THE CRYOSTAR magazine
N°5 Spring 2005

★ Pure dynamism

Cryostar design technology leads the way in CFD

★ The win, win turbine

Cut costs or increase output, an answer to Kyoto?

★ People power

forging links with local education pays dividends

EDITO

In this fifth edition of Cryostar Magazine, I wish to draw attention to the issue of quality. Quality can have a different meaning to different people at many levels. To Cryostar it is an all-encompassing badge on which we give our guarantee to customers.

It encompasses the fact that we believe in developing products and services to suit customers' needs; that we try to employ the best people possible; and that we respond to different markets and customer needs on as flexible basis as possible.

While this also reflects the diverse nature of our customers and markets, it underscores the reason why 'quality' is the bedrock upon which Cryostar stands. In today's markets it is, quite simply, just not enough to provide 'good' equipment, 'acceptable' service or bring forth 'ok' innovations.

Our customers are always looking for an edge in a very competitive world – be it in efficiencies, reliability, service support or engineering, to name but a few. At Cryostar, we work to help them attain that edge. And our contribution is 'quality'.

From people to product we strive to deliver quality in all its forms. We check-test every order before despatch; we have a global network of support centres and engineers; above all, we have a simple ethos at Cryostar – equipment reliability and guaranteed performance through quality.

We also back this up with a transparency our customers have come to appreciate. At our state-of-the-art Hesingue facility in France, Cryostar invites customers to witness-test their equipment. It is about customer satisfaction and a transparent working relationship between our engineers and the customer.

And to ensure quality of service, we have recently expanded our abilities in Asia (China, Malaysia, Korea) and are planning further international development.

At Cryostar we are serious about our customers' businesses, their needs and expectations and we are proud that the name Cryostar is synonymous with 'quality' at every level. Today, tomorrow and into the future, 'quality' is our badge of choice.

Daniel MEYER
President

The win, win turbine

Power management and plant efficiency is climbing the agenda in many industries as governments around the world look to tackle global warming via legislation. Cryostar technology can help, and at the same time offer the choice to cut costs or increase output...

The air separation and hydrocarbon processing industries face escalating financial burdens due to rising electricity prices, and in some cases taxation, sparked by the enforcement of the United Nations' 1997 Kyoto Protocol (see panel page 5) on greenhouse gas emissions.

In response, Cryostar is offering its cryogenic liquid turbines (also know as dense fluid expanders) as a means to realising significant power savings and/or greater plant efficiency. With the cryogenic liquid turbine the total plant power savings are between 1.5 per cent and three percent depending on plant size and the process design.

Such savings enable a return on the investment in under five years, typically only two to three years. In tests conducted at one customer's plant – utilising a generator-loaded cryogenic liquid turbine – the engineer's report stated: "There is a power saving of 485kW when running the plant with the liquid turbine in comparison to the performance test without the liquid turbine. In addition the liquid turbine generated an average of 73kW. Total power saving is therefore 558kW and in line with predictions. This saving corresponds to some 2.5 per cent of the plant power."

In another retrofit installation of a cryogenic liquid turbine with oil brake, the plant power savings were in the order of 370 kW. Again, this corresponds to about a two per cent plant power saving. The extra liquid production generated by such power saving has a commercial sales value of more than 1 million Euro per year.

These results are significant and reflect Cryostar's investment in this technology over the last twenty years. Cryostar specialises in rotating cryogenic machinery for process industries. It offers compressors for pressure increase at ambient and cryogenic temperatures, pumps for cryogenic liquids and liquefied gases, expansion turbines (turboexpanders) for air gases and hydrocarbon gases operating from ambient to cryogenic temperatures.

So it was only natural that to enhance its service offering, Cryostar engineered turbines for cryogenic liquids. These turbines expand a liquid gas, mostly a cryogenic liquid gas, from supercritical pressure into the liquid region and sometimes partially into the two-phase region of vapour and liquid.

To built such equipment requires an outstanding degree of technical knowledge of high speed rotating machinery, hydraulics and aerodynamics and especially of cryogenics. Cryostar combines these different engineering disciplines within one organisation which enabled the development today's cryogenic liquid turbine.

