



# DICREST

## PRESSURE VESSEL STEEL ADAPTED TO SOUR SERVICE CONDITIONS

### Specification DH-E51-E Edition April 2011<sup>1)</sup>

DICREST is DILLINGER HÜTTE GTS' designation for a series of fine grained pressure vessel steels offering specific properties for sour gas service. DICREST steels are produced in a way to provide an improved resistance to hydrogen induced cracking (HIC) and are available with a minimum thickness of 10 mm. The special sour service properties of DICREST steels are an addition to the properties in accordance with the specified standard and do not influence these. This material specification describes the steel design for DICREST steels

### Product description

#### HIC test

The HIC resistance of DICREST steels is verified in the HIC test. The HIC test conditions and requirements are to be agreed (e.g. according to customer specification).  
The specified HIC test values are only valid for the normalized+stress-relieved (PWHT) condition.

#### Dimensions and unit weights

The dimensions and unit weights which can be supplied depend on the steel type and the HIC test requirements (see e.g. Specification DH-E17).

### Production

In order to achieve the defined HIC resistance the following DICREST production process route is applied:

- hot metal desulfurization
- BOF converter treatment
- vacuum degassing on tank degassing unit
- desulfurization to very low S-contents
- clean steel treatment with stirring process
- inclusion shape control
- optimized casting conditions with minimization of segregation and special measures to assure high cleanliness
- high shape factor rolling (high thickness reduction)
- normalizing treatment
- stress relieving treatment on request (see "Delivery condition")

Only the combination of the above mentioned measures and the quality assurance adapted to DICREST assure that the specified HIC resistance is obtained homogeneously over the entire plate, respectively over the entire heat. This is also stated in the inspection certificate.

### Chemical analysis (heat analysis)

The alloying concepts of DICREST steels fulfill the requirements of the specified standard. Additionally the following values are valid:

$P \leq 0.010 \%$   
 $S \leq 0.0010 \%$

<sup>1)</sup> The latest edition of this material data sheet is available at <http://www.dillinger.de/>



## Delivery condition

The plates are usually delivered in the **normalized condition**. Other delivery conditions are possible on agreement as far as they are permitted by the standard, metallurgically necessary respectively reasonable. To achieve the specified HIC resistance a stress relieving treatment (PWHT) after processing is mandatory. If no **stress relief of the entire part** after processing is scheduled (e.g. if there is no forming or welding) a stress relieving treatment of the plates which is mandatory to obtain the specified HIC values has to be ordered.

If a hot forming of the plates is scheduled, delivery can be performed in the as rolled condition.

## Testing/Documentation

Testing of the mechanical properties is carried out on specimens in the agreed delivery condition and stress-relieved. The stress relieving conditions are to be agreed (e.g. according to customer specification). For deliveries in the as rolled condition the testing is carried out on specimens on which the agreed reference condition plus the agreed stress relieving was simulated.

Testing procedures and documentation are in accordance with the specified standard. If no other standard for ultrasonic testing is explicitly stipulated, ultrasonic testing is performed in accordance with EN 10160 class S2 + E3 on each plate. The test results are stated in a inspection certificate 3.1 in accordance with EN 10204, unless otherwise agreed.

## Identification of plates

For steels in accordance with ASTM/ASME the provisions of ASTM/ASME A/SA 20 apply; for steels in accordance with EN the provisions of EN 10028 apply; for other steel types marking has to be agreed upon.

## Processing recommendations (Welding, forming, heat treatment)

For processing the general technical rules in accordance with EN 1011 and CEN-TR 10347 shall be observed.

The weldability of DICREST steels is in accordance with the specified standard. DICREST steels are weldable using the classical welding processes. Other more particular welding processes like electron beam welding, laser-beam welding, electro-slag welding, electro-gas welding would require more intense studies including HIC test before being applied in fabrication.

The mechanical properties of heat affected zone and weld metal depend on the welding and heat treatment conditions. Welding parameters like heat input have to be limited according to the requirements. For steels with a minimum yield strength of 295 MPa or lower, the hardness in the weld and in the HAZ will normally not exceed 22 HRC due to the mandatory post weld heat treatment (stress relieving conditions see 'Testing/Documentation').

Generally it is recommended to perform welding procedure qualification tests to prove the suitability of the intended processing conditions, especially if the fabricator is not sufficiently experienced in welding of the steel type.

If the plates are hot formed, the general conditions for hot forming concerning temperature and holding time apply. To obtain the specified HIC properties, a subsequent stress relief heat treatment has to be performed.

The work hardening caused by cold deformation reduces the HIC-resistance of steels. In order to avoid such a degradation a thermal treatment in the temperature range of stress relief shall be carried out after cold forming or as a final heat treatment of the equipment. Should the cold deformation exceed 5 % we recommend to normalize and stress relieve the cold formed structure to regain the HIC properties.



## General technical delivery requirements

Unless otherwise agreed, the general technical delivery requirements as per ASTM/ASME A/SA 20 apply for steels according to ASTM/ASME and general technical delivery requirements as per EN 10021 apply for steels according to EN; for other steel types technical delivery conditions have to be agreed.

## Tolerances

Unless otherwise agreed, tolerances as per ASTM/ASME A/SA 20 apply for steels according to ASTM/ASME and tolerances as per EN 10029, with class B for the thickness apply for steels according to EN; for other steel grades tolerances have to be agreed.

## Surface condition

Unless otherwise agreed, the indications as per ASTM/ASME A/SA 20 apply for steels according to ASTM/ASME and the indications in accordance with EN 10163-2 class B2 apply for steels according to EN; for other steel grades surface conditions have to be agreed.

## General note

If special requirements, which are not listed 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 data sheet is a product description. This specification is updated as occasion demands. The latest version is available from the mill or as download at [www.dillinger.de](http://www.dillinger.de).

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