DILLINGER HÜTTE GTS

# P420M HT

## HIGH STRENGTH FINE GRAINED STRUCTURAL STEEL, THERMO-MECHANICALLY ROLLED, FOR HIGH TEMPERATURE APPLICATION

**Specification DH-E52-C**
**Edition: January 2010**

P420M HT is a high strength thermomechanically rolled fine grained structural steel with a minimum yield strength of 420 MPa (61 ksi) in its delivered condition (referring to the lowest thickness range). P420M HT is preferentially used for constructions within the steel and cement industry and constructions of installations, which require enhanced properties at elevated temperatures and which have to meet high safety standards. Due to its chemical composition and its low carbon equivalent, this steel has an excellent weldability and possesses high mechanical properties at elevated temperatures.

## Product description

### Designation and range of application

P420M HT can be delivered in two grades:

- **Basic quality (L2)** with minimum impact values at -20 °C — **P420M HT L2**
- **Low temperature quality (K4)** with minimum impact values at -40 °C — **P420M HT K4**

This specification applies to heavy plates with thicknesses of 10 to 100 mm.

### Chemical composition

For the ladle analysis the following limiting values (in %) are applicable:

| C | Si | Mn | P | S | N | Al | Nb [1] | V [1] | Mo | CEV [2] | CET [3] | Pcm [4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ≤ 0,10 | ≤ 0,35 | ≤ 1,40 | ≤ 0,020 | ≤ 0,010 | ≤ 0,020 | ≥ 0,020 | ≤ 0,05 | ≤ 0,12 | ≤ 0,50 | ≤ 0,39 | ≤ 0,26 | ≤ 0,19 |

Auxiliary data for the carbon equivalents CEV, CET and the Pcm value:

| | 50 mm | 80 mm |
|---|---|---|
| CEV | 0,36 | 0,37 |
| CET | 0,23 | 0,24 |
| Pcm | 0,16 | 0,17 |

Permissible product analysis tolerances on the limiting values of the ladle analysis:

| C | Si | Mn | P | S | N | Al | Nb | V | Mo | CEV [2] | CET [3] | Pcm [4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| + 0,02 | + 0,06 | + 0,10 | + 0,005 | + 0,003 | + 0,002 | - 0,005 | + 0,01 | + 0,01 | + 0,03 | + 0,02 | + 0,01 | + 0,01 |

### Delivery condition

Thermomechanically rolled (M) [5]

1) Additionally the following restrictions are valid: Nb + V ≤ 0.15%
2) CEV = C + Mn/6 + (Cr + Mo + V)/5 + (Cu + Ni)/15
3) CET = C + (Mn + Mo)/10 +(Cr + Cu)/20 + Ni/40
4) Pcm = C + Si/30 + (Mn + Cu + Cr)/20 + Ni/60 + Mo/15 + V/10 + 5B
5) Thermomechanical rolling leading to the delivery condition M can include processes with an increasing cooling rate with or without tempering including self-tempering but excluding direct quenching and quenching and tempering

## Mechanical and technological properties in the delivery condition

### Tensile test at ambient temperature - transverse test specimen

| Upper yield point $R_{eH}$ [1] [MPa] for plate thickness t [mm] | | | Tensile strength $R_m$ [MPa] for plate thickness t [mm] | Elongation $A_5$ [%] for plate thickness t [mm] |
|---|---|---|---|---|
| 10 ≤ t ≤ 16 | 16 < t ≤ 40 | 40 < t ≤ 100 | t ≤ 100 | t ≤ 100 |
| ≥ 420 | ≥ 400 | ≥ 390 | 500 - 660 | ≥ 19 |

For plate thicknesses greater than 15 mm, the adherence to grades Z15, Z25 or Z35 in accordance with EN 10164 or comparable regulations, which are characterized by a minimum reduction of area on tensile test specimen perpendicular to the plate surface, can be agreed when placing the order.

