
British Standard

Terms used in the iron and steel industry

Part 1. Glossary of heat treatment terms

[EU title: Vocabulary of heat treatment terms for ferrous products]

Termes utilisés dans l'industrie sidérurgique
Partie 1. Glossaire des termes du traitement thermique

Begriffe der Stahl- und Eisenindustrie
Teil 1. Begriffe der Wärmebehandlung

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National foreword

This Part of BS 6562 has been prepared under the direction of the Iron and Steel Standards Committee.

It is identical with Euronorm 52-1983 'Vocabulary of heat treatment terms for ferrous products', published by the Commission of the European Communities, and supersedes BS 2094 : Part 1 : 1954 which is withdrawn.

Part 2 of this British Standard is in course of preparation and will be entitled 'Glossary of terms used in classifying and defining steel industry products by shape and dimension'.

Terminology and conventions. The text of the Euronorm has been approved as suitable for publication as a British Standard without deviation. Some terminology and certain conventions are not identical with those used in British Standards; attention is drawn especially to the following.

Wherever the word 'Euronorm' appears, referring to this standard, it should be read as 'British Standard'.

Cross-references. The Technical Committee has reviewed the provisions of Euronorms 20, 103, 104, 105, 114 and 116, to which reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard. There are no corresponding British Standards for these Euronorms, but as the references are included purely for information this does not adversely affect the validity of the standard.

NOTE. Table I, referred to in 1.1, has been numbered table II in error in the Euronorm text.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

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1 SCOPE AND FIELD OF APPLICATION

The purpose of this Euronorm is:

1.1 to define the terms of the ferrous products heat treatment vocabulary.

These terms are divided into a main part and an annex:

- the main part gives an alphabetical list of the terms with their definitions and, where appropriate, comments. Definitions of foreign terms for which the language in question has no equivalents are given at the end of the main part under their reference number;
- the annex comprises the definitions of terms necessary to understand the main part.

Notes — The comments are printed in italics so as to differentiate between them and the definitions.

Any term defined in the main part of this Euronorm and used in a definition or a comment is written in capital letters.

The reference numbers given with each term are identical in all the versions and correspond to the French alphabetical order. In order to avoid any confusion, the numbers of the terms in the annex are preceded by the letter A. Table I below gives the list of terms arranged according to the order of the reference numbers.

1.2 to facilitate translations using the tables of equivalent terms.

These are listed in the different Community languages (Dutch, English, French, German, Italian), on the basis of the alphabetical list of the language in question.

TABLE II

Reference numbers and associated terms.

Note — Synonyms are given in *italics* underneath the term and listed at the end of the table (after the terms in the annex).

