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IGU

Current Situation and Considerations on LNG cold energy utilization

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AGA American Gas Association

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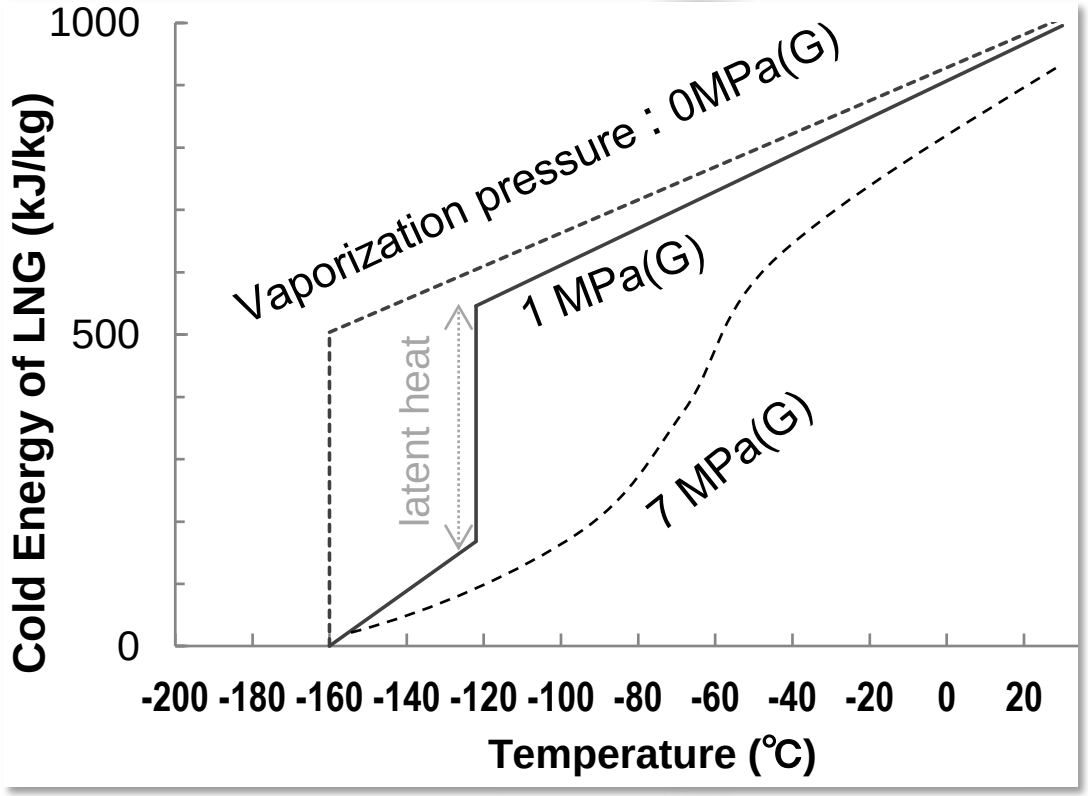
➢ A significant quantity of LNG cold energy is available

- Examples of LNG cold energy utilization
- Energy Savings
- Considerations on installing equipment

