INTRODUCTION TO CRYOGENIC STORAGE TANKS
Applicable code

Storage Tank Design

ATM

AWWA API 650

P<2.5 Psi

BS 2654

EN 14015

API 620

EN 14620

LPS

2.5 < P < 15 Psi

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TYPES OF STORAGE

- REFRIGERATED STORAGE
- PRESSURIZED STORAGE
- ATMOSPHERIC PRESSURE STORAGE

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LIQUIFIED GASES

- BUTANE  -0.5
- BUTADIENE  -4.5
- AMMONIA  -33
- PROPANE  -42
- PROPYLENE  -47
- ETHANE  -88
- ETHYLENE  -103
- METHANE  -161
- LNG  -161
- NITROGEN  -195
- LNG  -161
- NITROGEN  -195
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Types of cryogenic tank

- SINGLE CONTAINMENT
- DOUBLE CONTAINMENT
- FULL CONTAINMENT
1 primary container (steel)
2 bottom insulation
3 foundation
4 foundation heating system
5 suspended roof (insulated)
6 roof (steel)
7 loose fill insulation
8 outer steel shell (not capable of containing liquid)
9 bund wall
1 primary container (steel) 6 suspended roof (insulated)
2 secondary container (steel or concrete) 7 roof (steel)
3 bottom insulation 8 loose fill insulation
4 foundation 9 outer shell (not capable of containing liquid)
5 foundation heating system 10 cover (rain shield)
1 primary container (steel)  
2 secondary container (steel)  
3 bottom insulation  
4 foundation  
5 foundation heating system  
6 suspended roof (insulated)  
7 roof (steel)  
8 loose fill insulation  
9 concrete roof  
10 pre-stressed concrete outer tank (secondary container)
FULL CONTAINMENT

VAPOUR DISPERSION SCENARIO

CREDIBLE SPILL (by EN1473) for SINGLE CONTAINMENT

Tank Complete Failure

Vapor

Plant fence

Public Facilities

2.5 ~ 3 km

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FULL CONTAINMENT

CREDIBLE SPILL (by EN1473) for DOUBLE CONTAINMENT,
FULL CONTAINMENT

CREDIBLE SPILL (by EN1473) for FULL CONTAINMENT

PRV

Plant fence

Public Facilities

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Today’s Tank Marketplace

- All USA new and proposed grassroots LNG facilities are full containment
- Not just an LNG issue
- Products more dangerous than LNG
  - Ammonia
  - Ethylene
- Today’s Ammonia tanks mostly full containment.
Cryogenic storage tank general section
Performance criteria

The tank shall be designed so that:

- Under normal operating conditions, the liquid and the vapour is contained;
- It can be filled and emptied at the specified rates;
- Boil-off is controlled and in exceptional cases can be relieved to flare or vent;
- Pressure operating range specified is maintained;
- Ingress of air and moisture is prevented, except in exceptional cases when the vacuum relief valves have to be used;
- Boil-off is as specified and condensation/frost on the external surface is minimised. Frost heave of the foundation shall be prevented;
- Tank shall resist seismic forces;
Specials in cryogenic storage tank

- Mechanical design
- Thermal design
- Boil off rate
- Insulation
- Foundation
- Frost heave
- Roll over
- Cool down
- In tank pump

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Thermal design & insulation

- **Direct**
- **Diffuse**
- **Wind**
- **Ground Reflection**

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Expansion bellows
Insulation (perlite blocks)

Graph showing the compressive strength in kg/cm² over days for perlite cement ratios of 0.3125 (blue line) and 0.4375 (red line).
Insulation (Loose perlite)
There are two distinct types of base slab on ground type:

- **On Ground Type**
- **Elevated Type**
Foundation type selection

- **On ground type**
  - Good soil condition required.
  - Concrete slab required
  - Electric heaters are installed into the slab to avoid frost heave.
  - Small initial investment
  - Large running cost

- **Elevated type**
  - Poor soil condition
  - Piles are required
  - Large initial investment
  - Small maintenance cost
  - Elevated height is around 1.0 m to 1.5 m
heating system

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Cool down procedure (Cool down ring)
Cool down procedure (Cool down ring)

- Very Sudden change of metal temperature.
- Large temperature gradient between neighbor points.

BOG
VENTED GAS
SPRAY RING
LNG

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Cool down procedure (Cool down spray)
Cool down procedure (Cool down spray)

- Slow change of metal temperature.
- Low temperature gradient between neighbor points.

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IN TANK PUMP

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Thank You