Term

1 SOFTENING	34 CONTINUOUS-COOLING-TRANSFORMATION DIAGRAM (CCT diagram)
2 GRAIN REFINING	35 EQUIVALENT RULING SECTION <i>Equivalent diameter</i>
3 ALUMINIZING <i>Calorizing</i>	36 DIFFUSION TREATMENT
4 ENDOTHERMIC ATMOSPHERE	37 LOCAL HARDENING
5 EXOTHERMIC ATMOSPHERE	38 PRECIPITATION HARDENING
6 AUSFORMING	39 PRECIPITATION HARDENING TREATMENT
7 AUSTENITIZING	40 QUENCH HARDENING
8 AUTO-TEMPERING <i>Self tempering</i>	41 THROUGH-HARDENING
9 SELF-QUENCHING	42 SURFACE HARDENING
10 BLUEING <i>Steam treating</i>	43 DIRECT HARDENING
11 BORIDING	44 QUENCH HARDENING TREATMENT
12 BURNING	45 DOUBLE QUENCH HARDENING <i>Core refining</i>
13 MAXIMUM ACHIEVABLE HARDNESS	46 SECONDARY HARDENING
14 CARBONITRIDING	47 REVERSIBLE TEMPER EMBRITTLEMENT <i>Irreversible temper embrittlement</i>
15 CARBURIZING	48 SPHEROIDIZATION
15.1 BLANK CARBURIZING	49 SPHEROIDIZING
15.2 GAS CARBURIZING	50 GRAPHITIZATION
15.3 SALT BATH CARBURIZING	51 GRAPHITIZING
15.4 SOLID CARBURIZING <i>Pack carburizing</i>	52 GRAIN COARSENING
16 HEATING	53 HOMOGENIZING
17 HEATING CURVE	54 SOLUTION ANNEALING
18 (see definition)	55 IMPULSE HEATING
19 HEATING SCHEDULE	56 DRIP-FEED
20 HEATING RATE	57 ISOFORMING
21 CHROMIZING	58 JOMINY TEST
22 COMPOUND LAYER	59 SOAKING
23 DIFFUSION ZONE	60 MALLEABLIZING
24 QUENCH HARDENED LAYER	61 MEDIUM
25 CYANIDING	62 SOLUTION TREATMENT
26 THERMAL CYCLE	63 HEATING-UP TIME
27 DECARBURIZATION	64 NITROCARBURIZING
28 DECARBURIZING	65 NITRIDING
29 DISTORTION	66 BLANK NITRIDING
30 BAKING	67 PLASMA NITRIDING
31 DESTABILIZATION OF RETAINED AUSTENITE	68 NORMALIZING
32 STRESS RELIEF TEMPERING	69 OPERATION
33 TIME-TEMPERATURE-TRANSFORMATION DIAGRAM (TTT diagram)	70 INTERNAL OXIDATION
	71 PATENTING

72	DEPTH OF TRANSFORMATION	104	STABILIZING
73	CARBON POTENTIAL	105	STABILIZATION OF RETAINED AUSTENITE
74	QUENCHING CAPACITY	106	SULPHIDIZING
75	PREHEATING	107	OVERCARBURIZATION <i>Excessive case depth</i>
76	CASE DEPTH	108	(see definition)
77	EFFECTIVE CASE DEPTH AFTER CARBURIZING	109	CRACK
78	DEPTH OF DECARBURIZATION	110	AUSTENITIZING TEMPERATURE
79	DEPTH OF HARDENING	111	TRANSFORMATION TEMPERATURE
80	EFFECTIVE CASE DEPTH AFTER SURFACE HARDENING	112	QUENCHING TEMPERATURE
81	DEPTH OF NITRIDING <i>Effective case depth</i>	113	AGEING
82	CARBON RESTORATION	114	INTER-CRITICAL TREATMENT
83	RECRYSTALLIZING	115	SUB-ZERO TREATING <i>Deep freezing</i>
84	ANNEALING <i>Box annealing</i>	116	HEAT TREATMENT
85	BRIGHT ANNEALING	117	THERMOCHEMICAL TREATMENT <i>Cementation</i>
86	FULL ANNEALING	118	HARDENABILITY
87	INTER-CRITICAL ANNEALING	119	QUENCHING
88	ISOTHERMAL ANNEALING	120	DIRECT QUENCHING
89	SUB-CRITICAL ANNEALING	121	STEP QUENCHING
90	AIR COOLING	122	AUSTEMPERING
91	COOLING CURVE	123	MARTEMPERING
92	COOLING TIME	124	INTERRUPTED QUENCHING
93	(see definition)	125	CASE HARDENING
94	COOLING CONDITIONS	126	LIMITING RULING SECTION
95	COOLING SCHEDULE	127	(see definition)
96	COOLING RATE	128	(see definition)
97	(see definition)	129	(see definition)
98	CRITICAL COOLING RATE	130	(see definition)
99	STRESS RELIEVING	131	EFFECTIVE CASE DEPTH AFTER NITRIDING
100	RECOVERY	132	OVERHEATING
101	TEMPERING	133	OVERSOAKING
102	SHERARDIZING	134	(see definition)
103	SILICONIZING	135	(see definition)
		136	(see definition)

