CRYOGENIC RECIPROCATING PUMPS
FOR LIQUEFIED GASES
THE CRYOSTAR GROUP

As a pioneer in the design and manufacture of cryogenic equipment, CRYOSTAR started out in 1967 producing cryogenic pumps for liquefied industrial gases. The company has become a major actor in the field of industrial and medical gases, clean power generation, LNG and hydrocarbon applications. CRYOSTAR brings to you over 50 years of experience and know-how.

With its headquarters located in France and Business Centers in Brazil, China, India, Russia, Singapore, the United Kingdom, and the United States of America, along with numerous partners, CRYOSTAR is always close to customers, available and ready to act. CRYOSTAR employs close to 650 people all over the world. They are CRYOSTAR’s strongest asset. Together they share the same values to support the company towards ever greater innovation, technology and knowledge.

CRYOSTAR has equipped thousands of plants. Cryogenic pumps, expansion turbines, cryogenic compressors, small scale liquefaction plants, LNG vaporizers, cylinder filling stations, and natural gas fueling stations... these are at the heart of CRYOSTAR's products range.

To optimize your plant availability and consequent uptime, CRYOSTAR also offers full service solutions: on-site installation and commissioning based on strict safety standards (24/7 technical support, service contracts, on-site training support), maintenance and repair (technology updates, factory and on-site maintenance agreements), as well as equipment lifelong recurrent and up-to-date training sessions. Through our locations based on all continents, we make sure there is always a CRYOSTAR helper near you.

VISION

VALUES

★ Innovate
★ Take up challenges
★ Have a passion for excellence
★ Be generous in what we do
★ Respect and empower our people
★ Act with integrity

We are a leading innovative company, sustainably providing proactive customer service, supported by a strong culture encompassing skilled and engaged personnel.

Samuel ZOUAGHI
President
WORLDWIDE PRESENCE
CRYOSTAR company ensures a local presence for sales and service through its business centres and business partners network.

CRYOSTAR offers solutions to minimise downtime for its machines such as maintenance contracts, spare parts management and remote maintenance.

Product specialists will give you technical assistance by phone, and can launch an urgent intervention where necessary.

* Service partners able to do service on road tanker could also modify the external piping to replace an existing type of pump with another one.
INNOVATION
At CRYOSTAR, innovation is at the heart of everything we do, not just for teams dedicated to Research & Development, but also for teams who work every day to design the equipment we sell. A community of Experts, Specialists and Referents also capitalizes on their own experience and the feedback received from customers to continue to innovate.

TESTING
Every product (be it fresh off the assembly line or recently refurbished) is subject to stringent testing on CRYOSTAR cryogenic test facility. The performance test with liquid nitrogen ensures guaranteed performance for CRYOSTAR customers. A copy of the performance test is systematically included in the instruction and operating manual delivered together with the equipment.
HEALTH, SAFETY, ENVIRONMENT

CRYOSTAR’s HSE policy is based on a double certification: OHSAS 18001 and ISO 14001 (V2015).

This structuring approach made it possible to anchor continuous improvement in the company’s culture. CRYOSTAR guarantees its machines’ compliance with customer specifications and the regulations in the country where they are installed to enable customers to operate equipment with complete confidence. Safety of both property and people is our priority.

CRYOSTAR is committed to the social and societal area for its employees’ well-being. Therefore, diversity, balance and well-being at work, are notions which CRYOSTAR views as being of vital importance through targeted actions at the heart of its human resources policy.

QUALITY

The Quality department features a large and highly qualified multi-disciplinary team, which is involved in implementing Quality strategy in areas of the utmost importance:

★ Metrology / Quality System
★ Supplier Quality
★ Operational Quality
★ Engineering Quality
★ Product Safety

TRAINING

CRYOSTAR Training Center offers training sessions adapted to all the equipment and solutions.

Theoretical courses can be combined with practical sessions, depending on the availability of the equipment on the customer’s site or in CRYOSTAR’s factory.

