ISO 20421-1:2019 (E)

Cryogenic vessels — Large transportable vacuum-insulated vessels — Part 1: Design, fabrication, inspection and testing

Contents

		Foreword					
		Introd	Introduction				
1		Scope					
2		Norma	ative references				
3		Torme	and definitions				
3							
4		Symbo	Symbols				
5		General requirements					
6		Mecha	nical loads				
	6.1 6.2		General Load during the pressure test				
7		Chemi	ical effects				
8		Thermal conditions					
9		Materials					
	9.1 9.2		Selection of materials				
	9.2		Inspection documentation				
10		Desig	1				
	10.1		Design options				
	10.1	.1	General				
	10.1	.2	Design by calculation				
	10.1	.3	Design by calculation and pressure strengthening				
	10.1	.4	Design of components by calculation supplemented with experimental methods				
	10.2		Common design requirements				
	10.2	.1	General				
	10.2	.2	Design specification				
	10.2	-	Design loads				
	10.2	-	General				
	10.2		Inner vessel				
	10.2		Outer jacket				
	10.2		Self-supporting vessels				
	10.2		Inner-vessel supports				
	10.2		Surge plates				
	10.2 10.2		Outer-jacket supports Fastening points				
	10.2		Protection of upper fittings				
		.3.10	Stability				
		.3.11	Piping and valves				
	10.2		Fatigue				
	10.2		Corrosion allowance				
	10.2		Inspection openings				
	10.2		Pressure relief				
	10.2		General				
	10.2		Inner vessel				

```
Outer jacket
10.2.7.3
10.2.7.4
           Piping
10.2.8
           Valves
10.2.9
           Insulation
           Degree of filling
10.2.10
10.2.11
           Electrical continuity
10.3
           Design by calculation
           General
10.3.1
           Inner vessel
10.3.2
10.3.2.1
           General
10.3.2.2
           Design pressure, p
10.3.2.3
           Material properties, K
10.3.2.3.1 General
10.3.2.3.2 K20
10.3.2.3.3 Kt
10.3.2.3.4 Brittleness
10.3.2.3.5 Elongation
10.3.2.4
           Safety factors S, Sp and Sk
10.3.2.5
           Weld joint factor, n
10.3.2.6
           Corrosion allowances, c
10.3.3
           Outer jacket
10.3.3.1
           General
10.3.3.2
           Calculation pressure, p
10.3.3.3
           K20
10.3.3.4
           Safety factors S, Sp and Sk in relation to K, K20 or KT
10.3.3.5
           Plastic deformation
           Weld joint factor, η
10.3.3.6
           Corrosion allowances, c
10.3.3.7
           Attachments
10.3.4
10.3.5
           Piping and accessories
10.3.6
           Calculation formula
           Cylindrical shells and spheres subject to internal pressure (pressure on the concave
10.3.6.1
           surface)
10.3.6.1.1 Field of application
10.3.6.1.2 Openings
10.3.6.1.3 Calculation
10.3.6.2
           Cylindrical shells subject to external pressure (pressure on the convex surface)
10.3.6.2.1 Field of application
10.3.6.2.2 Openings
10.3.6.2.3 Calculation
           Spheres subject to external pressure (pressure on the convex surface)
10.3.6.3
10.3.6.4
           Dished ends
10.3.6.4.1 Field of application
10.3.6.4.2 Straight flange
10.3.6.4.3 Internal-pressure calculation (pressure on concave surface)
10.3.6.5
           Cones subject to internal or external pressure
10.3.6.5.1 Field of application
10.3.6.5.2 Openings
10.3.6.5.3 Non-destructive testing
10.3.6.5.4 Corner area
10.3.6.5.5 Internal-pressure calculation (pressure on concave surface) |\phi| \le 70^{\circ}
10.3.6.5.6 Internal-pressure calculation (pressure on the concave surface) |\phi| > 70^{\circ}
10.3.6.5.7 External-pressure calculation (pressure on the convex surface)
           Flat ends
10.3.6.6
10.3.6.6.1 Symbols and units
10.3.6.6.2 Field of application
10.3.6.6.3 Openings
10.3.6.6.4 Calculation
10.3.6.7
           Openings in cylinders, spheres and cones
10.3.6.7.1 Field of application
10.3.6.7.2 Reinforcement methods
10.3.6.7.3 Design of openings
10.3.6.7.4 Calculation
```

