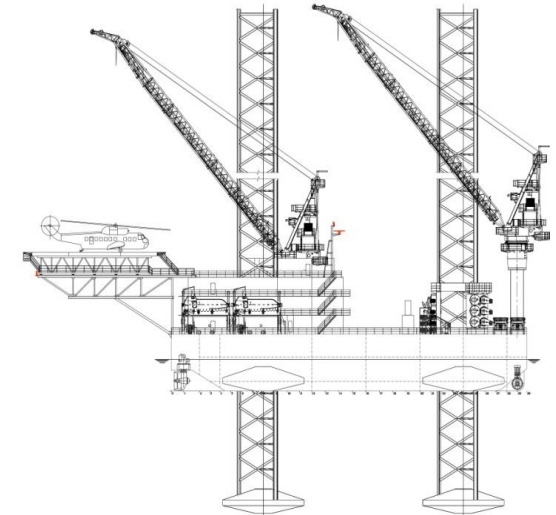
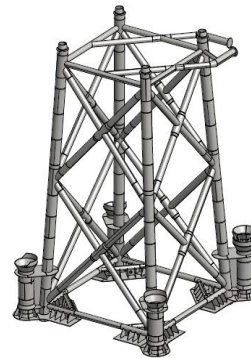
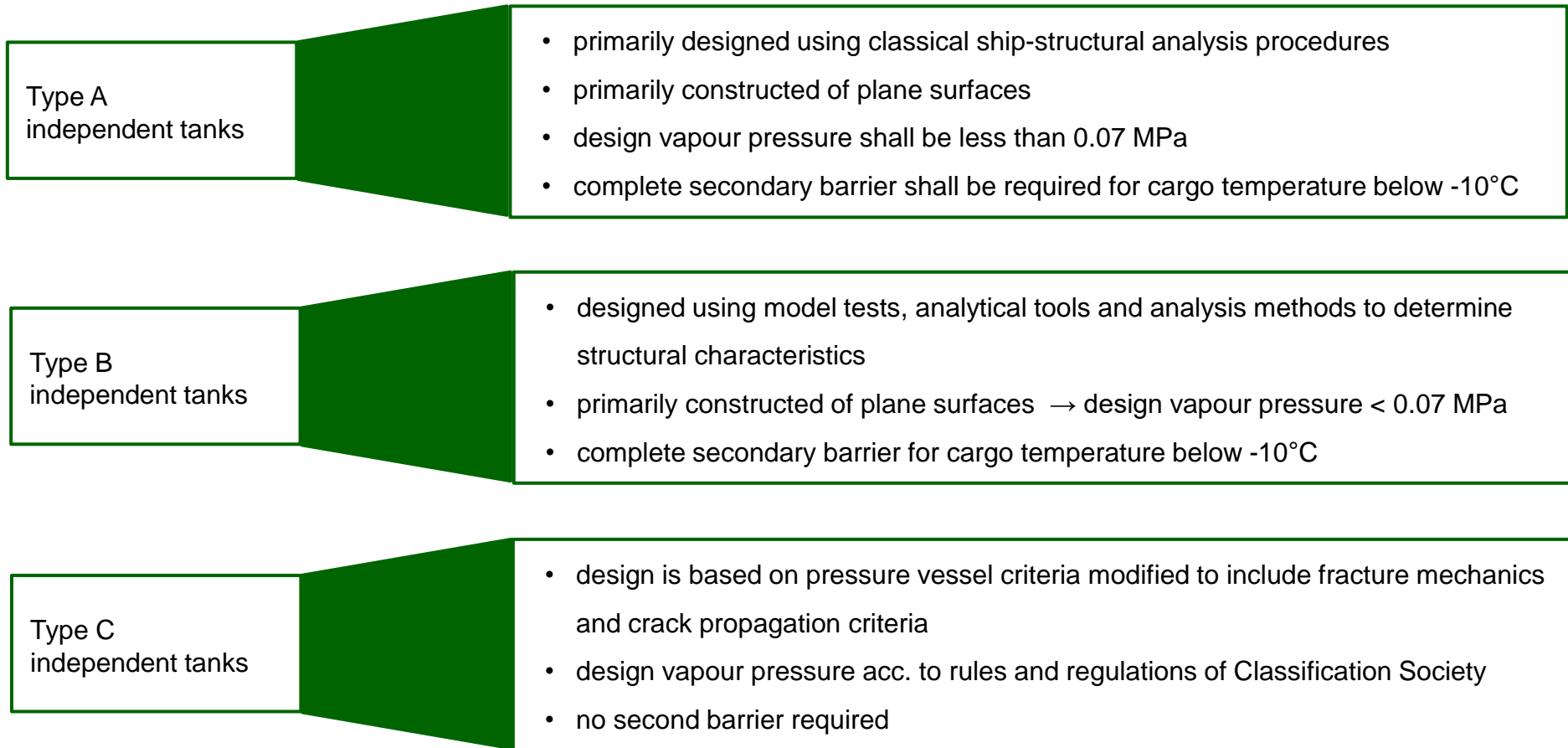




