



# FROSTBYTE

A NEWSLETTER FROM CRYOGENIC INDUSTRIES WINTER 2013

## Mobile Nitrogen Vaporizer Skid

Cryoquip Europe recently designed and manufactured a mobile nitrogen ISO container vaporizer skid for large flow rate applications. This mobile unit will be used for a variety of industrial applications including using pressured nitrogen to drive various pigs along pipelines for cleaning, gauging, inspections and maintaining product purity. These skids will also provide inert dry Nitrogen gas for drying and inerting pipe lines during routine maintenance.

The 40' ISO skid contains two identical vaporizers each designed for nominal flow rate of 2000 Nm<sup>3</sup>/hr. To provide continuous gas flow each vaporizer operates for 4-6 hours before being switched to the other unit to allow for defrost. The skidded system can be supplied with an automated switching system or manual valves. The vaporizers comprise a number of individual multi-finned extruded aluminium heat transfer elements, mounted vertically to ensure correct operation and even

liquid distribution. They are lined with stainless steel tube for added strength and durability allowing for high pressure operation when required. To insure long term integrity special anti-vibration mounts have been utilized to minimize the effects of road vibration and shock during transportation.

Cryoquip manufactures a variety of different size mobile ambient vaporizers from 50Nm<sup>3</sup>/hr to 4000 Nm<sup>3</sup>/hr with pressures up to 690 bar. For more information please visit [www.cryoquip.com](http://www.cryoquip.com).





# TESS a New ACD Turbosystem Design Assistant

Seamless turbosystem design requires both engineering discipline and engineering judgment. TESS, a new ACD design assistant, supports ACD Engineers with both.

TESS (Turbo-Expander Sizing & Simulation) is a modern, networked, graphical software system designed and built in-house to support ACD's specific processes. To achieve this end, ACD Engineers provided unparalleled contributions and insight.

TESS supports the design process, maintains design quality, provides project traceability, and catalogs project and design data, in addition to supporting future refinements and applications.

## Proposals, Projects, and Designs: Versioning, Discipline, and Traceability

With TESS, Turbosystems are defined and designed within the context of proposals and projects. Proposals and projects are retained and versioned (all revisions and release "versions" are maintained and managed)—and because TESS imposes a discipline on versioning, design, and editing—TESS provides visibility and traceability of proposals and projects as well as designs. In turn, it is ACD's clients who will derive the greatest benefits from ACD's adoption of TESS. In the proposal stage, ACD's Engineers are able to optimize the combined turbomachinery system while systematically evaluating each different off-design case.

## SQL Database: A Continuous Record of Process, Design, and Performance

TESS uses a modern SQL database (a Structured Query Language relational database management system) to store the hierarchy of proposals and projects as well as design and performance data.

Furthermore, TESS continuously stores the designer's settings and preferences, along with the design, workflow, and performance data into the database.

The database also captures all of the details for standard

### Proposals/Projects & Versioning

- Identification
- Status
- Notes, Comments, Contacts
- System Machines

### Machine Design State

- Settings, Preferences
- Layout & Components
- Fluids
- Geometry
- Performance

### Workflow State

- Completed Operations
- Operation Status

### Standard Data

- Frames, Screens, Valves, Bearings
- Characteristics, Limits
- Model Performance Curves

### User-defined Data

### Test Data

Figure 1, Data Maintained in the TESS Database

system frames and components, their sizes, characteristics, limits, and field/test data and performance curves.

Figure 1 illustrates some of the classes of data maintained by TESS.

## Managed Complexity with More Design Information for Flexibility

Engineers design using TESS's graphical interface, which highlights the operations currently available, all the while showing the status, characteristics, and performance of past operations.

TESS has abstracted design stages and operations (sizing, valves and screens, expander, compressor, seal gas analysis, etc.) and is configured to account for their

interdependencies and interactions. For each of these entities TESS provides enhanced support information, limits, rules, and trial simulations. The design engineer can utilize each of these, with up-to-date performance simulations and enhanced information, for greater efficiency and flexibility in analysis, design, and workflow. Once the combined turbomachinery system is optimized, TESS uniquely specifies the geometry of each component.