Demand for such technology is driven by the process industry, especially the industrial gases industry which continuously looks for greater efficiencies. Any air separation and liquefaction plant economy is driven by the electricity cost and overall plant efficiency, because the raw material (air) is free. The cryogenic liquid turbine meets this criteria exactly, offering a choice of improving efficiency or increasing production for the same input of energy.

Development started in 1982, when Cryostar designed the first cryogenic liquid turbine, generator-loaded, with significant liquid gas flashing in two phases at the turbine outlet. To accommodate the flashing, the turbine was built with a Pelton wheel. During start-up in summer 1983, different problems with the shaft sealing and the Pelton nozzles occurred. However, Cryostar engineers solved the teething problems and boosted the original turbine efficiency of 33 per cent to 36 per cent to above 70 per cent with flashing liquid nitrogen.

In 1986, Cryostar developed a turbine using a Francis-type wheel. For simplicity, the turbine was equipped with oil brake only, which meant that the recovered energy from the cryogenic liquid was diminished in a braking oil cycle.

Josef POZIVIL, Cryostar director of R&D, said: "This looks like a waste, but it's not. One must understand that for any kilowatt of energy, which is subtracted from the process at cryogenic liquid temperature one can save five to eight times more energy at the warm compression process end.
This is the saving which significantly improves the process power consumption. For low power cycles it is not worth recovering the energy from the cryogenic liquid turbine, but if the turbine power is higher, say above 50 to 80kW, the liquid turbines are built with electric generator loading for power recovery."

Of special note is the fact that the cryogenic liquid turbine can be easily installed in existing plants as a retrofit in parallel to the Joule-Thompson (J-T) expansion valve. Also the turbine operation is simple, just like the operation of the J-T valve. The plant load control signal acts on the turbine inlet nozzle actuator for nozzles opening and closing.

When developing a product like the cryogenic liquid turbine, and to get the major customers acceptance, rigorous testing is required. Cryostar therefore performs full-load full-speed string tests in liquid nitrogen cycle. For this test the turbine is driven by two large liquid nitrogen pumps in a

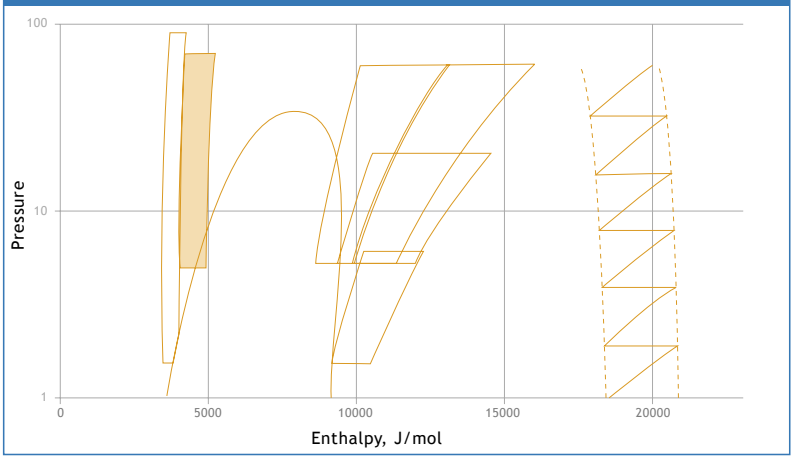
Fast facts

In the process industries there are different unit operations. Typical unit operations are pressure increase, pressure decrease, heat exchange, condensation, boiling among many others. The pressure increase is typically done for liquids by pumps and for gases by compressors; and the pressure decrease by turbines. There are many different turbine types: for gas or vapour pressure decreases the gas turbines and steam turbines for power generation and expansion turbines for process gas cooling; for liquid (mostly water) pressure decrease the Kaplan, Francis and Pelton turbines for power generation.

closed cycle. As with all Cryostar offerings these turbines are proof-tested as reliable and come with the company's performance guarantee.

For power-hungry industries, the Cryostar cryogenic liquid turbine is a crucial technology. And managing electrical consumption will continue to grow in importance as the Kyoto Protocol on global warming begins to bite.

Liquid turbine process in Log Pressure-Enthalpy diagram



Models available

Cryostar has developed a full range of dense fluid expanders suitable for the process industries for different applications, e.g. for expansion of cryogenic liquids, liquefied gases and other flashing liquids.

Based on the power capability of the models in the table above it can be noted, that the units up to the LTG 200 size are mostly utilized by the air separation process industry. The other larger models are for other process application in oil and gas industries.

