



## TWO CRYOGENIC PUMPS SERVICING A LIQUID EXPANSION TURBINE FOR A UNIQUE TEST

With its world's most advanced **Liquid Nitrogen test facility** and thanks to **2 Cryogenic Vertical Pumps**, Cryostar has realized a unique test which can duplicate the actual performances of a liquid turbine sold to Air Liquide. Complete testing in terms of performance and sophisticated equipment sold to our customers are now part of CRYOSTAR commitment in order to assure and deliver appropriate and reliable machines in the global cryogenic market.

Let's describe the machines that Cryostar has put in place in order to realize this unique test in Cryogenics.

- Two Cryogenic Vertical Pumps which are the result of over thirty years of experience in cryogenic pump design and processes application. These VP pumps incorporate the latest developments in low temperature materials and technology. 200 of those pumps are already in operation worldwide to assist and improve the Air liquefaction process.

**These VP pumps can achieve flow rates up to 3000 l/min at pressures up to 100 bar in order to perform the test of the generator loaded liquid turbine.**

- A Liquid turbine - LTG 90 model - loaded by a generator.

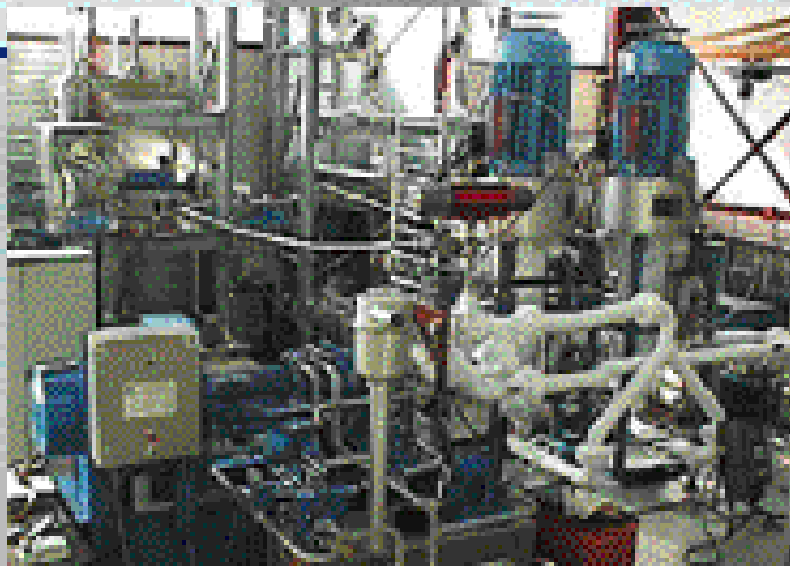
**This LTG can accept inlet pressure max. up to 90 bar and shaft power up to 300 kW in order to recover over 1,000 kW in total process plant.**

The outstanding point for this test is something unique: with our test facility and the 2 VP pumps in parallel we are now able to reproduce exactly the same conditions as these required when the liquid turbine will be in operation. Note that Cryostar can demonstrate the flexibility of this principle of Liquid Turbine during such a test by driving the pumps at variable speed.

Cryostar Liquid turbines can be used in most of the different liquefaction cycles (air separation, nitrogen liquefaction, LNG liquefaction plants, hydrocarbon processes) where they improve the liquefaction process. They are installed in parallel to the conventional Joule-Thompson (J-T) valve, which they replace during operation.

### **What benefits can our customers expect from liquid turbines?**

In most cases, a turbine can replace the J-T valve, achieving a significant improvement of the refrigeration-cycle efficiency and power savings (based on the regional price of electricity) which is lost otherwise. **Adding a cryogenic liquid turbine into your plant brings energy savings and increases annual revenues by 1 to 3%** (savings of energy or an increase of liquid production for a given refrigeration power and a given exchange surface).



The need for a liquid turbine to perform the function of the conventional J-T pressure letdown valve has been accomplished through a development of a Francis type turbine. 10 years ago the technology has proven to be fully safe and reliable.