## TESS Software's Logical Structure

TESS software has a state-of-the-art modular structure, and is built of models (especially of individual engineering entities and processes as well as abstractions), services (which provide resources, functions, or data as needed), and messages that communicate between them.

Figure 2 breaks down some important parts of TESS's modular structure, and provides a better idea of TESS's scope.

## Simulation Optimization and Future Adaptability

TESS is highly scalable and is designed to accommodate future turboexpander sizing and selection requirements. The database is structured to incorporate field/test data to improve prediction accuracy; it is possible to combine actual test performance data to adjust component characteristics with simulation algorithm to optimize TESS's simulations.

TESS not only facilitates today's Turbosystem designs but will also guide future concepts, developments, and products. For more information on ACD's line of turboexpanders, please visit [www.acdcom.com](http://www.acdcom.com).

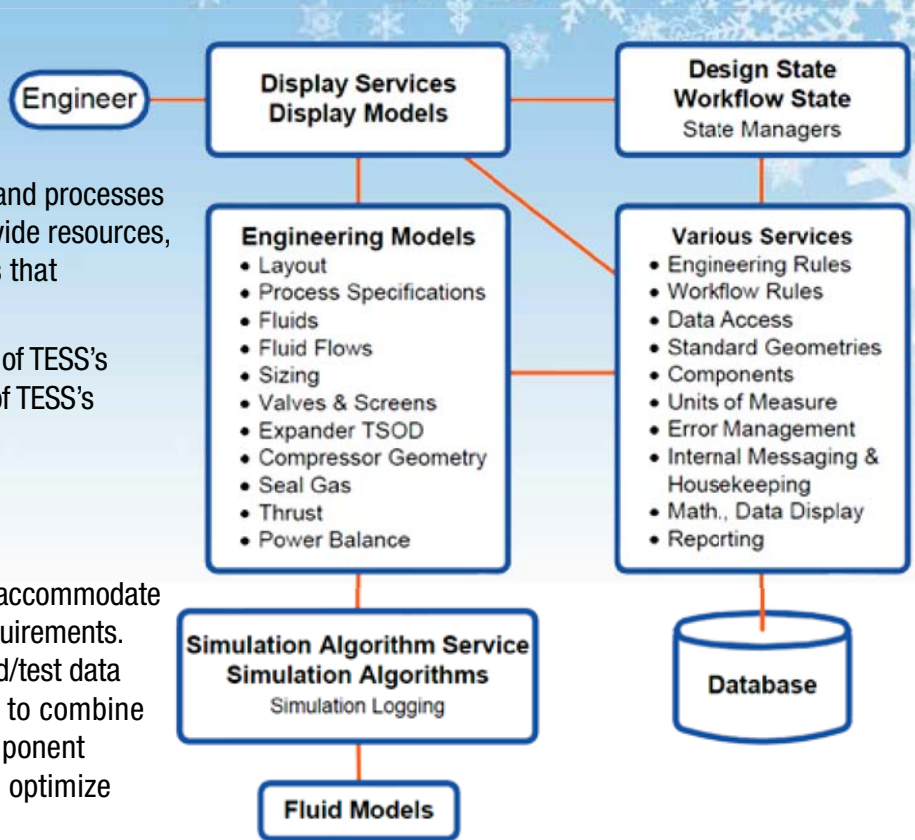
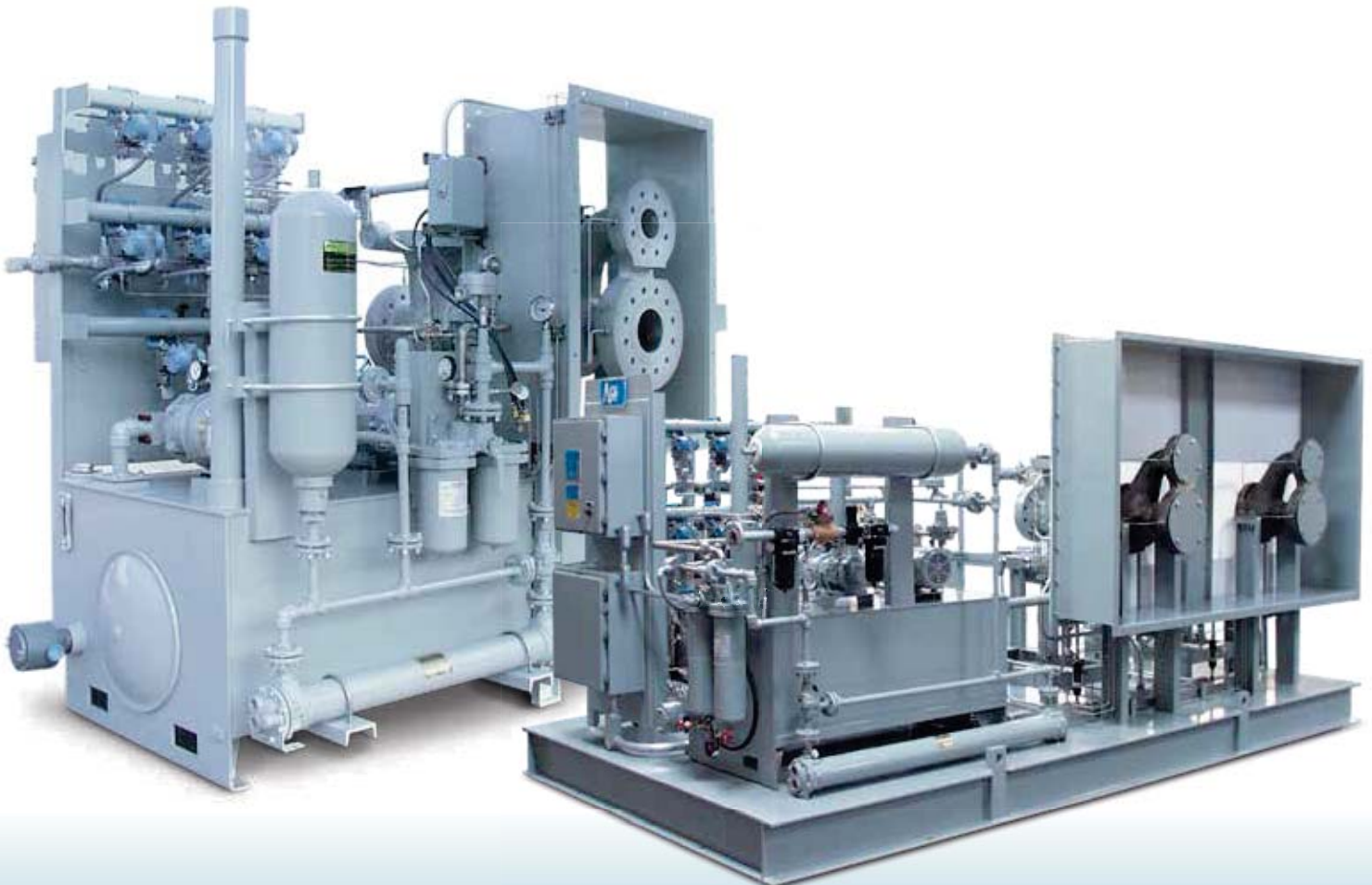


