ISO 20421-1:2019 (E)

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

Contents

		Forew	ord	
		Introd	uction	
1		Scope		
2		Normative references		
3		Terms and definitions		
4		Symbols		
5		General requirements		
6		Mechanical 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 Inspection documentation	
10		Desig	n	
	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		General	
	10.2	.2	Design specification	
	10.2	.3	Design loads	
	10.2	.3.1	General	
	10.2	.3.2	Inner vessel	
	10.2	.3.3	Outer jacket	
	10.2	.3.4 2 E	Self-supporting vessels	
	10.2	36	Surge plates	
	10.2	37	Outer-jacket sunnorts	
	10.2	.3.8	Fastening points	
	10.2	.3.9	Protection of upper fittings	
	10.2	.3.10	Stability	
	10.2	.3.11	Piping and valves	
	10.2	.4	Fatigue	
	10.2	.5	Corrosion allowance	
	10.2	.6	Inspection openings	
	10.2	.7	Pressure relief	
	10.2	.7.1	General	
	10.2	.7.2	Inner vessel	

10.2.7.3	Outer jacket
10.2.7.4	Piping
10.2.8	Valves
10.2.9	Insulation
10.2.10	Degree of filling
10.2.11	Electrical continuity
10.3	Design by calculation
10.3.1	General
10.3.2	Inner vessel
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	N20
10.3.2.3.3	
10.3.2.3.4	Dritteness Elemention
10.3.2.3.5	Safety factors S. Sn and Sk
10.3.2.4	Weld joint factor n
10.3.2.5	Corresion allowances c
10.3.2.0	Outor jackot
10.3.3 1	General
10.3.3.1	Calculation pressure n
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
10.3.3.6	Weld joint factor, n
10.3.3.7	Corrosion allowances. c
10.3.4	Attachments
10.3.5	Piping and accessories
10.3.6	Calculation formula
10.3.6.1	Cylindrical shells and spheres subject to internal pressure (pressure on the concave
	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
10.3.6.3	Spheres subject to external pressure (pressure on the convex surface)
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 \leq 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)
10.3.0.0	Fial Clius Symbols and units
10.3.0.0.1	Sympols and Units Field of application
10.3.0.0.2	nonings
10.3.0.0.3	Calculation
10.3.0.0.4	Calculation Onenings in cylinders, spheres and cones
10.3.0.7	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
- 11.3.1 Austenitic stainless steel
- 11.3.2 Ferritic steel
- 11.3.3 Aluminium or aluminium alloy
- 11.4 Hot forming
- 11.4.1 General
- 11.4.2 Austenitic stainless steel
- 11.4.3 Ferritic steel
- 11.4.4 Aluminium or aluminium alloy
- 11.5 Manufacturing tolerances
- 11.5.1 General
- 11.5.2 Plate alignment
- 11.5.3 Thickness
- 11.5.4 Dished ends
- 11.5.5 Cylinders
- 11.6 Welding
- 11.6.1 General
- 11.6.2 Qualification
- 11.6.3 Temporary attachments
- 11.6.4 Welded joints
- 11.7 Non-welded joints

12 Inspection and testing

- 12.1 Quality plan
- 12.1.1 General
- 12.1.2 Inspection stages during manufacture of an inner vessel
- 12.1.3 Additional inspection stages during manufacture of a large transportable cryogenic vessel
- 12.2 Production control test plates
- 12.2.1 Requirements
- 12.2.2 Extent of testing
- 12.3 Non-destructive testing
- 12.3.1 General
- 12.3.2 Extent of examination for surface imperfections
- 12.3.3 Extent of examination for inner-vessel weld seams
- 12.3.4 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
- 12.3.4.3 Extent of examination of non-welded joints
- 12.4 Rectification
- 12.5 Pressure testing
- 13 Marking and labelling
- 14 Final acceptance test
- 15 Periodic inspection
- 16 Documentation
- Annex A (informative) 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 B (informative) 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.2.9.1 Peak stress
- B.3 Limit for longitudinal compressive general membrane stress
- B.4 Stress categories and stress limits for general application
- B.4.1 General
- B.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
- B.4.6 Thermal stress
- B.5 Specific criteria, stress categories and stress limits for limited application
- B.5.1 General
- B.5.2 Attachments and supports
- B.5.3 Nozzles and openings
- B.5.4 Additional stress limits

Annex C (normative) Additional requirements for 9 % Ni steel

- C.1 General
- C.2 Specific requirements

Annex D (normative) Pressure strengthening of vessels from austenitic stainless steels

- D.1 General
- D.2 Application of this annex
- D.3 Materials
- D.4 Design
- D.4.1 General
- D.4.2 Design for internal pressure
- D.4.2.1 Design stress values
- D.4.2.2 Calculation of the strengthening pressure
- D.4.2.3 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 Welding
- D.5.4 Pressure-vessel drawing
- D.5.5 Inspection and testing
- D.5.6 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 Deformations at strengthening

Annex E (informative) Specific weld details

- E.1 Field of application
- E.2 Weld detail
- E.2.1 Joggle joint
- E.2.2 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 (informative) Base materials
- Annex H (informative) Components subject to external pressure (pressure on the convex surface) Calculation
 - H.1 General
 - H.2 Method 1
 - H.2.1 Cylindrical shells
 - H.2.1.1 Elastic buckling
 - H.2.1.2 Plastic deformation
 - H.2.1.3 Stiffening rings
 - H.2.2 Dished ends and spherical shells
 - H.2.2.1 Elastic buckling
 - H.3 Method 2
 - H.3.1 Cylindrical shells
 - H.3.1.1 Elastic buckling
 - H.3.1.2 Stiffening rings
 - H.3.2 Dished ends and spherical shells

Annex I (informative) Design of openings in cylinders, spheres and cones - Calculation

- I.1 General
- I.2 Method 1
- I.3 Method 2
- I.4 Reinforcement by increased nozzle thickness
- I.4.1 General
- I.4.2 Reinforcement by a combination of increased shell and nozzle thicknesses
- I.4.3 Multiple openings

Annex J (normative) Reference material & equivalent thickness

- J.1 General
- J.2 Method A
- J.2.1 Example 1
- J.2.2 Example 2
- J.3 Method B: Equivalent thickness

Annex K (normative) Refrigerated liquefied gases

Page count: 124