

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