Low Pressure LNG Tank and Bunker Storage Solutions

- founded in 1981, abh is the reliable partner for shipowners and yards all over the world for more than three decades, today abh has a team of abt. 25 experts covering all disciplines of design
- based on design & engineering abh successfully covers the business areas
 - merchant shipping
 - steel construction
 - offshore wind farm installation
 - offshore vessels
 - energy technology





membrane tanks

- design basis is the evidence that thermal and other expansions are compensated without any risk for the tightness of the membrane
- systematic approach based on analyses and testing
- for cargo below -10°C a complete secondary barrier is required
- max. vapour pressure 0.025 MPa, exception up to 0.07 MPa possible

integral tanks

- tanks form a structural part of the vessel's hull
- vapour pressure not to exceed 0.025 MPa normally, exception: 0.07 MPa
- tanks may be used for cargo with boiling point not below -10°C
- exception possible for lower temperature; additional analysis, second barrier

semi-membrane tanks

- non self supporting tanks in loaded condition, supported through thermal insulation by the adjacent hull structure
- vapour pressure max. 0.025 MPa with exception up to 0.07 MPa

Tank Types acc. to LR: Rules and Regulations for the Construction and Classification of Ships for the Carriage of liquified Gases in Bulk Cargo Containment Chapter 4, January 2016



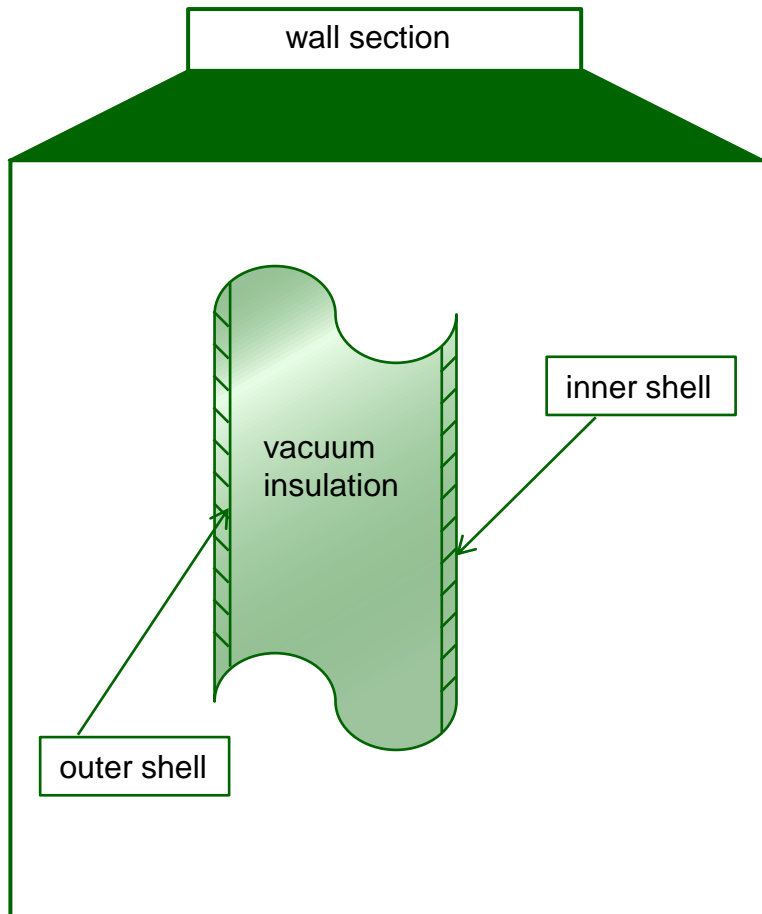
pending patent application

The Principle

- prismatic Low Pressure Tank (LPT)
- vacuum insulated
- box-in box principle
- high variance in tank shape
- max. utilisation of given space for LNG-storage

The Vacuum Insulation

- evacuated, rigid nanopores insulation boards
- insulation boards maintain the distance between outer and inner shell
- structural capabilities induced by the vacuum level



