

BALSA Series

Hydrogen Liquefaction
Systems



Product Information

BALSA Series Hydrogen Liquefiers

Cosmodyne's BALSA series Hydrogen Liquefier packages range from 5 mTPD to 30 mTPD. The packages utilize industry standard equipment and turboexpander technology to provide state-of-the-art machines to support the overall process integration. Cosmodyne's innovative and patent-pending process is highly efficient and allows for proportional turndown capability up to 30% of the total production, with minimal impacts to the specific power.

Cosmodyne can provide the entire process package from pretreatment and liquefaction on to storage, trailer loading systems and fueling stations. The system will also include Cosmodyne's in-house controls package including HMI.

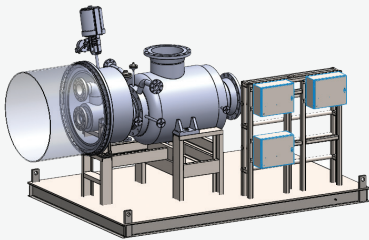
Highlights

- Over 60 years of cryogenic liquefaction design experience and over 450 cryogenic installations world-wide
- In-house oil-free turboexpander design with active magnetic bearings
- Highly efficient turndown to 30% of total production
- Small footprint, modular system for economic shipping and installation
- Rapid cold restart after shutdown

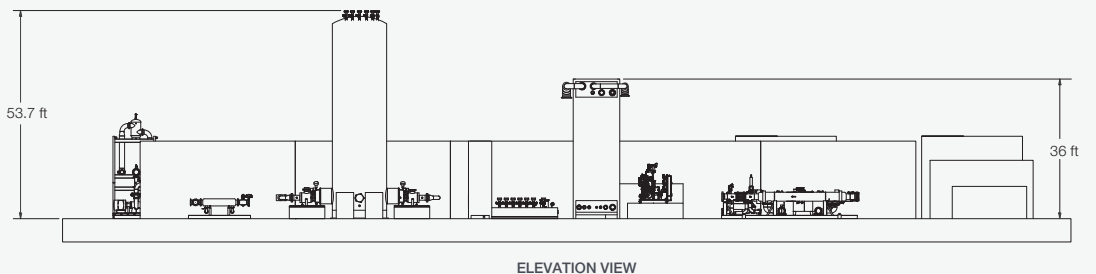
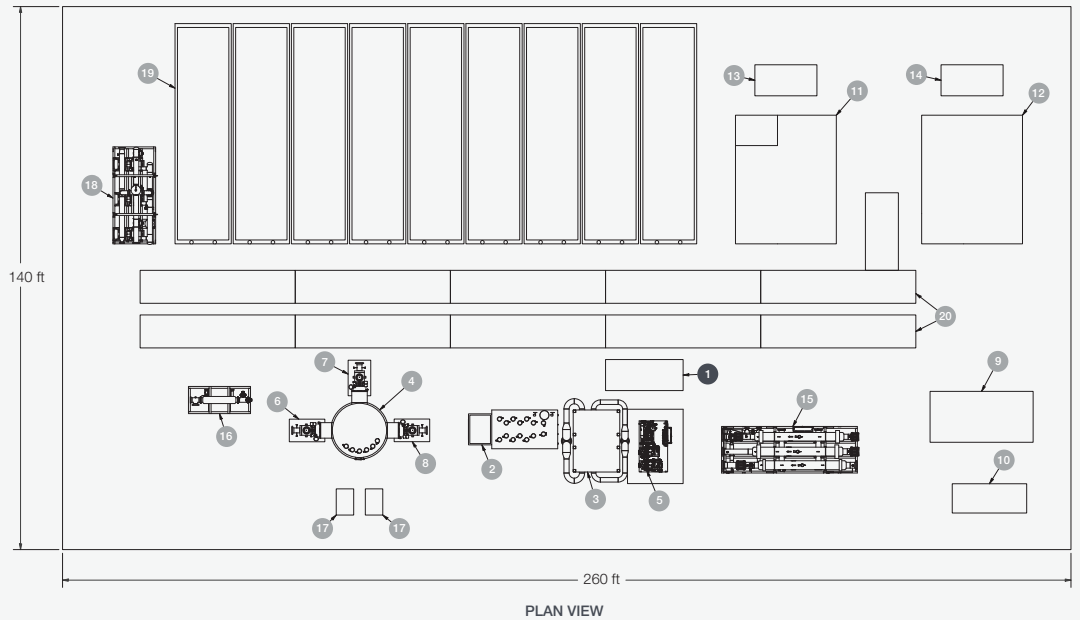
Nikkiso Competence for Liquid Hydrogen Supply Chain

Major Components	Liquefaction	Distribution
Pre-Treatment System	●	
Hydrogen Liquefier	●	
Storage Tanks	●	●
Trailer Loading	●	●
Trailer Unloading		●
Hydrogen Pumps for Trailer Filling		●
Fuel Supply System		●
Fueling Stations		●
Customer Stations		●
Vaporizers		●
Vacuum Jacketed Piping		●
BOG Management	●	●
Balance of Plant Equipment	●	●
Overall Process Guarantee	●	●
Commissioning/Installation Supervision	●	●
Maintenance Plans	●	●