★ Get the best out of your equipment
★ Maintain the equipment safely & efficiently
★ Improve your awareness to increase the MTBF
TYPICAL RECIPROCATING PUMP INSTALLATION

Storage tank

Electric trim heater (optional)

Ambient Air Vaporizer

Pressure build-up vaporizer (PBU)

Thermal relief valve

Pulsation damper

High pressure safety valve

Non return

Reciprocating pump skid

Electric trim heater (optional)

Buffer filling

Gas cylinder filling racks

Gas relief valve

Industrial process
**CONVENTIONAL TANK**

- GAS
- LIQUID
- VAPOUR SEPARATOR (OPTIONAL)
- DISCHARGE

**THERMOSYPHON TANK**

- GAS
- LIQUID
- SUCTION RETURN
- SUCTION LOWEST POINT
- DISCHARGE

**BENEFITS**
- Lower gas losses
- Shorter cooling down time
- Lower dry running risk
- Ideal for full automatic & unattended operation

### Skid
- A-
- XXX
  - Cold End type
  - Piston diameter (mm)
  - Stroke (mm)

### Execution
- XX
  - OLX
  - PPC
  - SDPD
  - SRP
  - MRP
  - LDPD
  - HPP

### Crank drive
- OL: simplex
- OL1: duplex
- OL2: triplex
- OL: simplex
- OL1: duplex
- OL2: triplex
- OL3: triplex

Example: **A-MRP 40/55-T OL1**
## COMPREHENSIVE RANGE OF RECIPROCATING PUMPS

### CYLINDER FILLING PUMPS FOR INDUSTRIAL & MEDICAL GASES

<table>
<thead>
<tr>
<th>PPC</th>
<th>SDPD</th>
<th>SRP / MRP</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gases</strong></td>
<td>LCO2, LN2O</td>
<td>LO2, LN2, LAr, LCO2, LN2O</td>
</tr>
<tr>
<td><strong>Design pressure</strong></td>
<td>120bar</td>
<td>320bar</td>
</tr>
<tr>
<td><strong>Cold End</strong></td>
<td>No insulation</td>
<td>Vacuum insulated</td>
</tr>
<tr>
<td><strong>Crank drive</strong></td>
<td>Grease lubricated</td>
<td>Grease lubricated</td>
</tr>
</tbody>
</table>

## HIGH DUTY PUMPS FOR CUSTOMER APPLICATIONS & LNG

<table>
<thead>
<tr>
<th>MRP &amp; LDPD Simplex, Duplex &amp; Triplex</th>
<th>HPP Simplex &amp; Triplex</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flow rate</strong></td>
<td>340 l/min (~13'000 Nm3/h of N2)</td>
</tr>
<tr>
<td><strong>Cold End</strong></td>
<td>Vacuum insulated with long life seals</td>
</tr>
<tr>
<td><strong>Crank drive</strong></td>
<td>Oil lubricated</td>
</tr>
<tr>
<td>INDUSTRY</td>
<td>APPLICATION</td>
</tr>
<tr>
<td>----------------------------------</td>
<td>--------------------------------------------</td>
</tr>
<tr>
<td>Industrial, Food &amp; Medical Gases</td>
<td>Gas cylinder filling</td>
</tr>
<tr>
<td></td>
<td>Liquid cylinder filling</td>
</tr>
<tr>
<td></td>
<td>High pressure testing / Inerting / Wobbing</td>
</tr>
<tr>
<td>Liquid Hydrogen</td>
<td>Compressed tube trailers / Fuel cell refueling</td>
</tr>
<tr>
<td>Liquid Natural Gas &amp; Biogas</td>
<td>CNG vehicle refueling</td>
</tr>
<tr>
<td></td>
<td>Peak shaving / High pressure engines</td>
</tr>
<tr>
<td>Other gases (Liquid ethylene, Ethane, Neon, Sulfur hexafluoride…)</td>
<td>Hydrocarbon processing / Gas compressing</td>
</tr>
<tr>
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<td></td>
</tr>
</tbody>
</table>

**Pressure (bar)**

![Flow Rate (l/min) vs. Pressure (bar) Diagram]