Model Liquid turbine	Power dissipation	Power (kW)	Inlet pressure (bar)	Turbine casing (inch)
LTP 60	Oil brake	30	30 – 80	2 x 2
LTP 70	Oil brake	60	30 – 80	3 x 3
LTG 70	El. generator	150	30 – 80	3 x 3
LTG 90	El. generator	300	30 – 80	3 x 3 , 4 x 4
LTG 120	El. generator	450	30 – 80	4 x 4 , 6 x 6
LTG 200	El. generator	750	30 – 80	6 x 6 , 8 x 8
LTG 300	El. generator	1500	30 – 100	8 x 8 , 12 x 12
LTG 400	El. generator	2500	30 – 100	8 x 8 , 12 x 12
LTG 500	El. generator	3500	30 – 100	12 x 12 , 16 x 16

Kyoto Protocol

The Kyoto Protocol states that developed countries must reduce their emissions of six key greenhouse gases, including carbon dioxide, methane and nitrous oxide, by at least five per cent below their 1990 levels before 2012.

Some 141 countries, accounting for 55% of greenhouse gas emissions, have ratified the treaty. Large developing countries including India, China and Brazil are not required to meet specific targets for now.

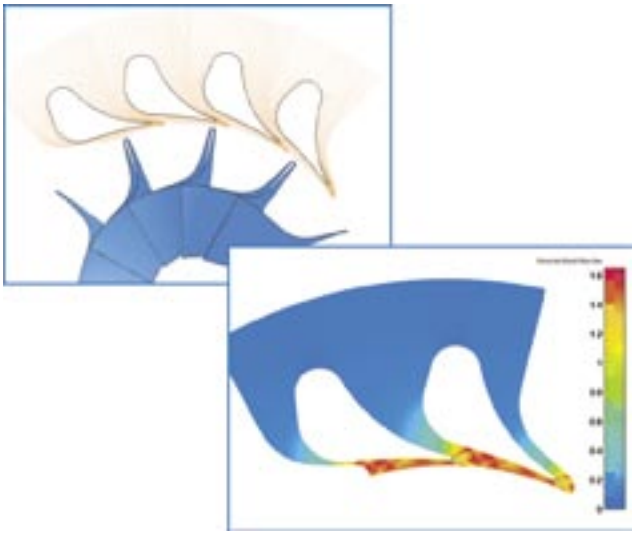
Nozzle studies

Cryostar prides itself on the innovative use of technology to ensure customer orders are delivered on time and to specification. Here, Cryostar magazine looks at the latest edition to the company's cutting-edge equipment test facility in Hesingue, France

It's pure dynamism

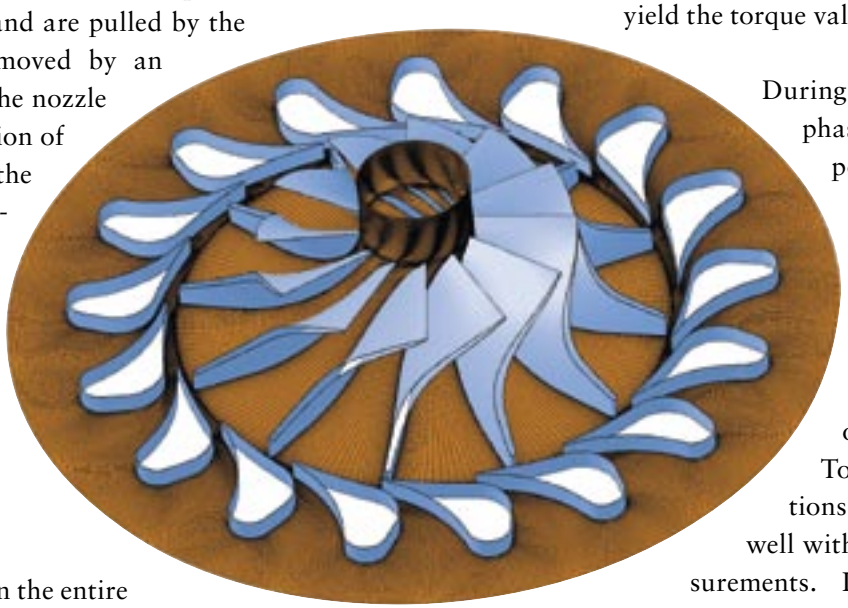
Computational Fluid Dynamics (CFD) is now fast and accurate and has been integrated in the turbo machinery design cycle at Cryostar. CFD is mainly used to simulate turbine and compressor stages as part of the company's stringent quality control.

