



DILLINGER HÜTTE GTS

# DILLIMAX 690 PE

HIGH STRENGTH FINE GRAINED PRESSURE VESSEL STEEL  
QUENCHED AND TEMPERED

Specification DH-E69-B  
Edition October 2004

**DILLIMAX 690 PE** is a high strength quenched and tempered, fine grained steel for pressure equipment with a minimum yield strength of 690 MPa in its delivered condition (referring to the lowest thickness range). Its mechanical properties are achieved by water quenching followed by tempering.

DILLIMAX 690 PE (Pressure Equipment) is preferentially used for pressure parts. Its mechanical properties and analysis are in full compliance with the P690Q (1.8879) according to EN 10028-6.

## Product description

### Designation and range of application

DILLIMAX 690 PE plates can be delivered in thicknesses from 10 to 150 mm according to the dimensional program. Dimensions, which deviate from the usual dimensional program for this type of steel, may be possible on request.

### Chemical composition

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

C	Si	Mn	P	S	Cr	Ni	Mo	V+Nb	B	CEV typical
≤ 0.20	≤ 0.80	≤ 1.70	≤ 0.025	≤ 0.015	≤ 1.50	≤ 2.50	≤ 0.70	≤ 0.18	≤ 0.0040	(*)

$$CEV = C + Mn/6 + (Cr + Mo + V)/5 + (Ni + Cu)/15$$

(\*) CEV 0.41% for plate thicknesses  $\geq 10 \leq 15$  mm

CEV 0.51% for plate thicknesses  $> 15 \leq 50$  mm

CEV 0.63% for plate thicknesses  $> 50 \leq 150$  mm

The steel is fine grained through sufficient aluminium content.

### Delivery condition

Water quenched and tempered according to EN 10028-6.

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## Mechanical and technological properties in the delivery condition

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

Plate thickness t [mm]	Tensile strength $R_m$ [MPa]	Minimum yield strength <sup>1)</sup> $R_{eH}$ [MPa]	Minimum elongation $A_5$ %
$\leq 65$	795 - 930	690	14
$> 65 \leq 100$	770 - 940	670	14
$> 100 \leq 150$	720 - 900	630	14

1) If not apparent, the yield strength  $R_{p0.2}$  is measured.

### Impact test on Charpy-V-transverse test specimens

Option	Test temperature [° C]	Impact values $A_v$ [J]	Lateral expansion [mm]
1	0	40	0.38
2	-20	27	

The test temperature is to be indicated on the order (option 1 or 2)

The specified impact values are minimum values for the average of 3 tests. The lowest individual value is not to be less than 70 % of the specified minimum.

### Testing

Tensile and impact tests will be performed according to EN 10028-1. However, if not otherwise agreed the test is performed once per heat and 40 t.

The impact test will be carried out on Charpy-V-specimens in accordance with EN 10045-1. Unless otherwise agreed, the test will be performed on transverse test specimens taken as follows:

- for plate thicknesses  $\leq 40$  mm: close to the surface
- for plate thicknesses  $> 40$  mm: 1/4 of the plate thickness

Unless otherwise agreed, the test results are documented in a certificate 3.1 B in accordance with EN 10204.

### Identification of plates

The marking is carried out via steel stamps with at least the following information:

- the manufacturer's symbol
- steel designation (DILLIMAX 690 PE)
- heat number
- plate number

### Fabricating properties

The entire fabrication and application techniques are of fundamental importance for the reliability of products manufactured with these steels. The fabricator should ensure that his calculation, design and manufacturing methods are suitable for the intended application, are state of the art and, that they correspond with the properties of the material. The customer is responsible for the selection of the material. The recommendations of EN 1011 should be observed.

### Cold forming

Cold forming means forming below the maximum allowable stress relief temperature (560 °C). DILLIMAX 690 PE can be cold formed with regard to its high yield strength. Flame cut or sheared edges in the bending area should be ground before cold forming. Cold forming is always related to a hardening of the steel and to a decrease in toughness. This change in the mechanical properties can, as a rule, be partially recovered through a subsequent stress relief heat treatment.

For larger cold forming amounts or if prescribed by regulations, a new quenching and tempering treatment may be necessary to restore the original mechanical properties. In this case we recommend you to consult us prior to ordering.

## Hot forming

Hot forming means forming at temperatures above the maximum allowable stress relief temperature (560 °C). The original quenched and tempered condition will thereby be altered. As a result, a new quenching and tempering treatment is always necessary after hot forming. It should be noted that when applying a new quenching and tempering treatment, it is not always possible to obtain the same properties as with the original heat treatment in the delivery condition, because the cooling conditions in the mill and in the fabricator's workshop can be different. In this respect we recommend you to contact us prior to ordering, in all cases where hot forming is required. However, it is the fabricator's responsibility to obtain the requested values of the steel through an appropriate heat treatment.

## Welding and flame cutting

Due to its high yield strength, the fabrication of DILLIMAX 690 PE requires special care. For general welding instructions, please consult EN 1011. In order to ensure that the tensile strength of the weld metal fulfils the requirements of the base material, the heat input and interpass temperature must be limited during welding. Experience has shown that the welding conditions should be chosen so that the cooling time  $t_{8/5}$  does not exceed 20 seconds. This is applicable when using suitable filler materials of a corresponding yield strength class.

The raised yield strength of the base material must be taken into account when the filler materials are chosen. It should be considered that increased heat input leads to lower tensile properties in the weld metal. If either during or after the manufacturing a stress relief heat treatment is planned, this must already be considered when selecting the filler materials. To avoid hydrogen-induced cold cracking, only filler materials which add very little hydrogen to the base metal, may be used. Therefore, shielded arc welding should be preferred. For manual arc welding, electrodes with basic coating (type HD < 5 in accordance with ISO 3690), which are dried according to the manufacturer's instructions, should be used. With increasing plate thicknesses and a high residual stress condition of the weld, low hydrogen annealing directly out of the weld heat is recommended.

For flame cutting, the following minimum preheating temperatures are recommended: 50 °C for plate thicknesses from 20 mm up to 50 mm and 50 - 150 °C for thicker plates, depending on thickness.

## Heat treatment

If a stress relieving has to be considered because of constructional regulations, constructive reasons or because it is necessary for the fabrication, please consult us. The properties of structural components can be altered by a stress relief heat treatment.

## 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, class B2.

## 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 the order. The indications in this specification are product descriptions. 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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