◆ Trends of LNG cryogenic energy utilization



Types of LNG Cold energy utilization

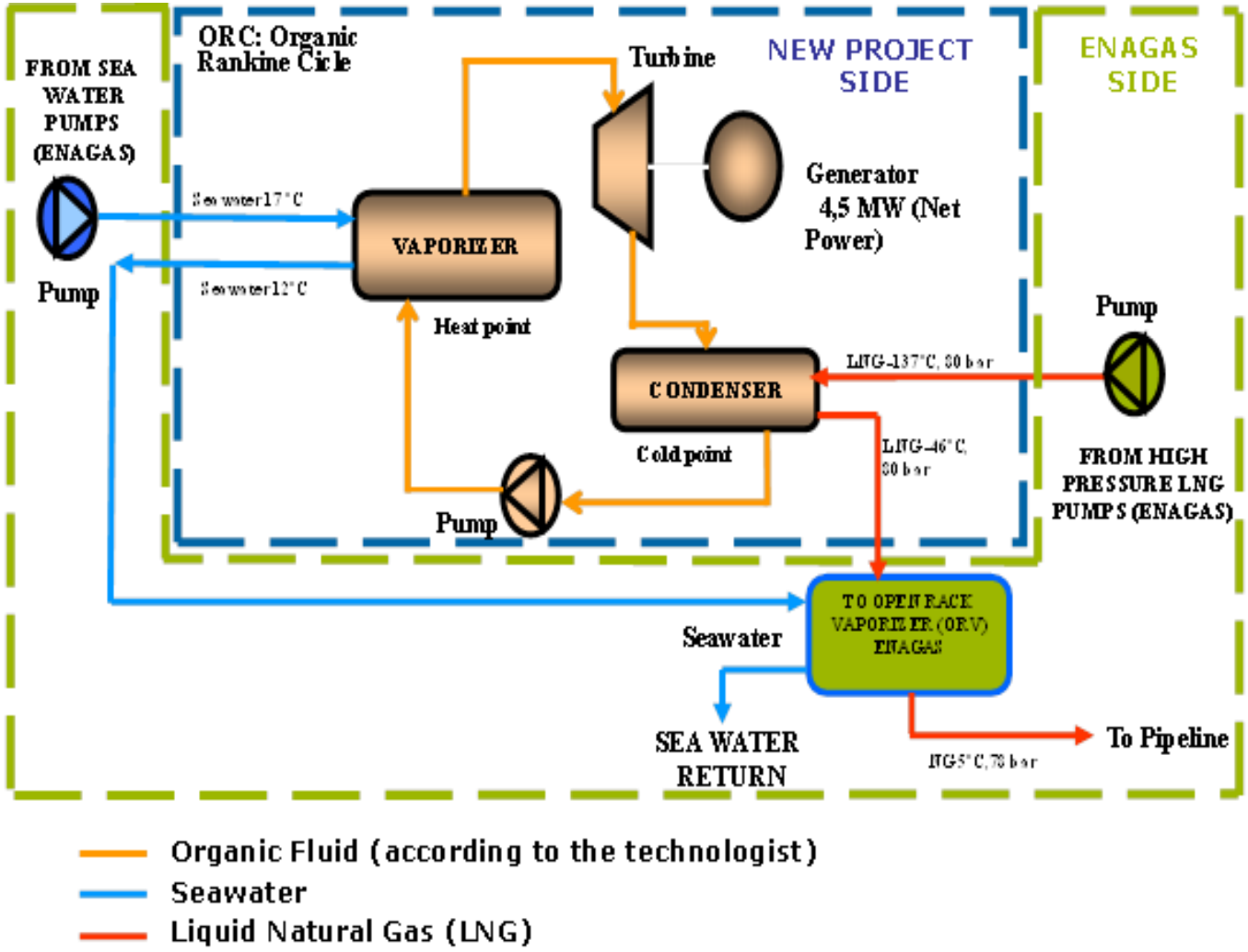
- Cryogenic Power Generation
- Air separation
- Liquefied carbon dioxide and dry ice
- Cryogenic energy Processing of rubber, plastic (frost shattering)
- LNG-BOG Re-liquefaction・LNG-BOG Recovery optimization
- Refrigerated warehouses

- Cryogenic Power Generation -

■ Huelva LNG Terminal（Enagás, Spain）

Huelva's Rankine cycle

Parameters	Values
Regasification Pressure	77 / 88 bar
LNG flow rate	265 / 128 t/h
Organic Rankine Cycle	
Generated net power	4.6 / 1.8 MW

