C (20°F) per hour until 650°C (1200°F)
- Air cooling

**Stress relieving**

After rough machining, stress in the tool can be released by heating at 650°C during 2 hours followed by air cooling.

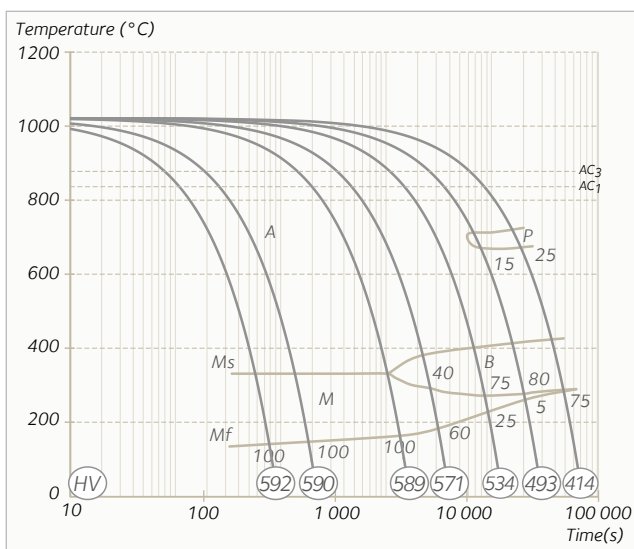
**Preheating (before austenitizing)**

Heating rate should be limited to 220°C /h (400°F/h), measured in the core of cavity. First preheating has to be done at  $T_s \approx 620^\circ\text{C}$  (1150°F) and hold until  $T_s - T_c < 110^\circ\text{C}$  (200°F) Second preheating has to be done at  $T_s \approx 830^\circ\text{C}$  (1530°F) and hold until  $T_s - T_c < 15^\circ\text{C}$  (25°F).

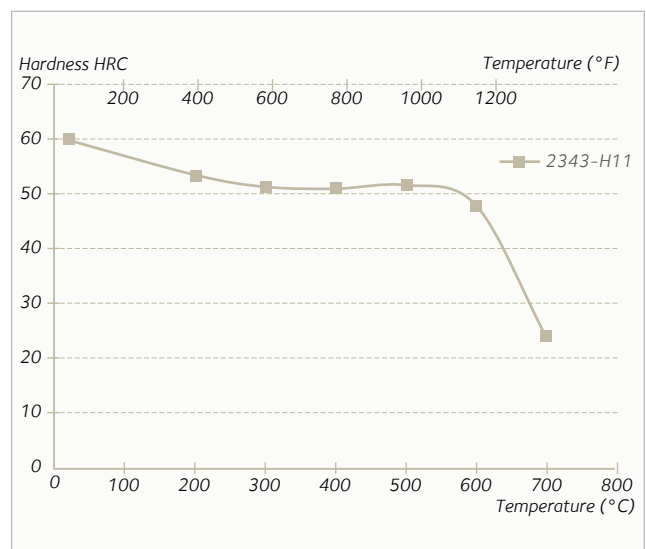
**Austenitizing**

After second preheating, austenitizing should be rapidly increased up to 1010°C (1850°F) and hold 30 mn after  $T_s - T_c < 15^\circ\text{C}$  (25°F). In any case, soaking time shall never exceed 90 mn max after  $T_s$  reaches 1030°C (1885°F).

**CCT Diagram**



**Tempering curve**



### Quenching

Quenching shall be performed in oil or pressurized gas. Pressurized gas should be preferred when quenching complex shapes. Fast cooling has to be applied from austenitizing temperature down to 150°C (300°F)

Cooling rate, measured at the surface of the cavity, must be at least 30°C/min (55°F/min) between austenitizing temperature and 530°C (990°F)

To limit stresses, a special attention shall be paid at the temperature difference between surface and core. Especially in the temperature range 400/450°C

(750/840°F), the temperature difference between surface and core shall not exceed 100°C (180°F).

Below 150°C (300°F), cavity should be air cooled to 50/80°C and should then be immediately loaded in a furnace to perform a first tempering.

Martempering bath is possible at 500-550°C to limit distortions.

### Tempering

A minimum of 2 tempering should be performed on 2343 immediately after quenching at a temperature depending on required temperature (see tempering curve below). The tempering temperature should be hold 2 hours minimum or 30mn per 25 mm of thickness (30mn/inch).

Avoid the brittle range of 430°C-550°C. Temper above 200°C.

After tempering pieces should be air cooled to room temperature.

Avoid sharp angles during machining

### Dimensional changes during hardening

It's is recommended to leave a machining allowance of 0,2% before heat treatment.

### Surface treatments

2343 grade is suitable for nitriding (30µm maximum) and for EDM. After machining by EDM, white layer should be removed by polishing or soft milling.

## DIMENSIONAL PROGRAM

| Thickness    |                                |
|--------------|--------------------------------|
| 11 - 100 mm  | Continuous casting, hot rolled |
| 101 - 200 mm | Ingot casting, hot rolled      |
| 201 - 350 mm | Ingot casting, forged          |

## YOUR CONTACTS

**Perrine Lavalley**

Tel. +33 3 85 80 52 56

[perrine.lavalley@arcelormittal.com](mailto:perrine.lavalley@arcelormittal.com)

<http://industeel.arcelormittal.com>

**Industeel France**

Le Creusot Plant

56 rue Clemenceau

F-71202 Le Creusot Cedex

*Technical data and information are to the best of our knowledge at the time of printing. However, they may be subject to some slight variations due to our ongoing research programme on steels. Therefore, we suggest that information be verified at time of enquiry or order. Furthermore, in service, real conditions are specific for each application. The data presented here are only for the purpose of description, and considered as guarantees when written formal approval has been delivered by our company. Further information may be obtained from the address opposite.*