### Tensile test at elevated temperature - transverse test specimen

| Plate thickness t [mm] | Minimum yield strength $R_{p0.2}$ [MPa] at a test temperature of | | | | |
|---|---|---|---|---|---|
| | 100 °C | 200 °C | 300 °C | 400 °C | 500 °C |
| 10 ≤ t ≤ 16 | 335 | 335 | 295 | 275 | 250 |
| 16 < t ≤ 40 | 320 | 320 | 280 | 260 | 240 |
| 40 < t ≤ 100 | 310 | 310 | 275 | 250 | 235 |

### Creep strain limit

The following values for 1% creep strain are extrapolated values according to the Larson Miller method. The values are based on tests with test duration up to 33,000 hours.

| Temperature [°C] | 1% creep strain limit [MPa] [2] for $10^4$ h | $10^5$ h |
|---|---|---|
| 400 | 380 | 330 |
| 410 | 369 | 312 |
| 420 | 355 | 293 |
| 430 | 339 | 274 |
| 440 | 323 | 253 |
| 450 | 305 | 231 |
| 460 | 287 | 208 |
| 470 | 267 | 184 |
| 480 | 247 | 159 |
| 490 | 226 | 133 |
| 500 | 204 | 106 |
| 510 | 180 | - |
| 520 | 156 | - |
| 530 | 131 | - |
| 540 | 105 | - |
| 550 | 78 | - |

1) If not apparent, the yield strength $R_{p0,2}$ is measured.
2) The indicated values are average values with a scatter band of ± 20% and they are for information only. The strength values for 1% (plastic) creep strain given up to the elevated temperatures listed in the table do not mean that the steels can be used in continuous duty up to these temperatures. The governing factor is the total stressing during operation. Where relevant, the oxidation conditions should also be taken into account.

**Impact test on Charpy-V-specimens**

| P420M HT | Direction of specimens | Minimum impact values $A_v$ [J] at a test temperature of | |
|---|---|---|---|
| | | -40 °C | -20 °C |
| Grundgüte L2 | längs | - | 60 |
| | quer (optional) | - | (40) |
| Kaltzähe Güte K4 | längs | 40 | - |
| | quer (optional) | (27) | - |

The specified values are minimum values; they are the average of 3 specimens, whereby the lowest individual value must not be less than 70% of the specified minimum.

## Testing

Tensile test, impact test in the longitudinal direction (optional in transverse direction), and on request tensile test at elevated temperatures, will be performed according to EN 10028. Unless otherwise agreed, the test results are documented in a certificate 3.1 in accordance with EN 10204.

## Identification of plates

Unless otherwise agreed the marking is carried out with low stress steel stamps with at least the following information:

- Steel grade (e.g. P420M HT L2)
- Heat number
- Number of mother plate and individual plate
- Manufacturer's symbol
- Authorized inspection representative's sign

## Processing

The entire processing and application techniques are of fundamental importance to the reliability of the products made from this steel. The user should ensure that his design, construction and processing methods are aligned with the material, correspond to the state-of-the-art that the fabricator has to comply with and are suitable for the intended use. The customer is responsible for the selection of the material. The recommendations in accordance with EN 1011-2 as well as recommendations regarding job safety in accordance with national rules should be observed.

### Formability

P420M HT has excellent cold forming properties. The only thing to note is that cold forming at temperatures below 150 °C leads to an increase of the hardness and a decrease of the toughness. These changes in mechanical properties can be partially recovered by a subsequent stress relieving. In case of higher cold forming ratios it is advisable to consult the steel manufacturer prior to placing the order or to monitor the effect of cold forming.
Regulations for pressure vessels limit cold forming, if no additional normalising or quenching and tempering is performed. This demand can restrict the use of TMCP-steel for construction parts with a high cold forming rate.
P420M HT has excellent forming properties up to a temperature of 600 °C. Forming at temperatures above 600 °C leads to changes in the original microstructure and cannot be recommended. It is impossible to re-establish the same material properties that had been achieved during the original manufacture through a further heat treatment.

**Weldability**

P420M HT has an excellent weldability if the general technical rules are observed (see SEW 088 or EN 1011). The risk of cold cracking is low which can be concluded from the low values for Pcm and CET. Hardening of the heat affected zone is low. For a wide range of welding parameters excellent properties in the HAZ have been reached.

**Heat treatment**

The stress relieving is carried out between 530 and 600 °C (986 and 1112 °F) followed by cooling in still air. The total holding time should not exceed 150 minutes, even if several operations are carried out. With holding times of more than 90 minutes the lower limit of the temperature range should to be aimed at. Flame straightening should be carried according to special work instruction (see Technical Information of Dillinger Hütte GTS “DI-MC - Structural steels“).

## Tolerances

Unless otherwise agreed, the tolerances will be in accordance with EN 10029, with class B for thickness.

## Surface quality

Unless otherwise agreed, the specifications will be in accordance with EN 10163-2, class B2.

## General note

If special requirements, which are not covered in this specification, are to be met by the steel due to its intended use or processing, these requirements are to be agreed before placing the order.
The information in this specification is a product description. This specification is updated at irregular intervals. The current version is relevant. The latest version is available from the mill or as download at http://www.dillinger.de/

## Distribution

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