Terms in the annex

A 137	ACICULAR STRUCTURE	A147	BANDED STRUCTURE
A138	STEEL	A148	CEMENTITE
A139	AUSTENITIC STEEL	A149	COALESCENCE OF A PRECIPITATE
A140	FERRITIC STEEL	A150	CONSTITUENT
A141	GRAPHITIC STEEL	A151	CRITICAL DIAMETER
A142	ALLOY	A152	LOW LOAD HARDNESS
A143	AUSTENITE	A153	MASS EFFECT
A144	RETAINED AUSTENITE	A154	EPSILON CARBIDE
A145	SELF-HARDENING STEEL	A155	EUTECTOID TRANSFORMATION
A146	BAINITE	A156	ALPHA IRON

A157	GAMMA IRON	A171	GRAIN BOUNDARY
A158	DELTA IRON	A172	MARTENSITE
A159	FERRITE	A173	SECONDARY MARTENSITE
A160	CAST IRON	A174	METASTABLE
A161	GRAIN	A175	MICROHARDNESS
A162	AUSTENITIC GRAIN SIZE	A176	PEARLITE
A163	(see definition)	A177	PROEUTECTOID CONSTITUENT
A164	McQUAID-EHN GRAIN SIZE	A178	RECALESCENCE
A165	GRAIN SIZE	A179	SENSITIZATION
A166	GRAIN GROWTH	A 180	SOLID SOLUTION
A167	HYPEREUTECTOID STEEL	A181	TRANSFORMATION TEMPERATURE <i>Critical point</i>
A168	HYPOEUTECTOID STEEL	A182	THERMOMECHANICAL TREATMENT
A169	INTERMETALLIC COMPOUND	A183	AGEING
A170	TRANSFORMATION RANGE <i>Inter-critical range</i>	A184	WIDMANNSTÄTTEN STRUCTURE

List of synonyms

————	<i>Box annealing</i> (see term 84)	————	<i>Equivalent diameter</i> (see term 35)
————	<i>Calorizing</i> (see term 3)	————	<i>Excessive case depth</i> (see term 107)
————	<i>Cementation</i> (see term 117)	————	<i>Intercritical range</i> (see term A170)
————	<i>Core refining</i> (see term 45)	————	<i>Irreversible temper embrittlement</i> (see term 47)
————	<i>Critical point</i> (see term A181)	————	<i>Pack carburizing</i> (see term 15.4)
————	<i>Deep freezing</i> (see term 115)	————	<i>Self tempering</i> (see term 8)
————	<i>Effective case depth</i> (see term 81)	————	<i>Steam treating</i> (see term 10)

2 DEFINITIONS

2.1 Main part

AGEING – 113 –

HEAT TREATMENT applied to a ferrous product after SOLUTION TREATMENT to bring its properties to the required level.

It consists of HEATING to and SOAKING at one or more specified temperatures, followed by cooling appropriately.

AIR COOLING – 90 –

Cooling a ferrous product in still air.

ALUMINIZING – 3 –

THERMOCHEMICAL TREATMENT which is applied to a ferrous product with the object of producing surface enrichment in aluminium.

Note — In English the term ‘calorizing’ is also used.

ANNEALING – 84 –

HEAT TREATMENT consisting of HEATING and SOAKING at a suitable temperature followed by cooling under conditions such that, after return to ambient temperature, the metal will be in a structural state closer to that of equilibrium.

As this definition is very general, it is advisable to use an expression specifying the aim of the treatment; see for example terms 85-89.

Note — In English, the term ‘box annealing’ is used when the annealing is effected in a sealed container to minimize oxidation.

AUSFORMING – 6 –

Thermomechanical treatment of a ferrous product which consists of plastically deforming the metastable austenite before subjecting it to the martensitic and/or bainitic transformation.

AUSTEMPERING – 122 –

HEAT TREATMENT involving AUSTENITIZATION followed by STEP QUENCHING, at a rate fast enough to avoid the formation of ferrite or pearlite, to a temperature above M_s and SOAKING to ensure partial or total transformation of the austenite to bainite.

The final cooling to ambient temperature is not at any specific rate.

AUSTENITIZING – 7 –

OPERATION during which the ferrous product is brought to a temperature such that the structure becomes austenitic.

