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

GB/T 16508.3-2022

Replacing GB/T 16508.3-2013

Shell boilers - Part 3: Design and strength calculation

锅壳锅炉 第3部分：设计与强度计算

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1 Scope

GB/T 16508.3-2022 is the Chinese national standard on shell boilers - part 3: design and strength calculation, in the field of energy and heat transfer engineering. The /T suffix marks it as a recommended standard: it is not compulsory by itself, but it becomes binding as soon as a contract, a tender or a customer specification calls it up - which in practice is how most foreign buyers meet it. It was issued on 11 July 2022 by the State Administration for Market Regulation; Standardization Administration of China, and has been in force since 1 February 2023. Classification: ICS 27.060.30, CCS J98. This page is published from the official record of the standard held by the Chinese standards administration: the identification, the dates, the classification and the issuing body are taken from there. The clause text, the tables and the numeric limits are in the document itself, which is delivered complete in English translation.

This document specifies the design requirements and strength calculation methods for pressure elements of shell boilers. It also specifies the test and finite element analysis verification methods for determining the maximum allowable working pressure of elements. This document is applicable to the design of pressure elements of shell boilers defined in GB/T 16508.1 [including cylindrical elements bearing internal (external) pressure, heads, tube plates, end covers, foot rings, etc.] and braces.

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 150.3, Pressure vessels - Part

3 Terms, definitions and symbols

For the purposes of this document, the terms and definitions defined in GB/T 2900.48 and GB/T 16508.1 as well as the followings apply.

3.1 calculating temperature Under normal working conditions, the metal temperature (arithmetic mean of inner and outer wall temperatures) of the set pressure element or non-pressure element under load.

3.2 working pressure Under normal design operating conditions, the highest pressure that the pressure element bears.

3.3 calculating pressure The pressure that is used to determine the required thickness of the pressure element at the calculating temperature.

3.4 required thickness The thickness of the pressure element that is determined by the theoretical calculation formula.

3.5 design thickness The sum of required thickness and additional thickness.

3.6 corrosion allowance thickness During the design service period, the additional thickness required for the element to consider corrosion thinning.

3.10 nominal thickness The thickness that the design thickness is rounded up to the steel standard specification.

3.11 effective thickness The thickness of the nominal thickness minus the corrosion allowance thickness, the lower tolerance of the steel thickness and the process additional thickness.

3.12 the highest fire line The highest point on the water side on the evaporating heating surface of the boiler that is washed by flames or high-temperature flue gas.

3.8 MPa and less than

5.3 MPa, the calculation of the smoke tubes under external pressure can be carried out in accordance with GB/T 150.3.

8 Convex head, flue roof, hemispherical flue and convex tube Nominal outer diameter
Nominal thickness plate

8.1 Overview This chapter specifies the design calculation methods for the convex head (including ellipsoid, hemispherical, butterfly, etc.), flue roof, convex tube plate (including ellipsoid, arch, etc.) subjected to internal or external pressure, etc. and structural requirements.

8.2 Symbols This chapter uses the following symbols.

4 Symbols

The following symbols apply to this document.

5.1 Basic requirements

5.1.1 Boiler design shall adopt advanced technology to make the product meet the requirements of being safe, reliable, highly efficient, economic and environment protective. Design according to the relevant regulations of GB/T 16508.1.

5.1.2 During design, according to the following requirements, determine the calculating loads that need to be considered and the load calculations that need to be performed.

5.1.3 The design shall ensure that the wall temperature of the element does not exceed the allowable temperature of the material used. Consider factors such as the temperature difference between the inner and outer walls of the tube on the heating surface and the inner wall's resistance to steam oxidation.

5.2.1 General requirements

5.2.1.1 The main pressure elements of the shell boiler include boiler shell, header, piping, centralized descending tube, flue, backfire chamber, tube plate (head), flue roof and foot ring, etc.

5.2.2.4 For the backfire chamber of a horizontal internal combustion boiler, the wall thickness of the cylinder shall be not less than 10 mm and not more than 35 mm.

5.2.2.5 The calculated length of the horizontal flat flue shall not exceed 2000 mm. When the two ends of the flue are connected to the flange of the tube plate, the calculated length of the straight flue can be enlarged to 3000 mm.

5.2.3 Safe water level

5.2.3.1 The minimum and maximum safe water levels of boilers shall be indicated on the boiler drawings.

5.2.4 Welding structure

5.2.4.1 The main welds of the main pressure elements of the boiler (including the longitudinal and circumferential welds of the boiler shell, flue, backfire chamber, header, etc. and the spliced welds of the head, tube plate, flue roof and foot ring, etc.) shall adopt full penetration structure. The braces shall not be spliced.

5.2.4.3 The connection between the tube joint and the boiler shell, header and piping shall adopt the full penetration joint type under the following circumstances.

5.2.4.4 The connection between the manhole ring, head hole ring of the boiler pressure elements and the cylinder, head and tube plate shall adopt a full penetration structure.

5.7 Element working pressure and element calculating pressure

5.7.1 The working pressure of the element is calculated according to the formula (2). In the formula, Δp_f is the pressure drop between the calculating element and the boiler outlet when the maximum flow rate of the boiler is taken.

5.7.2 Element calculating pressure is calculated according to formula (3). In the formula, Δp_a can be selected according to the range of boiler rated pressure (p_r) according to