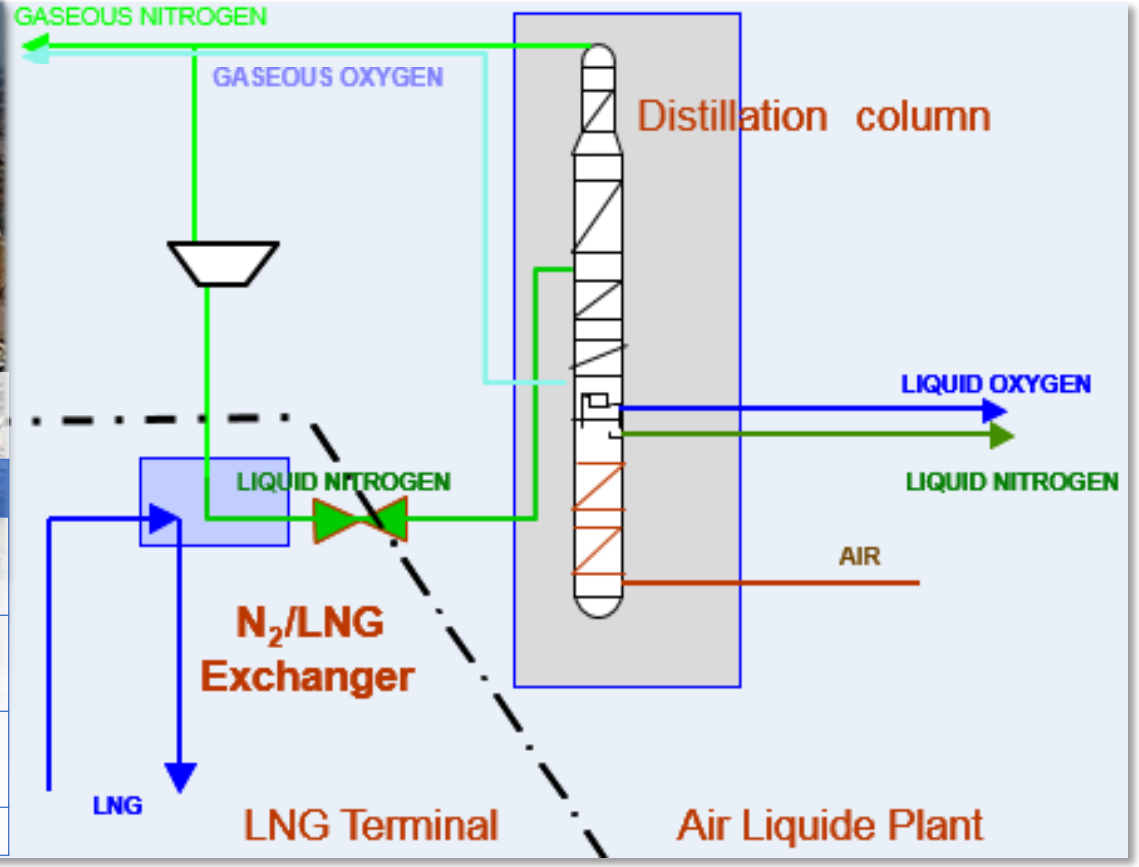


- Air separation -

- Synergy between Fos Tonkin terminal and Air Liquid plant (France)