● Supplied by Nikkiso ● Supplied by key partners



- 1 Inlet Pretreatment Skid
- 2 Cold Pretreatment Cold Box
- 3 Pre-cooling (80K) Cold Box Module (CBM)
- 4 Cryogenic Cooling (20K) CBM
- 5 N₂ Expander Module
- 6 Warm Medium-Pressure H₂ Expander
- 7 Warm High-Pressure H₂ Expander
- 8 Cold Hydrogen Expander
- 9 N₂ Compressors A
- 10 N₂ Compressors B
- 11 H₂ Compressors A
- 12 H₂ Compressors B
- 13 H₂ Compressors Cooler Skids A
- 14 H₂ Compressors Cooler Skids B
- 15 N₂ Expander Aftercooler Module
- 16 H₂ Expander Aftercooler Module
- 17 Vacuum Skid
- 18 Cooling Pump
- 19 Cooling System
- 20 Interconnecting Pipe Rack (optional)



Performance Specifications

BALSA Performance	BALSA-5	BALSA-15	BALSA-30
Production, mTPD	5	15	32.5
Feed Pressure, psig	250 - 350	250 - 350	250 - 350
Feed Gas Purity (Additional pretreatment available)	< 1 ppm CO ₂ < 1 ppm H ₂ O	< 1 ppm CO ₂ < 1 ppm H ₂ O	< 1 ppm CO ₂ < 1 ppm H ₂ O
Product % Para-Hydrogen (Options for ≥ 98+ % available)	≥ 95 %	≥ 95 %	≥ 95 %
Storage Pressure, psig	5	5	5
Product Temperature, °F	-421.3	-421.3	-421.3
Estimated Power*, kW	2,700	7,500	15,700
Estimated Specific Power**, kWh/kg	~12-13	~11-12	~10-11

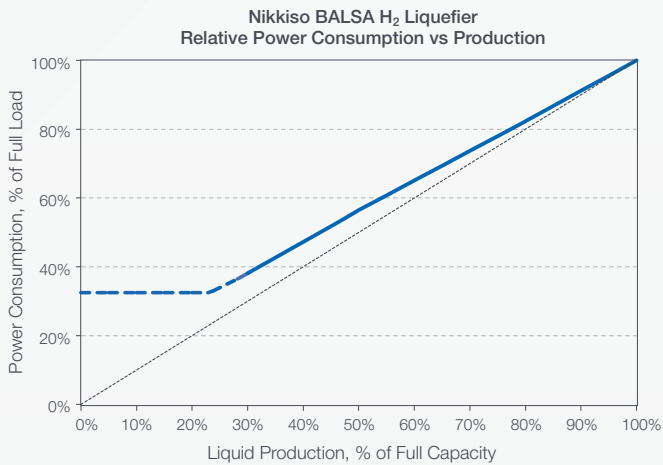
* Power is inclusive of pretreatment, precooling, liquefaction, and plantwide cooling system

** Performance is given at 95° F ambient temperature

Options and Accessories

- Additional ortho/para hydrogen conversion to achieve 98+% parahydrogen.
- Full integration with Nikkiso's truck loading system and refueling station.
- Optional interconnecting piping, support module, and vacuum jacketed piping.

Turndown Capability



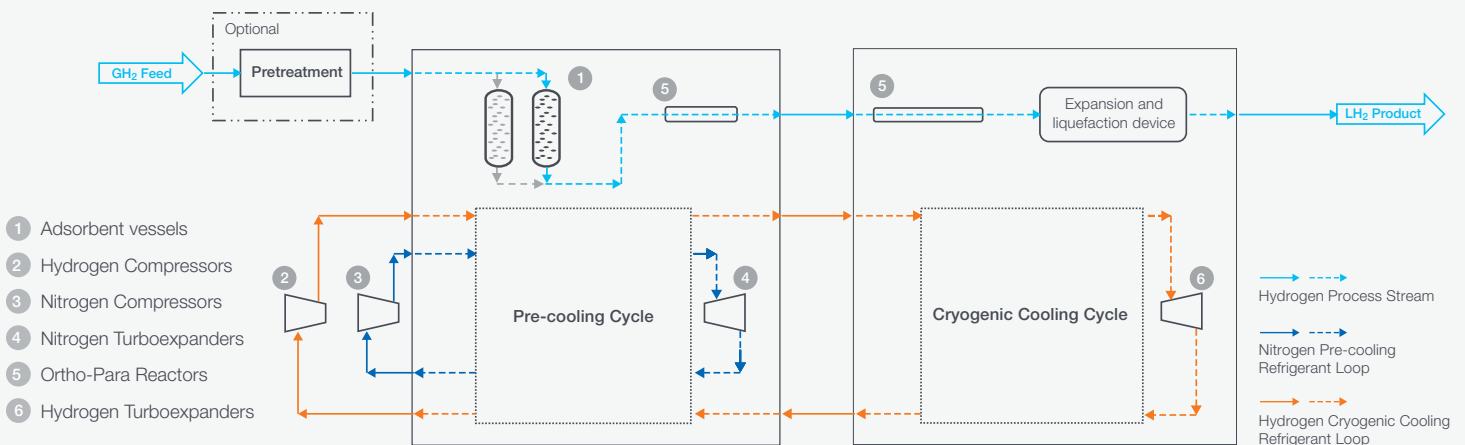
Turndown – Key Values

- 89% of max efficiency at 50% of max production
- 79% of max efficiency at 30% of max production
- Continuous operation at 30% of max production

Systemwide Benefits of Turndown

- Direct power savings
- Reduced hydrogen generation costs
- Maximize installed capacity without sold-out offtake
- Improved uptime in fluctuating grids
- Decreased energy storage capacity requirements

Block Flow Diagram





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