- required vacuum level 1 mbar
- heat conductivity of evacuated insulation 0.004 W/mK
- inner and outer shell of stainless steel
 - inner shell: 1.3912
 - outer shell: 1.4301
- wall thickness of outer and inner shell abt. 1 mm
- insulation boards withstand the external pressure of abt. 10 t/m_2 , caused by the evacuation
- inner and outer shells are to be welded heliumtight
- material of outer and inner shell are to be suitable for low temperatures

- low temperature suitability
- cold toughness
- low coefficient of linear expansion
- high tensile elongation
- vacuum tightness
- low permeation coefficient
- easy processability with established procedures
 - weldability by all common methods
 - bending
- approved material by classification society for marine applications

outer shell

1.4301, X5 CrNi 18-10

• material composition

	C	Si	Mn	P	S	Cr	Ni	N
min	./.	./.	./.	./.	./.	17,5	8	./.
max	0,07	1,0	2,0	0,045	0,03	19,5	10,5	0,1

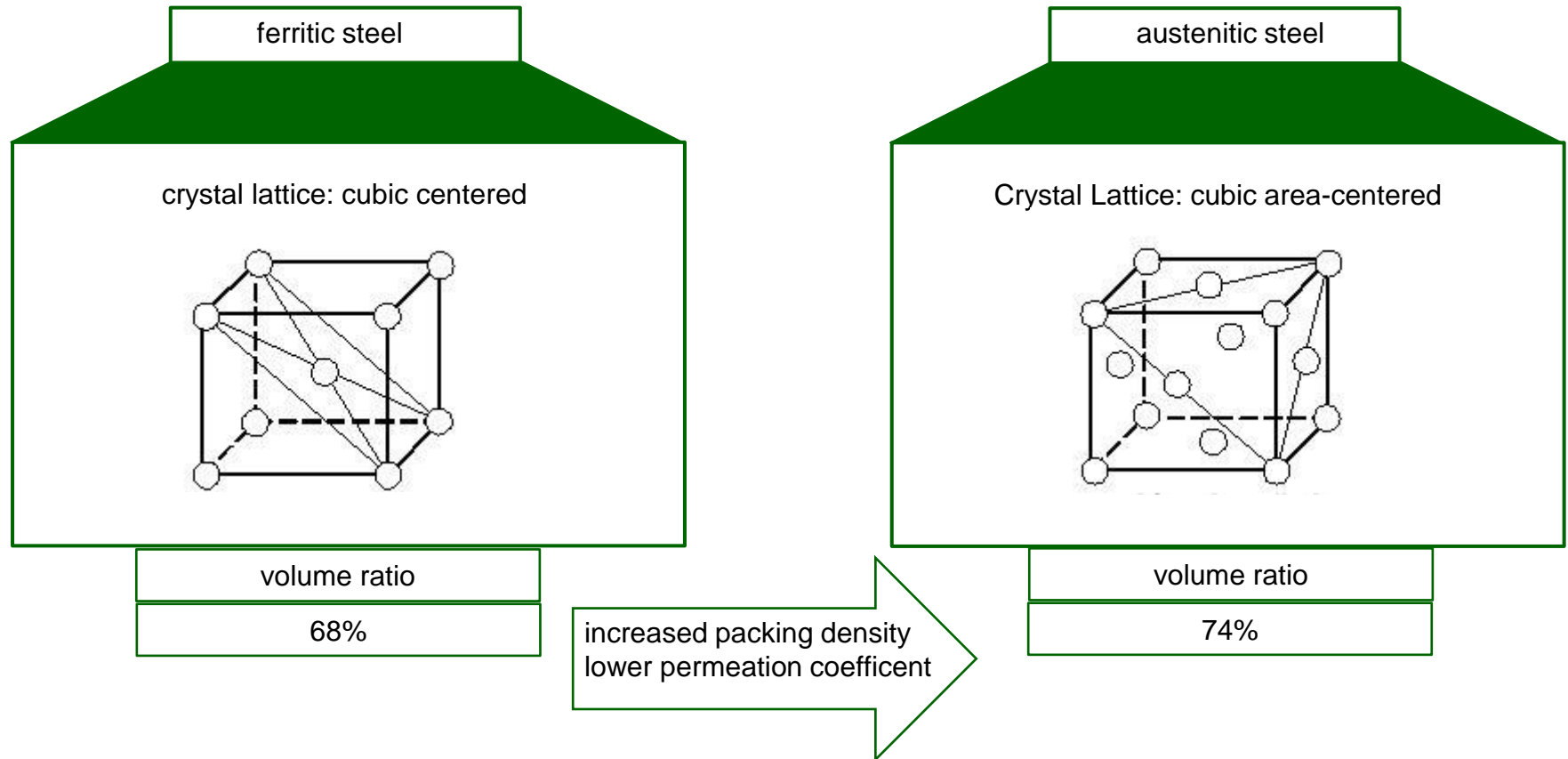
inner shell

1.3912, Ni 36

• material composition

	Ni	Cr	Fe	
min	35,0	./.	65	below 0,5% of C, Mn, Si, Co, P, S
max	37,0	0,25	63	

- low temperature suitability, 1.4301: -200°C / 1.3912: -250°C
- austenitic steel
- Iron-Nickel alloys, nickel ensures cold toughness (no embrittlement)



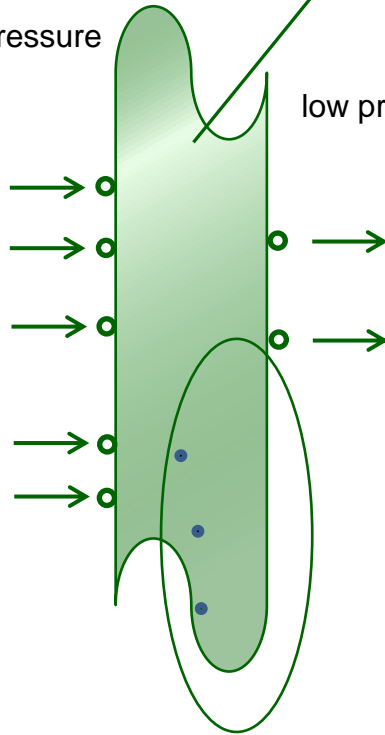
barrier, eg. inner and outer shell of the LPT-S tank

high pressure

low pressure

SORPTION

substances are absorbed on the surface of the solid



