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# DI-TANK 420

## Fine grain steels thermomechanically rolled intended for building of oil and gas storage tanks

Material data sheet, edition July 2024[1]

DI-TANK 420 is the Dillinger designation of fine grain steels thermo-mechanically rolled (M or TMCP) used for the fabrication of storage tanks for hydrocarbons in the oil and gas industry and complies with the relevant construction codes.
DI-TANK 420 HIC is produced in a way to provide an improved resistance to hydrogen induced cracking (HIC). The special sour service properties of the HIC variant are an addition to the properties in accordance with the specified standard. DI-TANK offers improved toughness properties and a very low carbon equivalent compared to the product standards mentioned below.

## Product description

**Designation and range of application**
The DI-TANK 420 offers three options, in accordance with different standards:
DI-TANK 420 / DI-TANK 420 HIC

- is an enhanced variant of P420ML2, complies with EN 10028-5 and simultaneously possible with the two following construction codes: EN 14620 ([2], see General Notes) and EN 13445.
- is an enhanced variant of A/SA841 grade B class 2, complies with ASTM/ASME A/SA841, A/SA841M and simultaneously possible with the construction codes API 650, API 620 ([2], see General Notes) and ASME VIII Division 1 & 2.

Examples for ordering: DI-TANK 420, SA841 grade B class 2
DI-TANK 420 HIC, P420ML2

The HIC resistance of DI-TANK 420 HIC is verified in the HIC test in accordance with NACE TM0284. The tests are performed with test solution A (see “HIC test”). The following acceptance criteria can be ordered:

| Acceptance criteria | CLR[a)] [%] | CTR[a)] [%] | CSR[a)] [%] |
|---|---|---|---|
| | ≤ 10 | ≤ 3 | ≤ 1 |

[a)] Averages for CLR, CTR and CSR per specimen (three microsections).

This material data sheet applies to heavy plates with thicknesses from 10 up to 40 mm.

[1] The current version of this material data sheet can be also found on: www.dillinger.de.

**Production**
BOF-converter or EAF process and metallurgical ladle treatment.
The steel is fully killed and fine grained by the addition of nitrogen fixing elements.
To achieve the defined HIC resistance of DI-TANK 420 HIC the following specific production process route is applied:

- hot metal desulfurization
- vacuum degassing on tank degassing unit
- desulfurization to very low S-contents
- inclusion shape control
- optimized casting conditions with minimization of segregation and special measures to assure high cleanliness
- highly sophisticated rolling process

Only the combination of the above-mentioned measures and the quality assurance adapted to HIC resistant steel assure that the specified HIC resistance is obtained. This is also stated in the inspection certificate.

**Chemical composition in % (heat analysis)**

| DI-TANK | C max | Si | Mn | P max | S max | N max | Cu max | Mo max | Ni max | Cr max | V max | Nb max | Ti max | Al min |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **420** | 0.13 | 0.15 – 0.50 | 1.00 – 1.60 | 0.020 | 0.003 | 0.01 | 0.30 | 0.08 | 0.25 | 0.25 | 0.06 | 0.03 | 0.02 | 0.020 |
| **420 HIC** | 0.06 | 0.15 – 0.50 | 1.00 – 1.60 | 0.015 | 0.0013 | 0.01 | 0.30 | 0.08 | 0.25 | 0.25 | 0.08 | 0.05 | 0.02 | 0.020 |

| DI-TANK | CE max [%][b)] |
|---|---|
| **420** | 0.42 |
| **420 HIC** | 0.39 |

b) CE = %C + %Mn/6 + (%Cr+%Mo+%V)/5 + (%Cu+%Ni)/15

**Delivery condition**
Thermo-mechanical rolling according to EN 10028-5 (M) or thermo-mechanical control process according to A/SA841, A/SA841M (TMCP).

## Mechanical properties (in the delivery condition)

**Tensile test at ambient temperature - transverse test specimens -**

| DI-TANK | Yield strength min [MPa] | Tensile strength [MPa] | Elongation min [%] |
|---|---|---|---|
| **420** | 420 | 552 - 660 | 20[c)] / 28[d)] |
| **420 HIC** | 420 | 500 - 660 | 20[c)] / 28[d)] |

c) $A_5$ in [%]

d) $A_2$ in [%] according to the used standard defined at the time of the inquiry

**Impact test on Charpy-V-specimens**
DI-TANK 420 offers 80 J at -50 °C (longitudinal and transverse) as minimum specified value.
This specified value is minimum value for the average of 3 specimens. No individual value is to be less than 70 % of the specified minimum.