Air Liquide Plant

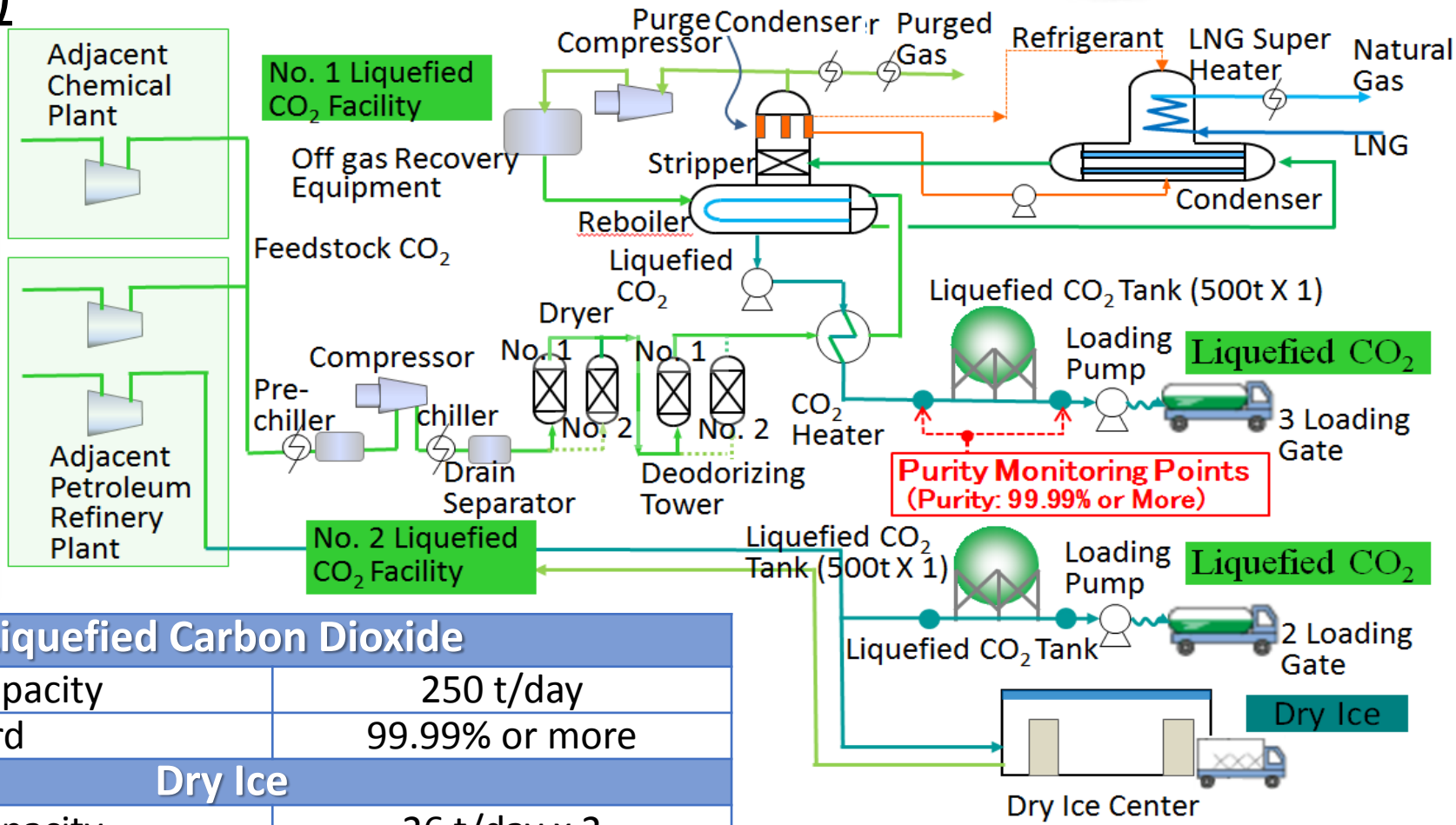
Parameters	LNG	Nitrogen
Operating Pressure	45 / 72 / 82 barg	33 / 36 / 55 barg
Operating Temperature	-160 / 160 / 20 °C	-110 / 8 / 20 °C (Inflow)
Flow-rate	100 / 585 / 900 m3 LNG/h	84000/ 113000 Nm3/h
Operating Temperature : -150 °C (Outflow)		



- ✓ Important electricity saving for the Air separation company as the traditional liquefaction process of Nitrogen is a very high energy-consumer
- ✓ Lower need of warmth for the LNG regasification process

- Liquefied carbon dioxide and dry ice -

Kinki Ekitan（Japan)