If this transformation is incomplete, the AUSTENITIZATION is termed partial.

AUSTENITIZING TEMPERATURE – 110 –

Highest temperature at which the ferrous product is held during AUSTENITIZATION.

AUTO-TEMPERING – 8 –

Spontaneous TEMPERING undergone by martensite during QUENCHING.

Note — In English the term ‘self tempering’ is also used to designate this treatment.

BAKING – 30 –

HEAT TREATMENT permitting the release of hydrogen occluded in a ferrous product without modifying its structure.

Takes place notably following an electrolytic plating or pickling operation.

BLANK CARBURIZING – 15.1 –

Simulation treatment which consists of reproducing the THERMAL CYCLE of CARBURIZATION without the carburizing MEDIUM.

This treatment makes it possible to assess the metallurgical consequences of the THERMAL CYCLE of CARBURIZING.

BLANK NITRIDING – 66 –

Simulation treatment which consists of reproducing the THERMAL CYCLE of NITRIDING without the nitriding MEDIUM.

This treatment makes it possible to assess the metallurgical consequences of the THERMAL CYCLE of NITRIDING.

BLUEING – 10 –

OPERATION carried out in an oxidizing medium at a temperature such that the polished surface of a ferrous product becomes covered with a thin, continuous, adherent film of blue-coloured oxide.

Note — In English, the term ‘steam treating’ is equally used when the oxidizing medium is steam.

BORIDING – 11 –

THERMOCHEMICAL TREATMENT which is applied to a ferrous product with the aim of producing a surface layer of boride.

BRIGHT ANNEALING – 85 –

ANNEALING carried out in a MEDIUM that allows the original metallic surface finish to be maintained by preventing oxidation of the metal.

BURNING – 12 –

Irreversible change in the structure and properties brought about by the onset of fusion at the grain boundaries.

CARBON POTENTIAL – 73 –

Carbon content at the surface of a specimen of pure iron in equilibrium with the CARBURIZING MEDIUM considered and under the conditions specified.

CARBON RESTORATION – 82 –

THERMOCHEMICAL TREATMENT intended to restore the carbon content of the surface layer, decarburized during an earlier treatment.

CARBONITRIDING – 14 –

THERMOCHEMICAL TREATMENT which is applied to a ferrous product in the austenitic state, to obtain a surface enrichment in carbon and nitrogen, which are in solid solution in the austenite.

Generally, this OPERATION is followed immediately by QUENCH HARDENING.

CARBURIZING – 15 –

THERMOCHEMICAL TREATMENT which is applied to a ferrous product in the austenitic state, to obtain a surface enrichment in carbon, which is in solid solution in the austenite.

The carburized ferrous product undergoes QUENCH HARDENING (immediately or later).

CASE DEPTH – 76 –

Distance between the surface of a ferrous product and a limit characterizing the thickness of the layer enriched in carbon. This limit should be specified.

Example — For the total CASE DEPTH, this limit will correspond to the carbon content of the unaltered base metal.

CASE HARDENING – 125 –

Treatment consisting of CARBURIZING or CARBONITRIDING followed by QUENCH HARDENING.

The QUENCH HARDENING could be, for example, DIRECT HARDENING.

CHROMIZING – 21 –

THERMOCHEMICAL TREATMENT which is applied to a ferrous product in order to obtain surface enrichment in chromium.

The surface layer can consist of practically pure chromium (on low-carbon steels) or of chromium carbide (on high-carbon steels).

COMPOUND LAYER – 22 –

Surface layer formed during a THERMOCHEMICAL TREATMENT and made up of the chemical compounds formed by the element(s) introduced during the treatment and certain elements from the base metal.

For example, the layer of nitride formed during NITRIDING, the layer of boride formed during BORIDING, the layer of chromium carbide formed during the CHROMIZING of high-carbon steel.

Note — In English, the term ‘white layer’ is improperly used to designate this layer.