It allows Cryostar design engineers to visualise certain flow areas inside a machine, which are impossible to reach by flow measurements, especially under cryogenic on-site conditions. At Cryostar, CFD is also used for axial thrust predictions and seal gas calculations.



Applications

Cryostar has used this technology on orders for big frame size hydrocarbon machines such as T400 and T500 frame size (where the 3-digit number indicates the nominal tip diameter on the expander wheel). For these, the expander inlet pressure was in a range between 60 and 150 bars. To keep the best efficiency over a wide flow range, variable geometry nozzles are used. Basically the nozzles are allowed to rotate around their pin located close to the trailing edge and are pulled by the displacement of a disk moved by an actuator. The torque on the nozzle pin, resulting from the action of the gas flowing around the nozzle, is an important parameter to dimension the actuator and nozzle assembly parts. A state of the art commercial CFD code helps us to accurately predict the torque.



How it's done

First, a mesh is generated in the entire expander stage; the number of cells approximates 600,000. Secondly, the 3D Reynolds Averaged Navier-Stokes equations are solved together with a Spalart-Allmaras turbulence model for closure. The first cell width is imposed so that the averaged y+ is 1.

Complete thermodynamic tables, to account for the real gas complex behaviour, generated by a commercial fluid properties software are read directly by the CFD code. Finally, CFD-predicted static pressure on the nozzle is integrated relatively to its pivot position to yield the torque value per nozzle.

During the design phase, the pivot position is optimised to reduce the torque as much as possible for all nozzle openings. Torque predictions match pretty well with on-site measurements. In summary, CFD technology is now an integral part of Cryostar's state of the art test facility.

Focus on Cryostar UK

Established for twenty years, Cryostar UK is a highly focused, professional business staffed by dedicated and skilled engineers and support personnel. Customers far and wide now depend on its expertise to deliver the right solutions on time, every time...

Second to none!

Quality, rapid response, dedicated after sales service – these are the watchwords that drive the staff of Cryostar UK. And such is the success of the business that it is now a service hub in the international Cryostar organisation, serving customers not just in the UK, but in Ireland, Scandinavia and across northern Europe.

The expertise of Cryostar UK even enables the business to reach as far as India, meeting customer needs in pumps, servicing of industrial gas products and spare parts–backed up by a major support and service network

The backbone of Cryostar UK is its operations department where skilled engineers and experienced support staff look to build partnerships with customers, to understand their needs and deliver cost-effective solutions.

Between them, the department's skilled technicians can boast more than 50 years experience on working with turbo machinery. All are equally able to deliver top quality service, no matter where the work needs to be carried out – in the field or in the workshop, it makes no difference to the Cryostar UK team.

And to ensure its engineers can meet customer requirements rapidly, Cryostar UK has invested in hundreds of thousands of GB pounds worth of ready-to-use stock. This strategic investment provides Cryostar UK with an after sales service edge that is second to none.

In fact, the quality and efficiency of its service offering is such that it is now a pivotal provider of resources and expertise for Cryostar customers internationally. Its partnership approach has also seen Cryostar UK extend its stock management system service to customers – managing, for one customer alone, an inventory worth £1.4 million.

Cutting edge

As part of its commitment to customers, Cryostar UK also operates a cutting-edge facility to test and repair pumps and turbines under cryogenic operating conditions. Again, this offering is all about rapid response, equipment reliability and the Cryostar guarantee of performance.

The facility includes

> Oxygen clean repair area
> Cryogenic Nitrogen test facility with 75Kw variable speed
> Test repair of mechanical seals
> Degreasing /washing for oxygen use
> Balancing to standard Q1 for up to 40kg
> Pressure testing up to 200bar (relief valves)
> Road tanker servicing and secure compound; and
> Lifting facilities up to three tonnes

Education and recruitment the two-way street

Since a company is only as good as its people, Cryostar pays special attention to the recruitment and career path of its staff. A major part of this strategy is forging links and partnerships with local education bodies...