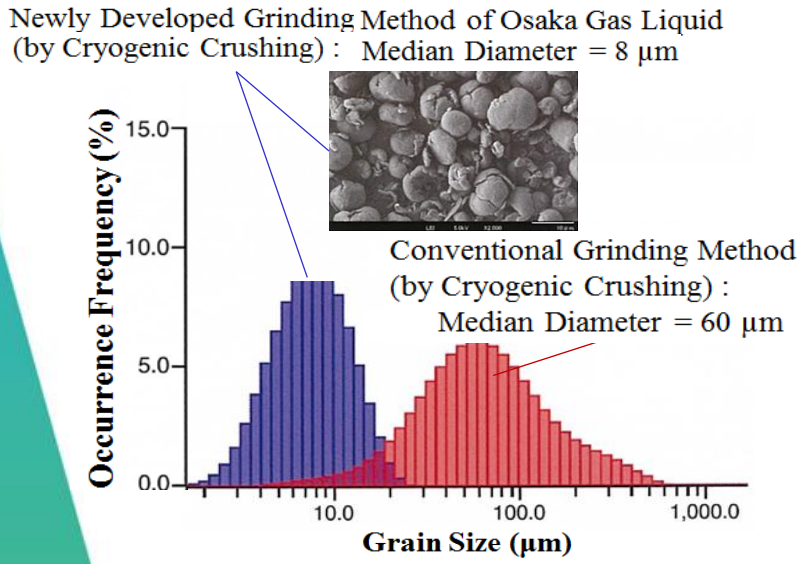


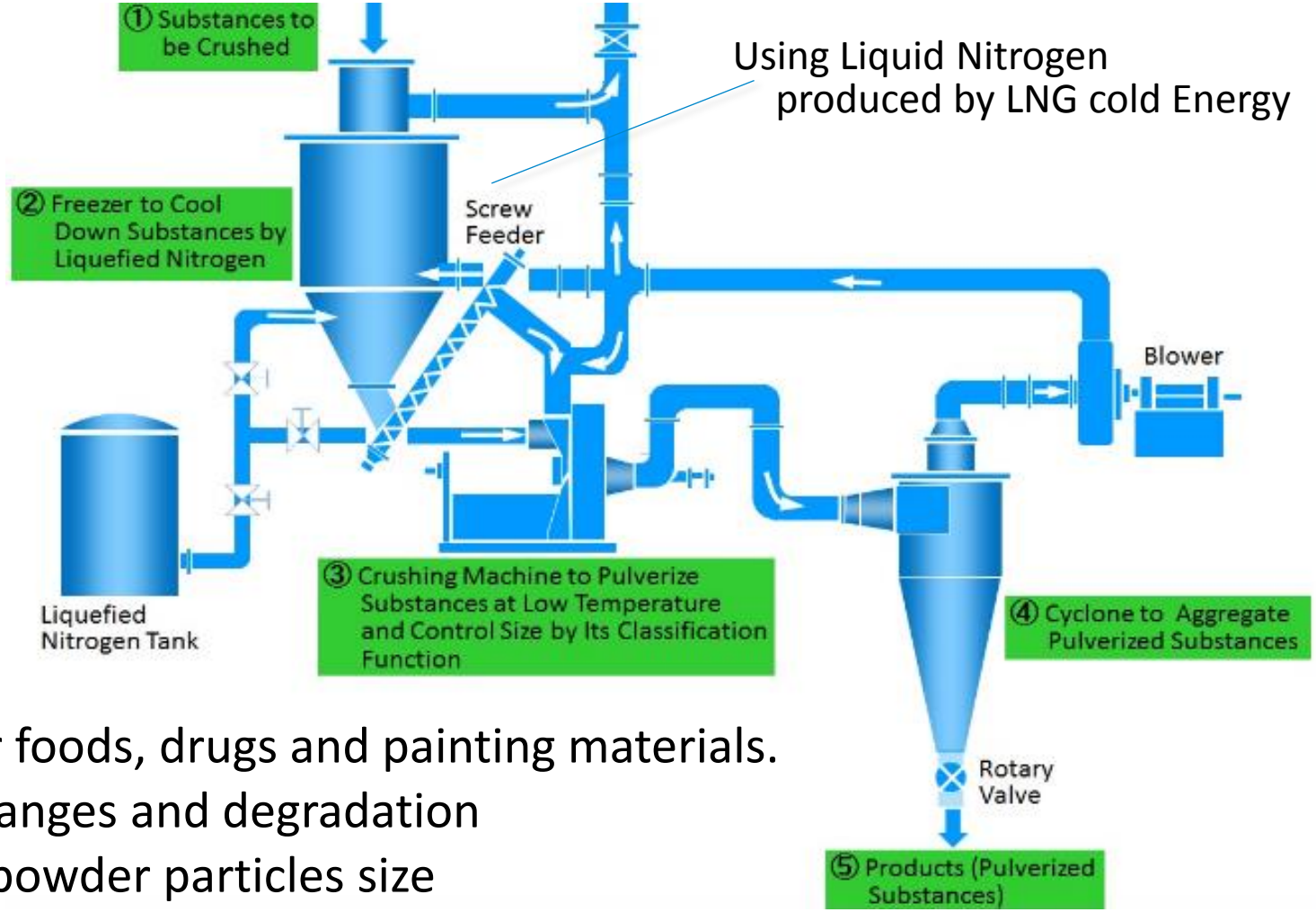
Liquefied Carbon Dioxide	
Production Capacity	250 t/day
Purity Standard	99.99% or more
Dry Ice	
Production Capacity	26 t/day x 2

