DI-TANK 420

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

Material data sheet, edition July 2021[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 offers three options, in accordance with different standards:

- **DI-TANK 420, P420ML2 / DI-TANK 420 HIC, P420ML2:**
  - 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.
- **DI-TANK 420, SA 841 B2:**
  - is an enhanced variant of A/SA 841 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, P420ML2
DI-TANK 420 HIC, P420ML2
DI-TANK 420, SA841 grade B class 2

The HIC resistance of DI-TANK 420 HIC, P420ML2 is verified in the HIC test in accordance with NACE TM 0284. The tests are performed with test solution A (see “HIC test”). The following acceptance criteria can be ordered:

[1] The latest edition of this material data sheet is available at http://www.dillinger.de.

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

[a] The CLR, CTR and CSR values (please refer to "HIC test") are mean values of three sections.

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

Production

BOF-converter process and metallurgical ladle treatment.

The steel is fully killed and fine grained by the addition of nitrogen fixing elements.

In order 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
420	0.13	0.15 - 0.50	1.00 - 1.60	0.020	0.003	0.01	0.30	0.08	0.30	0.25	0.06	0.03	0.02	0.020 - 0.060
420 HIC	0.06	0.15 - 0.50	1.00 - 1.60	0.015	0.0013	0.01	0.30	0.08	0.30	0.25	0.08	0.05	0.02	0.020 - 0.060

DI-TANK	CE max[a] [%]
420	0.42
420 HIC	0.39

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

Delivery condition

DITANK420: 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 conditions

Tensile test at room temperature

DI-TANK	Yield strength min [N/mm²]	Tensile strength [N/mm²]	Elongation min [%]
420	420	552-660	20 [a] / 28 [b]
420 HIC	420	500-660	20 [a] / 28 [b]

[a] A5%, [b] A2" 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 tests. 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 pieces.

HIC test

The HIC test is performed by the test house of Dillinger. Unless otherwise agreed, one set of tests is carried out per heat.

Test procedure in accordance with NACE TM 0284: The inspection test is performed in accordance with NACE TM 0284: a set of three specimens with defined dimensions are immersed for 96 h in a solution saturated with hydrogen sulfide. 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 sulfide and a pH ≤ 4.0 at the end of the test.
Crack evaluation in accordance with NACE TM 0284: 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 average values (3 sections) of CLR, CTR and CSR.

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
- Number of mother plate and individual plate
- The manufacturer's symbol
- Inspector's sign

Processing

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

Formability

Cold forming

DI-TANK 420 can generally be well cold formed with regard to 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 to consult us prior to ordering.

Hot forming and heat treatment

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 has to 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

[2] A stress relief heat treatment may be required above 580 °C by the API 650, API 620 and also 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 have to 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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