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**NATIONAL STANDARD OF THE
PEOPLE'S REPUBLIC OF CHINA**

GB/T 24174-2022

Replacing GB/T 24174-2009

Steel - Determination of the bake hardening index

钢 烘烤硬化值(BH)的测定方法

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Table of Contents

1	Scope
2	Normative references
3	Terms and definitions
4	Symbols and descriptions
5	Principle...
6	Test equipment
7	Specimens
8	Test methods
8.2	Test conditions
8.2.2	Tensile test rate
8.2.3	Baking treatment
8.3	Determination methods
8.3.1	Determination of BH
9	Calculation of test results...

1 Scope

China's national method for determining the bake hardening index of steel. It specifies the specimens, the equipment, the procedure and the calculation for determining the increase in yield strength produced in a steel sheet by a paint bake cycle after prestraining. The bake hardening index is the number that GB/T 20564.1 specifies and this standard measures, and it exists because the property is not a property of the steel alone but of a sequence. A bake hardening steel is delivered soft, is formed - which introduces dislocations - and is then baked, during which carbon in solution diffuses to those dislocations and pins them, raising the yield strength. Neither step alone produces the effect: forming without baking gives ordinary work hardening, and baking without forming gives almost nothing, because there are no dislocations to pin. So the measurement has to reproduce both, in the right order and to defined amounts. The method prestrains a tensile specimen by a specified amount - conventionally two per cent, chosen to represent the strain a real panel receives - records the flow stress at that point, unloads it, bakes it at a defined temperature for a defined time representing the paint cure, and then reloads it to yield. The bake hardening index is the difference between the new yield stress and the flow stress before baking. Because every one of those parameters changes the answer, the standard fixes the prestrain, the bake temperature and time, the specimen geometry and orientation, the strain rate and the definition of the yield point on a curve that may or may not show a

distinct yield after baking. It also fixes the time between forming and baking, since the effect decays with natural ageing. Issued on 15 April 2022 and in force since 1 November 2022, it replaces GB/T 24174-2009.

This Standard specifies the principle, test equipment, specimens, test methods, calculation of test results and test reports for the determination of the Bake-Hardening- Index (BH) of steel. This Standard applies to the determination of the Bake-Hardening-Index of steels with bake hardening phenomena. NOTE: This Standard is mainly used in the automotive industry.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 228.1-2021, Metallic materials - Tensile testing - Part 1: Method of test at room temperature

GB/T 8170, Rules of rounding off for numerical values and expression and judgement of limiting values

3 Terms and definitions

For the purposes of this document, the terms and definitions defined in GB/T 228.1- 2021 as well as the followings apply.

3.1 Bake-Hardening-Index; BH The increase in yield strength of the specimens pre-stretched with or without the specified amount of strain after baking at 170°C for 20min relative to the yield strength of the same or another specimen in the original state.

4 Symbols and descriptions

The symbols given in Table 1 apply to this document.

6 Test equipment

6.1 The accuracy requirements of the tensile testing machine and extensometer are in accordance with the provisions of GB/T 228.1-2021.

6.2 The temperature control accuracy of the heating device is $\pm 2^{\circ}\text{C}$. The resolution of the temperature measuring device shall not exceed 1°C .

7 Specimens

The specimen shall use the P5, P6 and P17 lead specimens in Annex B of GB/T 228.1-

2021. When the product standard or contract does not specify the specimen type number, the P17 specimen shall be used.

8 Test methods

8.1 Test classification According to the number of specimens used in the test, the test methods are divided into two categories.

a) Use a specimen to determine. According to the difference of determination methods, it is divided into BH2, BH2H, BH2L and BH2P. When the product standard or contract does not stipulate, BH2 shall be used.

b) Use two specimens to determine. Use BH0 to express.

8.2 Test conditions

8.2.1 Test temperature Unless otherwise specified, the test shall be carried out at room temperature within the range of 10°C ~ 35°C. For tests with strict temperature requirements, the test temperature shall be 23°C ± 5°C.

8.2.2 Tensile test rate

8.2.2.1 To better maintain the consistency of test results, a uniform tensile test rate shall be used.

8.2.2.2 When measuring $R_{t2.0}$, $R_{p2.0}$, $R_{p0.2}$, $R_{p0.2,t}$, R_{eL} and $R_{eL,t}$, it is recommended to set the test rate according to the beam displacement rate of 5% L_c per minute. When measuring $R_{eH,t}$, it is recommended to set the test rate according to the beam displacement rate of 2.5% L_c per minute. The test rate shall not be switched from the start of the stretch to the measurement of the above indicators.

8.2.3 Baking treatment

8.2.3.1 After the temperature of the heating device reaches 170°C, put the specimen to be baked. After the temperature of the heating device reaches 170°C again, keep the temperature for (20.0±0.5) min. Take out the specimen immediately. Place in air to cool to room temperature.

8.2.3.2 During baking, the specimens shall not be stacked. They shall be placed separately on the shelf.

8.2.3.3 The same tensile testing machine shall be used for the two tensile tests before and after baking.

8.3.1 Determination of BH

2 Use a tensile test specimen. According to the provisions of GB/T 228.1-2021, the

specimen is first subjected to pre-strain stretching with a total strain of 2.0%. Obtain $R_{t2.0}$. After the pre-tensile specimen is subjected to the prescribed baking treatment, the tensile test is performed on the sample again. Obtain $Re_{L,t}$ or $R_{p0.2,t}$ (when there is no apparent yield).

8.3.2 Determination of BH2H Use a tensile test specimen. In accordance with the provisions of GB/T 228.1-2021, the specimen is first subjected to pre-strain stretching with a total strain of 2.0%. Obtain $R_{t2.0}$. After the pre-tensile specimen is subjected to the prescribed baking treatment, the tensile test is performed on the specimen again. Obtain $Re_{H,t}$ or $R_{p0.2,t}$ (when there is no apparent yield).

8.3.3 Determination of BH2L Use a tensile test specimen. According to the provisions of GB/T 228.1-2021, the specimen is first subjected to pre-strain stretching with a total strain of 2.0%. Obtain $R_{p0.2}$. After the pre-tensile specimen is subjected to the prescribed baking treatment, the tensile test is performed on the specimen again. Obtain $Re_{L,t}$ or $R_{p0.2,t}$ (when there is no apparent yield).

8.3.4 Determination of BH2P Use a tensile test specimen. According to the provisions of GB/T 228.1-2021, the specimen is first subjected to pre-strain stretching with a total strain of 2.2%. Obtain $R_{p2.0}$. After the pre-tensile specimen is subjected to the prescribed baking treatment, the tensile test is performed on the specimen again. Obtain $Re_{L,t}$ or $R_{p0.2,t}$ (when there is no apparent yield). NOTE: For high strength steel, the total strain corresponding to R_p