- **MRP 40/30 OL1**
- **SRP 35/38**
- **SDPD 22/20, 30/20, 30/32**
- **PPC 35/26 & 45/26**
- **LDPD 50/55 OL1, OL2 & OL3**
- **LDPD 65/55 OL1, OL2 & OL3**
- **LDPD 88/55 OL1, OL2 & OL3**
- **HPP 75/110 Simplex**
- **HPP 75/110 Triplex**
- **215bar**
- **165bar**
- **90bar**
CRYOGENIC HIGH PRESSURE PUMPS

Maximum Safety
★ Oxygen compatible material / 100% filtration
★ Rugged coupling
★ Compliance with Pressure Equipment Directives

Minimum Product Losses
★ High vacuum insulation
★ High hydraulic efficiency insulation
★ Improved high pressure seals

Low NPSH Requirement
★ High efficiency suction valve
★ Large suction chamber
★ Improved degassing design

Maximum Reliability (longer maintenance intervals)
★ Large sealing area (thermal stability)
★ Long life low pressure seals (CRYOSTAR design)
★ Oil lubricated crank drive
**CRYOGENIC RECIPROCATING PUMPS FOR LIQUEFIED GASES**

**RECIProCATING PUMPS – DESIGN**

- Large Vacuum Insulation
  - Low NPSH requirements & faster cooldown
- Long life HP seals
  - Enhanced volumetric efficiency
- Self adjusting LP seals
  - Extended lifetime
- High efficiency suction valve
  - Low NPSH requirement & enhanced performance
- Large suction chamber with filter
  - Efficient degassing & pump protection

**HIGH DUTY PUMPS FOR CUSTOMER APPLICATIONS & LNG**

- Plug for oil fill and vent
- N2 purge inlet connection
- Heating cartridge connection
- Quick connector for oil drain with pipe
- Oil temperature probe connection
- Lantern N2 purge inlet connection
- Hot point probe connection
- Side cover with o-rings
- Oil gauge
  - minimum static level
  - oil quality check

*Available in simplex (OL1), duplex (OL2)* and triplex (OL3)*

*: for MRP and LDPD pumps
**INDUSTRIAL GASES HIGH PRESSURE CYLINDER FILLING (LO2/LN2/LAR)**

**NEW SRP 35/38 FOR SMALL & MID-SCALE FILLING PLANTS**

- **Flow rate**: Up to 15 l/min
- **Design pressure**: 380 bar
- **Power**: Up to 18.5 kW

**MRP 40/55 OL1 FOR MID & LARGE-SCALE FILLING PLANTS**

- **Flow rate**: Up to 25 l/min
- **Design pressure**: 550 bar
- **Power**: Up to 45 kW
SKID CONSTRUCTION

- Oxygen compatible lubricants
- Certified according to CE PED 97/23 / EC
- Designed and built in accordance with the Machinery Directive 2006/42 / EC Machine
- Stainless steel base frame for long-lasting durability
- Compact packaged unit including safety valves and emergency stop for maximum safety
LIQUID TO COMPRESSED NATURAL GAS PUMP (LCNG)

MRP 40/55 LNG

★ Suitable for compressed Natural Gas & Biogas vehicle refueling
★ Full instrumented for highest safety
★ Total compliance with ATEX directive
★ High reliability design with extended maintenance intervals

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
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</thead>
<tbody>
<tr>
<td>Flow rate</td>
<td>Up to 25/50/75 l/min (OL1/OL2/OL3)</td>
</tr>
<tr>
<td>Design pressure</td>
<td>400 bar</td>
</tr>
<tr>
<td>Power</td>
<td>Up to 90 kW</td>
</tr>
</tbody>
</table>
LIQUID TO COMPRESSED HYDROGEN PUMP (LCGH2)

MRP 40/55 LH2

The MRP LH2 for hydrogen has been designed to reduce to a minimum any loss of fluid during cooling down & cold standby.

- Reduced mass
- Increased insulation (vacuum volume, thermal barrier)
- Anti-radiation barrier
- Dedicated vacuum insulated suction head
- Design calculation considering all stresses related to thermal expansion

Safety warnings

- Risk of oxygen condensation on piping (liquefies at -183°C) has to be managed
- Nitrogen inerting is mandatory prior to any dismounting

Flow rate: Up to 15/30/45 (OL1/OL2/OL3)
Design pressure: 500 bar
Power: Up to 30 kW