For some staff the recruitment process starts directly at school. Like a scout for a football club, Cryostar is always on the lookout for those students at the top of their game with the right attitude.

To enable Cryostar access to a pool of emerging talent, the company works in partnership with two colleges of Mulhouse University, namely ESV (sales / marketing) and EIA (Purchasing / Supply Management).

Philippe Kuter, director of Ecole Internationale de l'Achat, Mulhouse University, said: "Our aim is to train junior purchasers. As a matter of fact, we recruit young technicians and train them in purchasing techniques, so that they can lead global projects including technical, organisational and business-related projects.

"Our partnership with Cryostar means the company is well placed and informed to employ our students when they end their studies. It also sponsors events such as our 'Negotiation Challenge', involving purchase and sales students. To date, Cryostar has employed five of our students over the last three years."

This partnership is very much a two-way street. In return for a recruitment forum, Cryostar is committed to the two colleges and their educational excellence.

Confirms Philippe Kuter: "Cryostar staff teach our students the purchasing techniques used in the real world and that provides them with practical up-to-date know how. More over, Cryostar executives are involved in demonstrating what being a manager is all about, transferring real interpersonal and ethics skills to our students."

Students tend to be chosen by Cryostar when they enter the university and are recruited as apprentices for a two-year period. During this phase, they spend half their time at Cryostar and half at Mulhouse. This way they learn the theory and the practical side of the job.

It also provides Cryostar with the opportunity to get to know the students and to assess whether they fit with the company's needs and culture. Every year Cryostar organises a trophy – the Cryostar Cup – for the students with the best negotiation skills.

At the age of 25, Laurent Reichenshammer is Cryostar's sales engineer responsible for Central and Eastern Europe. "I completed an apprenticeship with Cryostar while studying for my Mechanical Engineering degree (IUT GMP Mulhouse), and my diploma from the Business School ESV Mulhouse," said Laurent. "The fact that I had been in a professional environment for four years allowed me to build up valuable experience before starting my career.

"During my time in Cryostar I have passed through many departments, such as engineering, administration, project management, and marketing and sales. And thanks to the international structure of the company I even had the chance to spend nine months in the USA, in the business unit located in Whitehall, Pennsylvania."

27-year-old Jonathan Dreyer is purchasing manager for Cryostar USA and lives in California. He first came across Cryostar while at Mulhouse University where the company's operations and purchasing director, Christian Misbach, was his purchasing and negotiation tutor.

Said Jonathan: "At the time, Cryostar impressed me as a company really committed to being ahead of the curve in terms of purchasing, industrial practices and just in the Cryostar way of thinking.

"However, after I passed my exam I joined a huge company where people weren't valued as highly. For this reason I decided in 2003 to apply to Cryostar. All those positive images of Cryostar I picked up at university and what I learned from Christian Misbach, combined to make me realise it was a company I wanted to be a part of."

Now, for Jonathan, everyday is different from the day before. "Working in this company requires you to be very reactive, able to work autonomously, and have a great deal of methodology and technical knowledge," he admits. "But I love that and I will never regret my choice. As long as you prove your capabilities, involvement and willingness... Cryostar will do everything to help realise your ambitions. And that's a great thing."

Laurent Reichenshammer added: "Cryostar is a great opportunity for students looking for an internship, or an apprenticeship, in a cutting-edge environment with modern work practices and international possibilities. I have done well so far but I am aware that even now, my learning and development has only just begun."

In conclusion, Mulhouse University's Philippe Kuter said: "This partnership with Cryostar provides our students with the key to door to enter professional business life, while we, as teachers, get real support for our courses. Long may our relationship continue and grow in the future!"

News

Everyone wins with us!

Cryostar's Middle East Win With Us competition has been won by Mahmood Javed from Abdullah Hashim Gas. His prize is a three-day return trip for two to France, flights and hotel included, and a visit to the main Cryostar site here in Hésingue.

Congratulations also go to A. Adhikari, from AIGCO and A. Reza Gharegozlou, from Prime Co. Middle East, as second and third winners respectively. Each receive money-off vouchers for Cryostar spare parts.

Everyone who took part in the competition received a Cryostar desk clock or other goodies.

Entries, by post fax and the internet, were staggering – more than tripled the industry average with over 87 per cent of those taking part confirming they had learned something new about Cryostar.