DESORPTION

the adsorbate escapes as a gas on the other side of the solid (increase of pressure within the vacuum space)

DIFFUSION

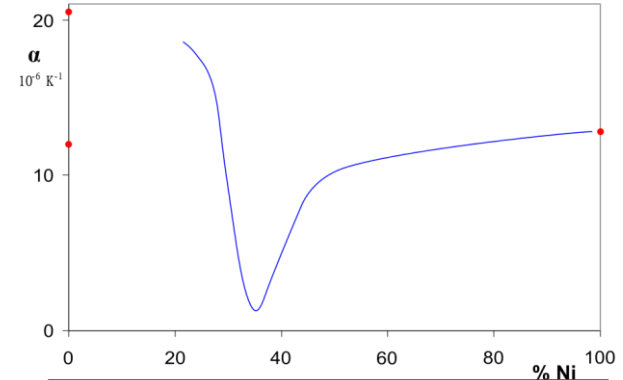
the permeant penetrates the solid material through pores or molecular interstices

austenitic steel is impermeable to air at a pressure difference of 1013 mbar and a wall thickness of 1 mm

1.4301

20°C – 100°C:	16,0 [10 ⁻⁶ K ⁻¹]
20°C – 200°C:	16,5 [10 ⁻⁶ K ⁻¹]
20°C – 300°C:	17,0 [10 ⁻⁶ K ⁻¹]
20°C – 400°C:	17,5 [10 ⁻⁶ K ⁻¹]
20°C – 500°C:	18,0 [10 ⁻⁶ K ⁻¹]

1.3912



$\alpha \approx 1,2 * 10^{-6} K^{-1} @ 36\% Ni$

example: thermal shrinkage of inner tank wall

1.4301

$L_0 = 3030 \text{ mm}, T = -162^\circ\text{C} \rightarrow \Delta T = 182 \text{ K}$

$$\Delta l = l_0 * \Delta T * \alpha = 8,82 \text{ mm}$$

1.3912

$$\Delta l = l_0 * \Delta T * \alpha = 0,66 \text{ mm}$$

- austenitic steel is good weldable
 - weldable with filler metall
 - approved filler metall
 - weldable without filler metall
 - plasma welding and TIG welding as established processes
 - laser welding
- welding processes are approved by classification societies
 - process audit
 - audited welders
 - quality assurance system
 - material certificates
 - certificate of conformity



The aim of the LPT-S project is an AIP.

Thank you very much for your kind attention.

MariGreen
Maritime Innovationen in Green Technologies



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