DIN EN 14197-2:2006-11 (E)

Cryogenic vessels - Static non-vacuum insulated vessels - Part 2: Design, fabrication, inspection and testing

Contents

Page

Introduction 6

1 Scope 7

2 Normative references 7

3 Terms and definitions and symbols 8
3.1 Terms and definitions 8
3.2 Symbols 9

4 Design 10
4.1 Design options 10
4.2 Common design requirements 10
4.3 Design by calculation 14

5 Fabrication 47
5.1 General 47
5.2 Cutting 47
5.3 Cold forming 47
5.4 Hot forming 48
5.5 Manufacturing tolerances 49
5.6 Welding 52
5.7 Non-welded permanent joints 53

6 Inspection and testing 54
6.1 Quality plan 54
6.2 Production control test plates 54
6.3 Non-destructive testing 56
6.4 Rectification 59
6.5 Pressure testing 60

Annex A (normative) Elastic stress analysis 61

A.1 General 61
A.2 Terminology 61
A.3 Limit for longitudinal compressive general membrane stress 63
A.4 Stress categories and stress limits for general application 64
A.5 Specific criteria, stress categories and stress limits for limited application 65

Annex B (normative) Additional Requirements for 9 % Ni steel 70

B.1 Introduction 70
B.2 Specific requirements 70

Annex C (Informative) Pressure strengthening of vessels from austenitic stainless steels 72

C.1 Introduction 72
C.2 Field of application 72
C.3 Definitions and units of measurement 72
C.4 Materials 73
C.5 Design 74

C.6 Manufacturing and inspection 77
C.7 Comments 78

Annex D (informative) Pressure limiting systems 84

Annex E (informative) Specific weld details 85

E.1 Field of application 85
E.2 Specific weld detail 85
E.3 Oxygen service requirements 86

Annex F (normative) Additional requirements for flammable fluids 89

Annex G (informative) Increased material property for austenitic stainless steel 90

Annex H (normative) Base materials 91

Annex I (informative) Other materials 93

Annex ZA (informative) Clauses of this European Standard addressing essential requirements or other provisions of EU Directives 95

Figures Figure 1 - Stiffening rings 24

Figure 2 - Sectional materials stiffeners 24

Figure 3 - Dished ends 25

Figure 4 a) - Unpierced dished end 25

Figure 4 b) - Dished end with nozzle 25

Figure 4 c) - End with knuckle and crown of unequal wall thickness 26

Figure 4 d) -- Weld outside 0,6 Da 26

Figure 4 e) -- Weld inside 0,6 Da 26

Figure 4 f) -- End welded together from round plate and segments 27

Figure 5 -- Design factors for 10 % torispherical dished ends 27

Figure 6 -- Design factors for 2:1 torispherical dished ends 28

Figure 7 a) -- Geometry of convergent conical shells 28

Figure 7 b) -- Geometry of a divergent conical shell 29

Figure 8 -- Geometry of a cone opening 29

Figure 9 -- Geometrical dimensions in the case of loading by external pressure 29

Figure 10.1 - Permissible value vK pS 15 for convergent cone with an opening angle = 10° 30

Figure 10.2 - Permissible value v15K pS or convergent cone with an opening angle = 20° 31

Figure 10.3 - Permissible value v15K pS for convergent cone with an opening angle = 30° 32

Figure 10.4 - Permissible value v15K pS for convergent cone with an opening angle = 40° 33

Figure 10.5 - Permissible value v15K pS for convergent cone with an opening angle = 50° 34

Figure 10.6 - Permissible value v15K pS for convergent cone with an opening angle = 60° 35

Figure 10.7 - Permissible value v15K pS for convergent cone with an opening angle = 70° 36

Figure 10.8 - Permissible value v15K pS for convergent cone (corner joint) with an opening angle = 10° to 70° 37

Figure 11 -- Opening factor CA for flat ends and plates without additional marginal moment 38

Figure 12 - Design factors for unstayed circular flat ends and plates 40

Figure 13 -- Design factor CE for rectangular or elliptical flat plates 41

Figure 14 -- Increased thickness of a cylindrical shell 42

Figure 15 -- Increased thickness of a conical shell 42

Figure 16 -- Set-on reinforcement ring 42

Figure 17 -- Set-in reinforcement ring 42

Figure 18 -- Pad reinforcement 43

Figure 19 -- Nozzle reinforcement 43

Figure 20 -- Necked out opening 43

Figure 21 -- Pad 44

Figure 22 -- Calculation scheme for cylindrical shells 44

Figure 23 -- Calculation scheme for spherical shells 45

Figure 24 -- Calculation scheme for adjacent nozzles or in a longitudinal direction of a cylinder 45

Figure 25 -- Openings between longitudinal and circumferential direction 46

Figure 26 -- Calculation scheme for adjacent nozzles in a sphere or in a circumferential direction of a cylinder 46

Figure 27 a) -- Seams which do not require a taper 50

Figure 27 b) -- Seams which do require a taper 50

Figure 27 -- Plate alignment 50

Figure 28 -- Gauge details 52

Figure A.1 -- Stress categories and limits of stress intensity 68

Figure A.2 -- For vessels not subject to external pressure 69

Figure C.1 -- Stress/strain curve for carbon steel 79

Figure C.2 -- Stress/strain curve for austenitic stainless steel 79

Figure D.1 -- Examples of relief systems 84

Figure E.1 -- Joggle joint 86

Figure E.2 -- Intermediate end 87

Figure E.3 -- Backing strip 87

Figure E.4 -- End plate closure (examples) 88

Figure E.5 -- Non full penetration nozzle welds 88