Following the success of this competition, Cryostar hopes to extend the formula to other regions. The aim is to raise awareness of Cryostar, its capabilities and values and entrants are asked to answer three simple questions about the company.

Asian strategy

Reinforcing its commitment to Asian customers in Malaysia and South Korea, Cryostar has made a number of strategic moves. In China, it is setting up a fully equipped business centre in Hangzhou, the capital of Zhejiang province.

While in Malaysia, Cryostar now provides distribution and product services also covering the adjacent countries of Thailand, Indonesia and the Philippines. In South Korea, Cryostar has also recently certified its agent Tachyon to provide local maintenance services on distribution equipment.

For further information on these and other developments, please contact your local Cryostar representative.

International standard

Cryostar has achieved international recognition for its achievements in quality management systems. Lloyd's Register Quality Assurance (LRQA) awarded the company ISO 9001: 2000 for the design, manufacture and servicing of equipment offerings. LRQA is one of the world's most renowned 'third party' management system certification bodies.

Cryostar has also renewed the EC certification of conformity in accordance with the requirements of the pressure equipment directive 97/23/CE and relevant regulations (modules H and H1).

Innovation with Certification

A new high-pressure gas-filling valve could hold the key to fast change-out and minimum maintenance downtime. Its cartridge design is innovative and the valve is easily convertible for automatic operation

Cryostar, in partnership with Tecnocryo, has designed a new high-pressure gas-filling valve. The main innovation of the new valve is its easy conversion from manual to automatic and the cartridge concept for quick maintenance, said Hamid Ouali, Business Manager for Cryostar Automation.

The valve can be converted while keeping the main valve body intact, including internal parts. No change in the valve body means that there is no need to disassemble the valve from the piping for upgrading. There is equally no change required to either the skid shape or style.

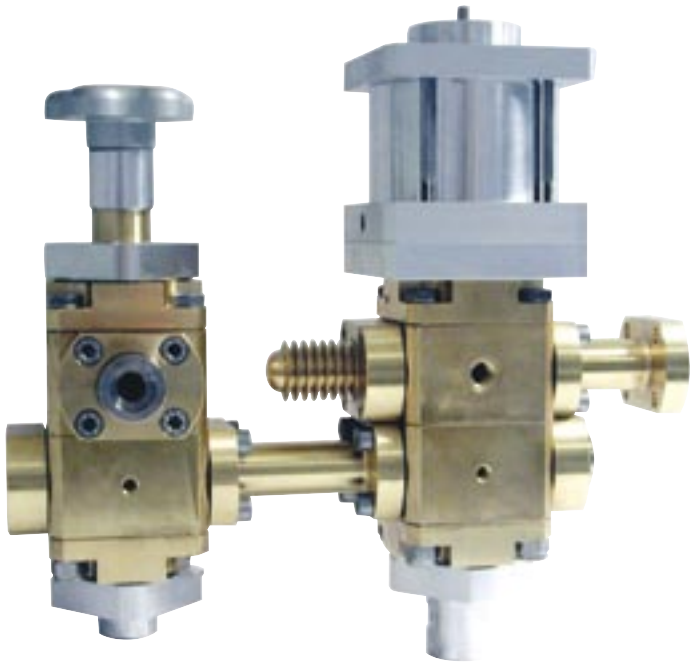
Hamid Ouali said: "The technology behind the valve ensures that whether manual, automatic or upgraded from one to another, it is cost efficient and reliable. And thanks to the cartridge design, the valve maintenance is optimised in terms of intervention time, skill requirements, stock management and cost. When maintenance is required, the cartridge is replaced while the valve body remains on skid."

The valve is also BAM* approved for adiabatic compression in oxygen to a maximum of 420 bar operational pressure. Valves are connected to each other by fixed brass lengths with O-ring seals. The valve has others accessories such as heat dissipater and inlet on line filter which improve the reliability and reduce the maintenance cost.

All valves are delivered with an oxygen degreasing and test certificate (pneumatic tests with dry nitrogen at 465 bar). Delivery time is around eight weeks from receipt of order.

Hamid Ouali added: "Cryostar has worked closely with Tecnocryo to bring this new product to market and like all our service offerings, it is innovative, practical, efficient and cost effective. However, whatever our customer requirements, our engineers will explore, develop and implement a solution adapted specifically to their needs."
The new high-pressure gas valve is part of a complete range of products available from Cryostar Automation for all gas filling applications.