✓ The Electricity consumption in producing carbon dioxide by about half, since it can produce it at a lower pressure and temperature

- Frost shattering /Cryogenic Crushing -

■ Osaka Gas Liquid Company, Ltd.（Japan）



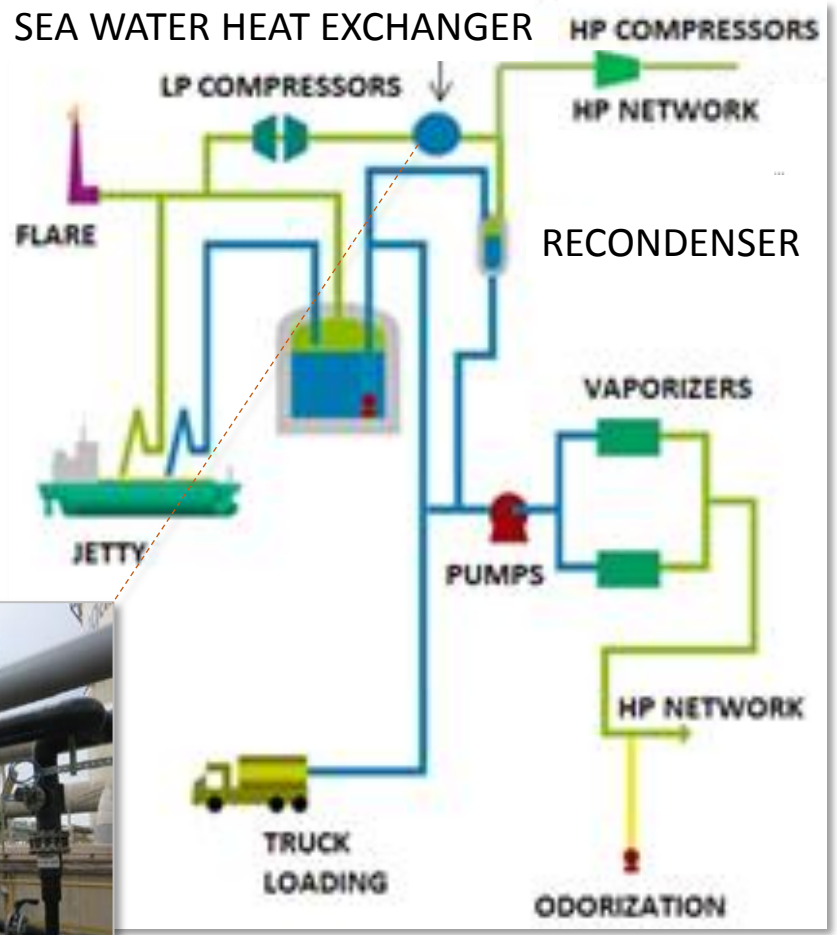


- Increasing demand for foods, drugs and painting materials.
  - Reduces property changes and degradation
  - Good control of the powder particles size
  - Crush easily material with low melting points / high elasticity / oil- or water-rich

- LNG-BOG Recondenser/Recovery optimization -

■ Cartagena LNG terminal （Spain）

- The sea water heat exchanger was installed between LP compressors and recondenser
- BOG temperature is reduced in 50°C.