CONTINUOUS - COOLING - TRANSFORMATION DIAGRAM (CCT DIAGRAM) – 34 –

Set of curves drawn in a semi-logarithmic coordinate system with logarithmic time/temperature coordinates and which define each variation in temperature as a function of time during cooling, the temperature at which the austenite begins and ends its transformation.

In general a complementary curve joins the points corresponding to the temperatures at which the proportion of phase transformed reaches 50%. Information is also given about the transformation products and their proportions. Finally, the hardness measured after return to ambient temperature, is shown for each of the COOLING CURVES.

COOLING CONDITIONS – 94 –

The conditions under which the cooling of the ferrous product takes place: nature and temperature of the MEDIUM, agitation, etc.

COOLING CURVE – 91 –

Graphical representation of the variation of temperature as a function of time during cooling.

COOLING RATE – 96 –

Characterizes the variation in temperature as a function of time during cooling.

One distinguishes between:

- an instantaneous rate corresponding to a specified temperature,
- an average rate over a defined interval of temperature.

COOLING SCHEDULE – 95 –

Variation in temperature as a function of time during cooling, which must be followed.

COOLING TIME – 92 –

The interval of time separating two characteristic temperatures on the cooling curve. It is always necessary to specify precisely what the temperatures are.

CRACK – 109 –

Fissure produced in the ferrous product by the immediate or deferred effects of heating or cooling.

Generally, the term 'crack' is completed by an indication of the conditions under which the crack appeared, e.g. quenching crack, heating crack.

CRITICAL COOLING RATE – 98 –

COOLING RATE corresponding to the critical variation of temperature as a function of time during cooling.

CYANIDING – 25 –

CARBONITRIDING carried out in a bath of molten salts containing cyanides.

DECARBURIZATION – 27 –

Depletion of carbon from the surface layer of a ferrous product.

This depletion may be either partial: PARTIAL DECARBURIZATION, or nominally complete: COMPLETE DECARBURIZATION.

The sum of the two types of DECARBURIZATION, PARTIAL AND COMPLETE, is termed TOTAL DECARBURIZATION. (See EU 104)

DECARBURIZING – 28 –

THERMOCHEMICAL TREATMENT intended to produce DECARBURIZATION of a ferrous product.

DEPTH OF DECARBURIZATION – 78 –

Distance between the surface of a ferrous product and a limit characterizing the thickness of the layer depleted in carbon.

Note — This limit differs according to the type of DECARBURIZATION (see DECARBURIZATION) and can be defined by reference to a structural state, a level of hardness or the carbon content of the unaltered base metal (see EU 104), or any other prescribed carbon content.

DEPTH OF HARDENING – 79 –

Distance between the surface of a ferrous product and a limit characterizing the penetration of QUENCH HARDENING. This limit may be defined starting from a structural state or a level of hardness.

DEPTH OF NITRIDING – 81 –

Distance between the surface of a ferrous product and a limit characterizing the thickness of the layer enriched in nitrogen. This limit should be specified.

Note — When this limit is a level of hardness, the term 'effective case depth' is used in English.

DEPTH OF TRANSFORMATION – 72 –

Development of QUENCH HARDENING of a piece from its surface. The DEPTH OF TRANSFORMATION is generally measured in terms of the DEPTH OF HARDENING.

DESTABILIZATION OF RETAINED AUSTENITE – 31 –

Phenomenon occurring during TEMPERING which allows the retained austenite to undergo martensitic transformation within a temperature range where it would not previously have transformed.

DIFFUSION TREATMENT – 36 –

HEAT TREATMENT (or OPERATION) intended to cause the diffusion towards the interior of the ferrous product of elements previously introduced into the surface.

Example — Diffusion treatment after GAS CARBURIZING.

DIFFUSION ZONE – 23 –

Surface layer formed during a THERMOCHEMICAL TREATMENT containing, in solid solution or where appropriate partially precipitated, the element(s) introduced during the treatment. The content of these elements diminishes continuously as the base metal is approached.

The precipitates in the diffusion zone can be nitrides, carbides, etc.

DIRECT HARDENING – 43 –

QUENCH HARDENING TREATMENT of a ferrous product carried out immediately after a THERMOCHEMICAL TREATMENT.