* BAM (Bundesanstalt Für Materialforschung und prüfung) is an independent German agency, which provides certification concerning the use of materials with oxygen. They are recognised throughout the industry as the specialists in this area.



Technical Features	
Operation Pressure	420 bar
Nominal Diameter	15 mm Kv values (5.12m3/h A B, 5.65 B A)
Spindle	Carodur coated with special
Seat	Monel / Peek
Internal Seal	EPDM
Actuator	Single effect NC or NO Double effect (when automatic)
Actuator Casing	Aluminium
Limit Switches	2 induction type with aluminium body
Valve certificate	BAM—ZBA—0001-2005

Events

★ **May 24-27, 2005**

ILMAC, Messe Basel, Hall 1, Basel, Switzerland
www.ilmac.ch

★ **Jully 11-14, 2005**

OIL & GAS MALAYSIA 2005, Malaysia International Exhibition & Convention Centre (M.I.E.C.C.), Kuala Lumpur, Malaysia.

★ **August 29 - September 2, 2005**

2005 Cryogenic Engineering Conference and International Cryogenic Materials Conference, Keystone Resort & Conference Center, Keystone, Colorado, USA
www.cec-icmc.org

★ **September 13-15, 2005**

EXPOGAZ, Palais des Congès, Paris, France
www.expogaz-expo.com

★ **November 22-25, 2005**

2nd European Hydrogen Energy Conference & Exhibition, Zaragossa, Spain

Tools and datas:
Approximate LNG Conversions

	GAS			LIQUID						High-Heat Val.
	Cubic Feet	MCF	Cubic Meter	Pounds	Gallons	Cubic Feet	Barrels	Cubic Meters	Metric Tonnes	Therms (100,000 Btu)
1 Cubic Foot (gas)	1.000000	0.00100	0.02831	0.04357	0.01210	0.00162	0.00029	0.00005	0.00002	0.01034
1 MCF (gas)	1,000.00	1.000000	28.31257	43.57000	12.10400	1.62000	0.28800	0.04600	0.02000	10.34000
1 Cu Meter (gas)	35.32	0.03532	1.000000	1.53889	0.42751	0.05722	0.01017	0.00162	0.00071	0.36521
1 Pound (liquid)	23.00	0.02300	0.64982	1.000000	0.27800	0.03700	0.00700	0.00100	0.00044	0.23800
1 Gallon (liquid)	82.62	0.08300	2.33911	3.60000	1.000000	0.13400	0.02400	0.00380	0.00160	0.85800
1 Cubic Foot (liquid)	618.00	0.61700	17.47690	26.90000	7.48000	1.000000	0.17800	0.02800	0.01200	0.63800
1 Barrel (liquid)	3,470.00	3.47000	98.30754	151.20000	42.00000	5.62000	1.000000	0.15900	0.06800	35.89000
1 Cubic Meter (liquid)	21,830.00	21.83000	615.49067	951.10000	264.20000	35.32000	6.29000	1.000000	0.43100	225.80000
1 Metric Ton	50,580.00	50.58000	1,415.62854	2,204.60000	612.30000	81.96000	14.58000	2.32000	1.000000	523.20000
1 Therm (100,000 Btu)	96.67	0.09670	2.73816	4.20200	1.16600	0.15700	0.02800	0.00440	0.00190	1.000000

★ Donations raise the roof

Cryostar has raised enough euros to rebuild a village destroyed by the tsunami in southeast Asia.

The huge fundraising effort began in January when Cryostar opened a company donation for the victims of the tsunami, and offered to multiply by five the amount given by employees.

After one week the 270 workers had managed to raise 4712 euros, taking the multiplied donation to a massive 23,560 euros. This figure finally rose to 28,272 euros and was donated to Aide et Action, a French non-governmental organisation.

The charity visited Cyrostar to show how the money was to be spent, and announced that it would be enough to erect an entire village.

Cryostar has decided to finance the building of the village and sponsor it in the future.

Daniel Meyer, President of Cryostar said: “We are very surprised and pleased by the amount raised. We did not expect to reach such a sum. It shows that Cryostar’s people are very human and show their generosity in assisting people in distress.”

Where the new village will be, and what it will be called, have yet to be decided.

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