BOG/sea water heat exchanger

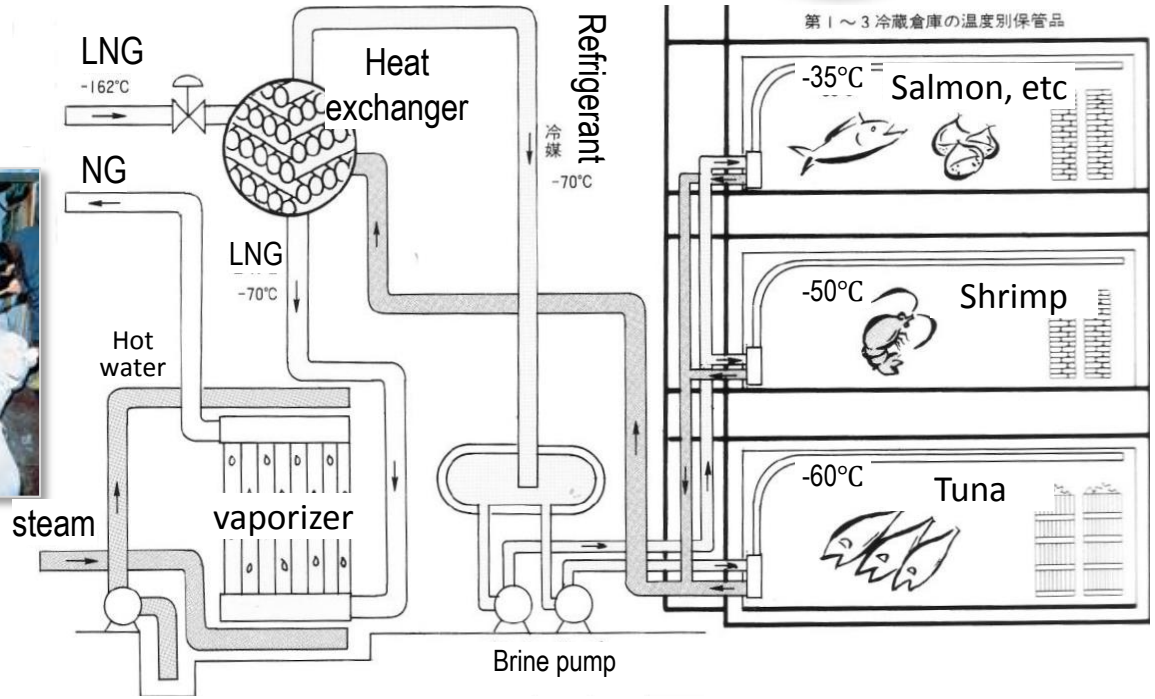
Flow rate BOG (Shell side) : 30 000 kg/h
Sea water flow rate (plate side) :150 m^3/h

- ✓ The BOG recovery rate is increased by almost 15%
- ✓ Reduce OPEX of HP and LP compressors at low send-out rates

- Refrigerated warehouses -

Japan Super Freeze (Japan)

Negishi terminal and Japanese super freeze



- LNG is supplied from the neighboring Tokyo Gas Negishi terminal and a cryogenic warehouse utilizing cold heat generated when LNG vaporizes is installed.
- The warehouse inside temperature is managed in the range of -40 to -60 ° C.
- Higher grade marine products such as tuna, fish eggs and shrimp are preserved.

✓ This cryogenic warehouse equivalent to 50% of the domestic super freeze warehouse (below -40° C) capacity in the metropolitan area

◆ Trends of LNG cryogenic energy utilization business

■ Japan

- Most of the LNG terminals (30000 t/y >) carry out some sort of LNG cold energy utilization.
- Some satellite terminal (< 10000 t/y), gas turbine intake cooling
- Liquid hydrogen production attached to air separation equipment.
- Metal recycling from waste such as home appliances crushed using LNG cryogenic energy

■ Spain

- A New Company has been developed by Enagás named “e4efficiency Ltd”. Market study near LNG Terminals has been doing :

  preservation and frozen food warehouses, dry-ice factories, the air separation industry, sea water purification, hemoglobin conservation, data centers, etc...

Thanks for your attention!