In general this treatment is carried out after CARBURIZING and, if necessary, after cooling to the temperature most appropriate to the hardening of the product.

DIRECT QUENCHING – 120 –

QUENCHING carried out immediately following a THERMOCHEMICAL TREATMENT.

DISTORTION – 29 –

Any change in the shape and original dimensions of a ferrous product occurring during HEAT TREATMENT.

DOUBLE QUENCH HARDENING – 45 –

HEAT TREATMENT consisting of two successive QUENCH HARDENING TREATMENTS, generally carried out from different temperatures.

In the case of carburized products, the first QUENCH HARDENING can be obtained by DIRECT QUENCHING, the second being carried out from a lower temperature.

Note — The incorrect expression ‘double hardening’ in the United Kingdom is used to designate this treatment. In the case of carburized products, the term ‘core refining’ is used in English to designate the first quench hardening.

DRIP-FEED – 56 –

Process involving the drop by drop introduction of a suitable liquid into the interior of a HEAT TREATMENT furnace under atmosphere.

For example, this process is currently used for GAS CARBURIZING.

EFFECTIVE CASE DEPTH AFTER CARBURIZING – 77 –

Distance between the surface of a ferrous product and the position where the Vickers hardness under a load of 9.81 N is $HV_1 = 550$ (see EU 105).

Note — If the load or the hardness level are different, they should be stated.

EFFECTIVE CASE DEPTH AFTER NITRIDING – 131 –

DEPTH OF NITRIDING defined by reference to a specific hardness level.

EFFECTIVE CASE DEPTH AFTER SURFACE HARDENING – 80 –

Distance between the surface and the point whose Vickers hardness, measured under a load of 9.81 N, is equal to 80% of the minimum surface hardness required for the ferrous product considered. (See EU 116).

EURONORM 116 indicates equally that:

- *Loads other than the conventional load may be used after agreement, to measure this depth, these loads are 4.9 N and 49 N.*
- *The Rockwell test may be similarly used, after prior agreement defining the limiting hardness value.*

ENDOTHERMIC ATMOSPHERE – 4 –

Furnace atmosphere produced endothermically and with a CARBON POTENTIAL capable of being matched to the carbon content of the ferrous product under HEAT TREATMENT in order to reduce, increase or maintain the carbon level at the surface of the ferrous product.

EQUIVALENT RULING SECTION – 35 –

Diameter of the cylinder of the same steel (of length 3 d) such that the cooling rate in its centre would be identical to the slowest cooling rate recorded in the ferrous product considered, for the same cooling conditions.

Note — In English the term ‘equivalent diameter’ is also used.

EXOTHERMIC ATMOSPHERE – 5 –

Furnace atmosphere produced exothermically and controlled so that it does not oxidize the ferrous product.

FULL ANNEALING – 86 –

ANNEALING at a temperature above Ac_3 .

GAS CARBURIZING – 15.2 –

CARBURIZING in a gaseous atmosphere.

GRAIN COARSENING – 52 –

ANNEALING carried out at a temperature well above Ac_3 for a SOAKING period sufficient to bring about grain growth.

GRAIN REFINING – 2 –

HEAT TREATMENT with the object of refining or making uniform the grain size of a ferrous product and comprising HEATING it at a temperature slightly above Ac_3 (Ac_1 for hypereutectoid steels), without prolonged SOAKING at this temperature, followed by cooling at a suitable rate.

GRAPHITIZATION – 50 –

Precipitation of carbon in the form of graphite.

GRAPHITIZING – 51 –

HEAT TREATMENT applied to cast irons or hypereutectoid steels to bring about GRAPHITIZATION.

HARDENABILITY – 118 –

Capacity of a ferrous product to give rise to martensitic and/or bainitic transformations.

HARDENABILITY is often characterized under defined experimental conditions by the development of hardness as a function of the distance from a quenched surface (for example the Jominy curve).

HEAT TREATMENT – 116 –

Series of OPERATIONS in the course of which a solid ferrous product is totally or partial exposed to THERMAL