**See following extract from BOC PP managers Neil Robertson/Jolanda Van Hout re on site performance test results - Liquid Turbine:**

«As can be seen there is a power saving of 485 kW when running with the liquid turbine c.f. the performance test without the liquid turbine. In addition the liquid turbine generated an average of 73 kW. Total power saving is therefore 558 kW and in line with predictions. The unit runs well, gives predicted benefits and, subject to a long term run, should be used (when justified) elsewhere in the group. It also gives Cryostar a satisfactory reference for 3<sup>rd</sup> party sales».

Feedback indicate the range where liquid turbines usually provide a benefit.

**Liquid turbines sizes**

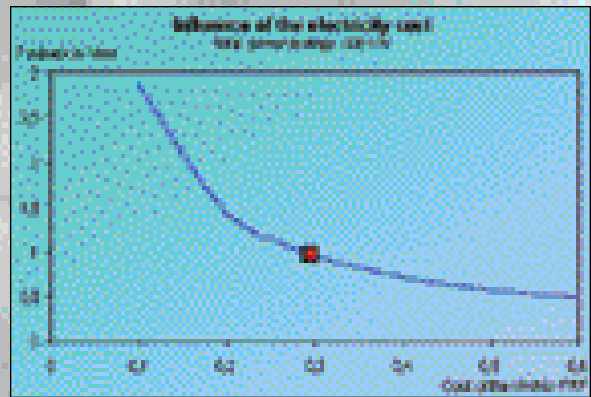
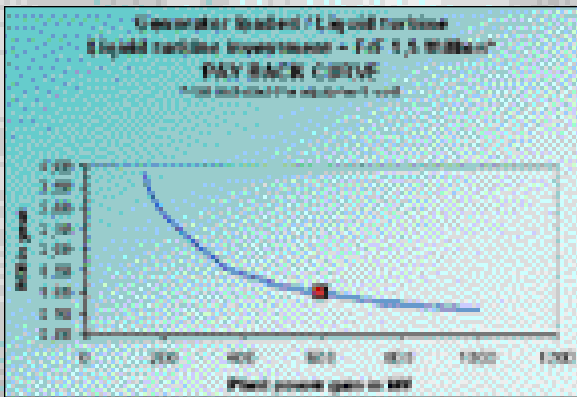
**20 - 300 kW for ASU / ALU / NLU plants.**

**500 - 1500 kW (or larger) for the natural gas industry.**

**CRYOSTAR's main references for Liquid Turbines**

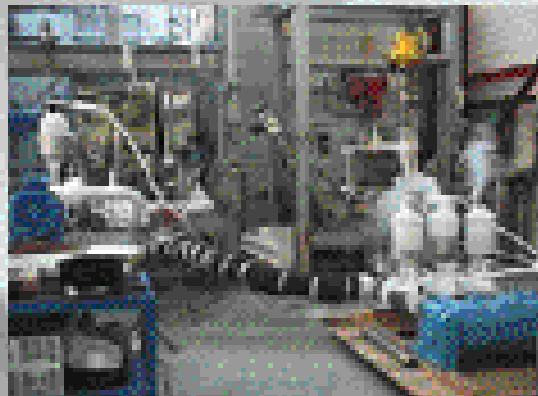
Air Liquide - BOC - Linde - Air Products

**The following diagrams enable to determine your return on investment with a Cryostar generator loaded machine**



The following table provides a summary of Cryostar evolution to show what service can be accomplished for professionals of the cryogenic market

	LN2 Test Facility		VP Pumps	Liquid Turbine
	Centrifugal Pumps	Reciprocating Pumps		
LN2 tank volume	53,000 l	16,000 l		
Flow	15,000 l 4,400 Usgpm	100 l 27 Usgpm	3000 l/min	100 000 Nm <sup>3</sup> /h
Pressure	100 bar	600 bar	100 bar	90 bar
Power	500 kW	150 kW	500 kW	300 kW
Outstanding points and particularity	<ul style="list-style-type: none"> <li>- Unique LN2 test stand in the world.</li> <li>- Liquid Turbine in parallel to the JT valve brings energy savings up to 3% and pay back can be done in a very short time (1 to 2 years).</li> <li>- CRYOSTAR is the only company in the world that can achieve such actual testing</li> </ul>			



Appart from this previous unique test and for additional information, we have made special test with high pressure Triplex pump combined with a high flow, low pressure centrifugal pump.



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