DILLINGER HÜTTE GTS

# DIROS 500

HIGH STRENGTH FINE GRAINED STEEL FOR PRESSURE VESSELS, QUENCHED AND TEMPERED

Specification DH-E07-B
Edition August 1998

DIROS 500 is a vacuum treated quenched and tempered fine grained steel. It is predominantly applied for pressure vessels e.g. in offshore and onshore constructions where weight saving is a very important parameter.

Due to its production route and its chemical composition DIROS 500 has excellent mechanical properties combined with good weldability. DIROS 500 is an enhanced version of P500Q of EN 10 028-6 or ASTM/ASME A/SA 533 Type C.

## Product description

### Designation and range of application

DIROS 500 can be delivered in two grades as follows:

- **High tensile strength grade** (HT) with minimum tensile strength of 600 N/mm² and a minimum yield strength of 500 N/mm²
- **Sour service grade** (S) with minimum tensile strength of 580 N/mm² and a minimum yield strength of 460 N/mm² fulfilling additional sour service requirements

This specification applies to plate thicknesses from 10 to 130 mm.

### Chemical composition according to heat analysis (in %)

| grade | C | Si | Mn | P | S | N | Al | Cu | Mo | Ni | Cr | CEV | Pcm |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HT | ≤ 0.13 | ≤ | 1.00 | ≤ | ≤ | ≤ | ≥ | ≤ | ≤ | ≤ 1.20 | ≤ | ≤ 0.64 | ≤ 0.28 |
| S | ≤ 0.11 | 0.40 | - 1.60 | 0.012 | 0.002 | 0.01 | 0.015 | 0.30 | 0.60 | < 1.00 | 0.60 | ≤ 0.60 | ≤ 0.26 |

V+Nb ≤ 0.01 %

CEV = C + Mn/6 + (Cr + Mo + V)/5 + (Cu + Ni)/15
Pcm = C + Si/30 + (Mn + Cu + Cr)/20 + Ni/60 + Mo/15 + V/10 +5B

### Delivery condition

Water quenched and tempered; if the heat treatment is to be performed after forming, delivery in the as rolled condition is possible. In this case the testing of the mechanical and technological properties is provided on the basis of simulated heat treated specimens.

## Mechanical properties in the delivery condition

**Tensile test at ambient temperature for all plate thicknesses** (transverse test specimens)

| grade | yield strength $R_{eH}$, N/mm² minimum | tensile strength $R_m$, N/mm² | elongation $A_5$ %, minimum |
|---|---|---|---|
| DIROS 500 HT | 500 | 600 - 770 | 18 |
| DIROS 500 S | 460 | 580 - 750 | |

For plate thicknesses ≥ 15 mm, the adherence to grades Z15, Z25 or Z35 in accordance with EN 10 164 or comparable regulations, which are characterized by a minimum reduction of area on through-thickness tensile test specimens, can be stipulated on the order.

**Tensile properties at higher temperatures *)** (transverse test specimens)

| | test temperature °C | | | | |
|---|---|---|---|---|---|
| | 100 | 150 | 200 | 250 | 300 |
| minimum yield strength $R_{p0,2}$ | 90 % | 88 % | 86 % | 82 % | 82 % |
| minimum tensile strength $R_m$ | 88 % | 86 % | 85 % | 82 % | 82 % |

***) Percentage of specified minimum value at room temperature**

Unless otherwise agreed, the high temperature tensile test is carried out at 150 °C

**Impact test with Charpy-V specimens** (specimens' location in accordance with EN 10 028-1)

| test temperature in °C | minimum impact value in J (transverse test specimens) |
|---|---|
| - 50 | 50 |

The specified value is the minimum value for the average of three tests. No individual value is to be less than 70 % of the specified minimum.

Toughness requirements at other temperatures can be agreed upon on the inquiry.
Impact test with specimens taken in mid-thickness can be agreed upon on the inquiry.

## Sour service requirements

DIROS 500 S fulfills the following requirements:
- hardness requirements as per NACE standard MR 0175
- other requirements upon agreement on the inquiry

## Testing

Unless otherwise agreed, sampling, testing method and tests are in accordance with the provisions in EN 10 028. The plates are delivered with inspection certificate or inspection report in accordance with EN 10 204. The document type and, if the tests are not to be performed by the manufacturer's expert, the inspection body are to be stated on the order.

## Identification

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

- manufacturer's symbol
- steel designation
- heat number
- number of rolled plate/single plate
- inspector's stamp

# Fabrication properties

The entire fabrication and application techniques are of fundamental importance to the reliability of the products made from these steels. The fabricator should ensure that his calculations, design and fabricating methods are aligned with the material, are state-of-the-art and suitable for the intended use. The customer is responsible for the selection of the material.

## Forming properties

DIROS 500 can be hot or cold formed. Cold forming can be performed at room temperature or at a temperature 50-100 °C below the tempering temperature. For both cases it must be generally taken into account that the plates' original toughness level will be reduced by cold forming. If forming is done at temperatures above the tempering temperature indicated in the plate certificate a further complete heat treatment (quenching and tempering) is necessary. For a further heat treatment of the steels it has to be taken into account that, due to e.g. different heat treatment facilities, it is not always possible to achieve the same properties as at the original heat treatment at Dillinger Hütte GTS. Therefore we recommend to consult Dillinger Hütte GTS if a further quenching and tempering treatment is planned. Please refer to our experience and facilities concerning the fabrication of e.g. heads and shells.

## Welding and flame cutting

DIROS 500 has an excellent weldability if the general technical rules (material sheet SEW 088 or ECSC Information circular No. 2 "Weldable fine grained structural steels: Recommendations for processing in particular for welding" should be followed accordingly) are observed. The risk of cold cracking is low; therefore preheating for flame cutting is in general not necessary, regardless of plate thickness.
Remark: Further information available upon request.

## Heat treatment

- Austenitizing and tempering treatment:
  Austenitizing at 890 - 950 °C, water quenching.
  Tempering after water quenching according to the manufacturer's recommendations.

- Stress relieving treatment at 550 - 620 °C, holding time at least 30 min; for holding times exceeding 3 h or higher temperatures we recommend to consult Dillinger Hütte GTS.

# General technical delivery requirements

Unless otherwise agreed, the general technical delivery requirements in accordance with EN 10 021 apply.

# Tolerances

Unless otherwise agreed, tolerances are in accordance with EN 10 029, with class B for the thickness.

# Surface condition

Unless otherwise agreed, the indications in accordance with EN 10 163 class B2 apply.

# General notes

If special requirements, which are not listed in this specification, have to be met by the steel due to its intended use or processing, these requirements have to be agreed before placing the order.

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