

DIN EN 13445-6:2016-12 (E)

Unfired pressure vessels - Part 6: Requirements for the design and fabrication of pressure vessels and pressure parts constructed from spheroidal graphite cast iron

| Contents | | Page |
|-----------------|--|-------------|
| Foreword..... | | 5 |
| 1 | Scope | 7 |
| 2 | Normative references | 7 |
| 3 | Terms, definitions, units and symbols | 8 |
| 3.1 | Terms and definitions | 8 |
| 3.2 | Units | 9 |
| 3.3 | Symbols | 9 |
| 3.4 | Inter-relation of thicknesses definitions | 11 |
| 4 | Service conditions | 11 |
| 4.1 | Cyclic loading..... | 11 |
| 4.2 | Limitations on temperature and energy content | 12 |
| 5 | Requirements | 12 |
| 5.1 | Materials | 12 |
| 5.2 | Design | 14 |
| 5.2.1 | Technical documentation | 14 |
| 5.2.2 | Design methods | 14 |
| 5.3 | Founding..... | 20 |
| 5.3.1 | General..... | 20 |
| 5.3.2 | Welding..... | 20 |
| 6 | Material testing..... | 20 |
| 6.1 | General..... | 20 |
| 6.2 | Frequency and number of tests | 20 |
| 6.3 | Chemical analysis..... | 20 |
| 6.4 | Graphite structure..... | 21 |
| 6.5 | Inspection documents..... | 21 |
| 7 | Testing and final assessment..... | 21 |
| 7.1 | Testing | 21 |
| 7.1.1 | General..... | 21 |
| 7.1.2 | Testing requirements for $C_Q = 0,8$ | 21 |
| 7.1.3 | Testing requirements for $C_Q = 0,9$ | 21 |
| 7.1.4 | Surface imperfections | 22 |
| 7.1.5 | Cracks, laps, cold shut and non-fused chaplets | 23 |
| 7.1.6 | Ultrasonic testing and/or sectioning | 23 |
| 7.1.7 | Magnetic particle testing (only for ferritic grades)..... | 23 |
| 7.1.8 | Penetrant testing..... | 23 |
| 7.1.9 | Radiographic testing | 23 |
| 7.1.10 | Surface roughness | 24 |
| 7.1.11 | Minimum wall thickness..... | 24 |
| 7.1.12 | Wall thickness tolerances..... | 24 |
| 7.1.13 | Other dimensions | 24 |
| 7.1.14 | Qualification of testing personnel..... | 24 |
| 7.2 | Final assessment | 24 |
| 7.2.1 | General..... | 24 |
| 7.2.2 | Hydraulic test pressure | 24 |
| 8 | Pressure vessels constructed of a combination of parts in different materials | 25 |
| 9 | Marking and documentation..... | 25 |
| 9.1 | Marking of castings | 25 |
| 9.2 | Name plate for the complete pressure vessel | 25 |
| 9.3 | Documentation | 25 |

H.3.4 Material tests51
H.4 Allowable number of cycles51
Annex Y (informative) History of EN 13445-653
Y.1 Differences between EN 13445-6:2009 and EN 13445-6:201453
Y.2 List of corrected pages of Issue 2 (2015-07).....53
Y.3 List of corrected pages of Issue 3 (2016-07).....53
**Annex ZA (informative) Relationship between this European Standard and the essential requirements
of Directive 2014/68/EU aimed to be covered54**
Bibliography55

| | |
|---|-----------|
| Annex A (normative) Technical data for the design calculations..... | 26 |
| A.1 Purpose..... | 26 |
| A.2 Technical data..... | 26 |
| A.2.1 Ferritic spheroidal graphite cast iron according to EN 1563:1997..... | 26 |
| A.2.2 Austenitic spheroidal graphite cast iron according to EN 13835:2002..... | 27 |
| Annex B (informative) Ductility | 28 |
| Annex C (informative) Determination of the minimum local wall thickness and minimum required burst test pressure | 29 |
| Annex D (normative) Assessment of fatigue life..... | 30 |
| D.1 Purpose..... | 30 |
| D.2 Specific definitions..... | 30 |
| D.3 Specific symbols and abbreviations | 30 |
| D.4 Limitations..... | 31 |
| D.5 General..... | 31 |
| D.6 Simplified fatigue assessment | 31 |
| D.6.1 Pseudo-elastic stress range | 31 |
| D.6.2 Correction factors..... | 32 |
| D.6.3 Fatigue design curves..... | 32 |
| D.6.4 Allowable number of cycles | 38 |
| D.6.5 Allowable stress range $\Delta\sigma$ | 38 |
| D.7 Detailed fatigue assessment | 38 |
| D.7.1 Pseudo-elastic stress ranges..... | 38 |
| D.7.2 Corrections to stress range..... | 39 |
| D.7.3 Fatigue design curves..... | 40 |
| D.7.4 Allowable number of cycles | 41 |
| D.7.5 Allowable stress range..... | 42 |
| D.8 Assessment rule for total fatigue damage..... | 42 |
| D.9 Repairs of surface imperfections..... | 42 |
| Annex E (normative) Design by analysis for castings..... | 43 |
| E.1 Introduction | 43 |
| E.2 Special requirements to EN 13445-3:2014, Annex B..... | 43 |
| E.2.1 Addition to B.8.2.3: Design checks for normal operating load cases..... | 43 |
| E.2.2 Addition to B.8.2.4: Design checks for testing load cases | 43 |
| E.3 Additions to EN 13445-3:2014, Annex C..... | 43 |
| E.4 Requirements..... | 44 |
| Annex F (informative) Recommendations for in-service validation and inspection | 45 |
| F.1 Purpose..... | 45 |
| F.2 Tests during operation..... | 45 |
| F.3 Measures to be taken when the calculated allowable fatigue lifetime has been reached | 46 |
| F.3.1 General..... | 46 |
| F.3.2 Testing of vessels and pressure parts at end of life without indicated damages | 46 |
| F.3.3 Hydraulic testing of vessels and vessel parts with indicated damages | 46 |
| Annex G (normative) Specific design requirements..... | 47 |
| G.1 Scope | 47 |
| G.2 Design | 47 |
| G.2.1 General..... | 47 |
| G.2.2 Cover thickness, pressure to convex side..... | 48 |
| G.2.3 Pressure to concave side | 48 |
| G.2.4 Flange thickness..... | 48 |
| Annex H (normative) Experimental cyclic pressure testing procedure..... | 49 |
| H.1 Purpose..... | 49 |
| H.1.1 General..... | 49 |
| H.1.2 Experimental methods and other design methods | 49 |
| H.2 Validity | 49 |
| H.3 Tests requirements..... | 49 |
| H.3.1 General..... | 49 |
| H.3.2 Number of parts | 49 |
| H.3.3 Procedure | 49a |