10.3.7

Calculations for operating loads

11		Fabrication				
	11.1		General			
	11.2		Cutting			
	11.3		Cold forming			
	11.3		Austenitic stainless steel			
	11.3		Ferritic steel			
	11.3		Aluminium or aluminium alloy			
	11.4		Hot forming			
	11.4		General			
	11.4	_	Austenitic stainless steel			
	11.4		Ferritic steel			
	11.4 11.5		Aluminium or aluminium alloy Manufacturing tolerances			
	11.5		General			
	11.5		Plate alignment			
	11.5		Thickness			
	11.5		Dished ends			
	11.5		Cylinders			
	11.6	-	Welding			
	11.6		General			
	11.6	.2	Qualification			
	11.6	.3	Temporary attachments			
	11.6	.4	Welded joints			
	11.7		Non-welded joints			
12		Inened	ction and testing			
12		-				
	12.1		Quality plan			
	12.1		General			
	12.1		Inspection stages during manufacture of an inner vessel			
	12.1	.3	Additional inspection stages during manufacture of a large transportable cryogenic			
	400		vessel			
	12.2 12.2		Production control test plates			
	12.2		Requirements Extent of testing			
	12.3		Non-destructive testing			
	12.3		General			
	12.3		Extent of examination for surface imperfections			
	12.3		Extent of examination for inner-vessel weld seams			
	12.3	-	Acceptance criteria for surface and volumetric imperfections as classified in ISO 6520-1			
			·			
	12.3	.4.1	Acceptance levels for predominantly static loaded vessels			
	12.3	.4.2	Acceptance criteria for fatigue loaded vessels			
	12.3		Extent of examination of non-welded joints			
	12.4		Rectification			
	12.5		Pressure testing			
13		Markir	ng and labelling			
14		Final a	acceptance test			
15		Dorino	lia inanastian			
15		Period	lic inspection			
16		Docun	nentation			
Annex	Α	(inforr	native) Examples of tank plates			
	A.1		Example 1: Tank plate (of the complete tank) for fixed tanks of road tankers (tank			
			vehicles), demountable tanks, tank containers and tank swap bodies			
	A.2		Example 2 :Tank plate for the inner vessel of fixed tanks of road tankers (tank vehicles),			
			demountable tanks, tank containers and tank swap bodies			
Annex	В	(inforr	native) Elastic stress analysis			
	B.1		General			
	B.2		Terminology			

	B.2.1		Stress intensity
	B.2.2		Gross structural discontinuity
	B.2.3		Local structural discontinuity
	B.2.4		Normal stress
	B.2.5	-	Shear stress
	B.2.6		Membrane stress
	B.2.7		Primary stress
	B.2.8		Primary local membrane stress
	B.2.9		Secondary stress
	B.2.9		Peak stress
	B.3		Limit for longitudinal compressive general membrane stress
	B.4 B.4.1		Stress categories and stress limits for general application General
	В.4.2 В.4.2		General primary membrane stress category
	B.4.3		Local primary membrane stress category
	B.4.4		General or local primary membrane plus primary bending stress category
	B.4.5		Primary plus secondary stress category
	В.4.5 В.4.6		Thermal stress
	B.5		Specific criteria, stress categories and stress limits for limited application
	B.5.1		General
	B.5.2	2	Attachments and supports
	B.5.3	3	Nozzles and openings
	B.5.4	Į.	Additional stress limits
Annex	_	/norma	ative) Additional requirements for 9 % Ni steel
Aillex	C	(110111)	Additional requirements for 5 % Ni Steel
	C.1		General
	C.2		Specific requirements
Annex	D	(norma	ative) Pressure strengthening of vessels from austenitic stainless steels
		•	,
	D.1		General
	D.2		Application of this annex
	D.3		Materials
	D.4 D.4.1		Design General
	D.4.2	-	Design for internal pressure
	D.4.2		Design stress values
	D.4.2		Calculation of the strengthening pressure
	D.4.2		Calculation of wall thicknesses
	D.4.3		Design for external pressure
	D.5		Manufacturing and inspection
	D.5.1		Strengthening procedure
	D.5.2		Procedure record
	D.5.3	3	Welding
	D.5.4		Pressure-vessel drawing
	D.5.5	5	Inspection and testing
	D.5.6	3	Data plate
	D.6		Comments
	D.6.1		Strengthening theory
	D.6.2		Work-hardened material
	D.6.3		Derivation of formula
	D.6.4	1	Deformations at strengthening
Annex	Е	(inform	native) Specific weld details
		•	
	E.1 E.2		Field of application Weld detail
	E.∠ E.2.1		
	E.2.1		Joggle joint Intermediate ends
	E.2.3		Backing strip
	E.2.4		End plate closure
	E.2.5		Nozzle weld
	E.2.6		Non-continuous fillet weld on attachments
	E.3		Oxygen service requirements
	-		

Annex F (normative) Outer-jacket relief devices

F.1		Field of application				
F.2		Requirements				
F.2.	1	General				
F.2.	2	Design				
F.2.	3	Materials				
F.2.	4	Testing				
F.2.5		Inspection				
F.2.	6	Marking				
Annex G	(inforn	native) Base materials				
Annex H	(inforr Calcul	native) Components subject to external pressure (pressure on the convex surface) — lation				
H.1		General				
H.2		Method 1				
H.2	.1	Cylindrical shells				
H.2.1.1 H.2.1.2 H.2.1.3 H.2.2 H.2.2.1 H.3 H.3.1		Elastic buckling				
		Plastic deformation				
		Stiffening rings				
		Dished ends and spherical shells				
		Elastic buckling				
		Method 2				
		Cylindrical shells				
H.3	.1.1	Elastic buckling				
	.1.2	Stiffening rings				
H.3	.2	Dished ends and spherical shells				
Annex I	(inforn	mative) Design of openings in cylinders, spheres and cones — Calculation				
I.1		General				
1.2		Method 1				
1.3		Method 2				
1.4		Reinforcement by increased nozzle thickness				
1.4.	-	General				
1.4.2		Reinforcement by a combination of increased shell and nozzle thicknesses				
1.4.3	3	Multiple openings				
Annex J	(norm	ative) Reference material & equivalent thickness				
J.1		General				
J.2		Method A				
J.2.	-	Example 1				
J.2.	.2	Example 2				
J.3		Method B: Equivalent thickness				
Annex K	(norm	ative) Refrigerated liquefied gases				

Page count: 124