## Testing

Tensile test and impact tests are carried out according to the relevant standards. Unless otherwise agreed, the impact test will be performed at -50 °C on transverse test specimens.

**HIC test**
The HIC test is performed at the DILLINGER laboratory. Unless otherwise agreed, one test per heat is carried out.
Test procedure in accordance with NACE TM0284: The inspection test is performed in accordance with NACE TM0284: three specimens or more (depending on plate thickness) with defined dimensions are immersed for 96 h in a solution saturated with hydrogen sulphide. In general, the test is performed with test solution A.

Test solution A contains 5 % sodium chloride with 0.5 % acetic acid. It has a pH of 2.6 - 2.8 before saturation with hydrogen sulphide and a pH ≤ 4.0 at the end of the test.
Crack evaluation in accordance with NACE TM0284: When the immersion is finished the specimens are cut to perform metallographic crack evaluation on 3 sections of each specimen. The crack dimensions are put in proportion to the sections' dimensions and are described by CLR (crack length ratio), CTR (crack thickness ratio) and CSR (crack sensitivity ratio) values. The test result and acceptance criteria are the averages of CLR, CTR and CSR values of three microsections per specimen.

## Identification

In addition to the marking required by the product specification, at least the following information will be marked, with low stress steel stamps:
- steel designation (DI-TANK 420 P420ML2 or DI-TANK 420 HIC P420ML2 or DI TANK 420 SA841 B 2)
- heat number
- rolled plate number and single plate number
- the manufacturer's symbol
- inspector's mark

## Processing

The recommendations in accordance with EN 1011 and CEN-TR 10347 should be observed. 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 must comply with and are suitable for the intended use. The customer is responsible for the selection of the material.

**Cold forming**
DI-TANK 420 can generally be well cold formed regarding its high toughness, i.e., formed at temperatures below 580 °C. Cold forming is always related to a hardening of the steel and to a decrease in toughness. This change in the mechanical and HIC properties can, as a rule, be partially recovered through a subsequent stress relief heat treatment at a temperature below 580 °C. When DI-TANK 420 HIC is cold formed more than 5 % a subsequent stress relief heat treatment is necessary. Irregularities at the flame cut or sheared edges in the bending area should be ground before cold forming. For larger cold forming amounts we recommend you consult us prior to ordering.

**Hot forming**
Hot forming, i.e., forming at temperatures above 580 °C, leads to changes in the original material condition. It is impossible to re-establish the same material properties that had been achieved during the original manufacture through a further heat treatment. Therefore, hot forming is not permitted. The same limitation applies for heat treatments.

**Flame cutting and welding**
DI-TANK 420 can be flame cut in all thickness ranges without preheating due to its low hardenability. Plasma and laser cutting can also be carried out without preheating for typical thickness. The family of DI-TANK has an excellent weldability if the general technical rules are observed (EN 1011 must be applied analogously). The risk of cold cracking is low, so a preheating may not be necessary for most of the welds. When welding thicker plates preheating can still be avoided if filler materials and welding conditions are applied that lead to a very low hydrogen transfer (up to 5 ml/100 g DM according to ISO 3690).
The low contents of carbon and other alloy elements lead to favourable toughness properties in the heat-affected-zone, even with relatively high heat inputs. Depending on the chosen welding process, welding filler material as well as toughness requirements in the heat affected zone, also it permits $t_{8/5}$ cooling times above of 25 s as stated in EN 1011-2. The upper limit of heat input is however dependent from the toughness requirements in particular the impact test temperature.

## Tolerances

Unless otherwise agreed, the tolerances for the thickness in accordance with class B of EN 10029 in case of ordering the P420ML2 variant, otherwise in accordance with ASTM-A20 in case of ordering the A/SA841(M) grade B class 2 variant, are applicable.

## Surface quality

Unless otherwise agreed, the provisions in accordance with class B2 of EN 10163-2 in case of ordering the P420ML2 variant, otherwise in accordance with ASTM-A20 in case of ordering the A/SA841(M) grade B class 2 variant, are applicable.

## General note

²A stress relief heat treatment may be required above 580 °C by the API 650, API 620 and EN 14620. The standards authorize a reduction of the PWHT temperature (below 580 °C) providing a longer holding time, with the purchaser's agreement. Then, the parameters of the PWHT must be specified and agreed at the time of the inquiry. Nevertheless, DI-TANK 420 is offered with a HP value (Pcrit) of 17.6.

If special requirements which are not listed in this material data sheet, 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 data sheet is a product description. This data sheet is updated as occasion demands. The latest version is available from the mill or as download at www.dillinger.de.

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