Figure 2, TESS Modular Overview



# Understanding Specific Power

Specific power is a useful way to compare air separation plant efficiencies. However, when evaluating integrated liquefier air separation plants the results can sometimes be misleading since the specific power calculation only looks at the total liquid production and does not account for the product split [Liquid Oxygen (“LOX”) product versus Liquid Nitrogen (LN<sub>2</sub>) product as a percentage of the total liquid product] or other gaseous products.

The product split can have a significant impact on specific power evaluation. Two plants producing the same amount of total liquids can have considerably different specific powers depending on the product split. There are also variations in specific power due to the plant cycle; however compressor sizing has similar effects with all designs.

Consider the following typical cases. Case 1 is a mixed mode operation where the feed air compressor output is matched to the LOX requirement of 50% of the total liquid production and the recycle compressor capacity is matched to the total liquids output (100% consisting of 50% LOX and 50% LN). In other words, the main air compressor size was dictated by the amount of oxygen molecules needed for the required LOX production and the liquefier/refrigeration size (recycle compressor and expander sizes) was determined by the total liquid output. A typical specific power would be 0.77 Kwh/Nm<sup>3</sup> based on total liquids produced (See FIGURE 2). No specific power credit is given for available gas products.

For our Case 2 (Max LOX) a larger feed air compressor capacity was required to provide the oxygen molecules needed for the maximized LOX production resulting in a product split of 83% LOX and 17% LIN. As before almost the entire recycle compressor output is utilized to make similar refrigeration as Case 1. Hence, the recycle compressor will remain unchanged from Case 1. Please see Figure 2 graph showing the power split between the main air and recycle compressors for each case. However, Case 2 has higher specific power than Case 1 (See figure 3). This is due to the fact that while total liquid produced in the plant is the same for both Case 1 and Case 2 (e.g., similar recycle compressor load), for Case 2 the amount of LN<sub>2</sub> available as product is much less because the balance of LN<sub>2</sub> available from the plant is used as the reflux for the upper column for LOX production. The higher specific power in Case 2 is not due to inefficiencies in the process design but solely due to product split between LOX and

LIN. Simply put, with a fixed refrigeration capacity (recycle compressor & expander capacity); the higher the LOX split, the higher the specific power. Figure 4 shows a typical effect of LOX production as a percentage of total liquid production on specific power (power per unit of production) for a POPLAR air separation plant with integral liquefier.

While there are numerous factors to consider when evaluating and comparing plant performance, one can

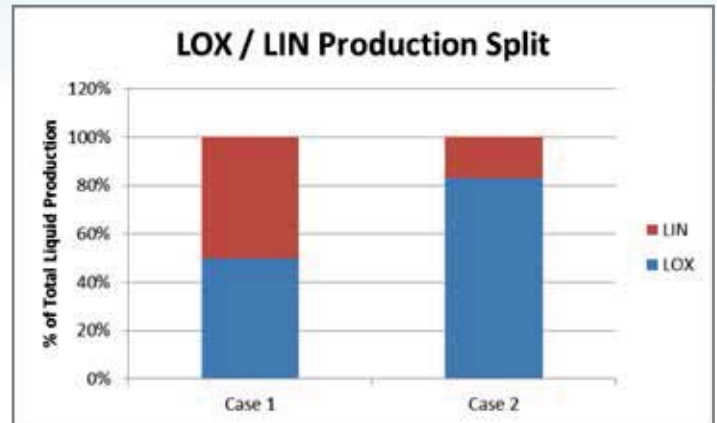


Figure 1 –Liquid Production Split

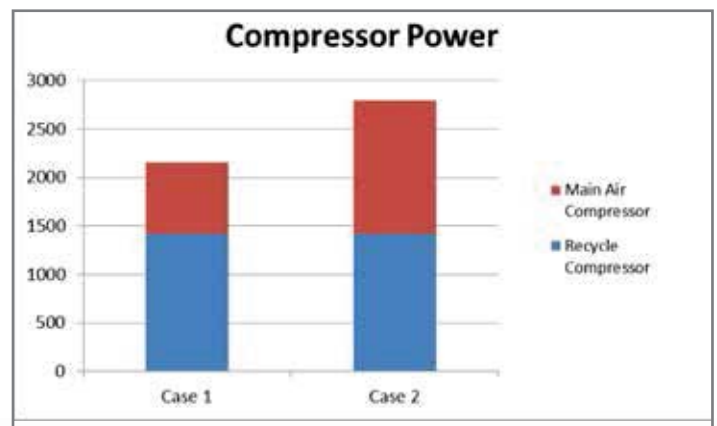


Figure 2 – Compressor Power Split



see from the above example that merely looking at the specific power and total liquid production when evaluating plant performance can result in a distorted conclusion. The product splits must be examined when using specific power for performance comparison.

Cosmodyne has been building air separation plants since 1958 with over 400 plants installed worldwide. We offer the most efficient plants in the industry with guaranteed performance and quality. For further assistance or information please visit [www.cosmodyne.com](http://www.cosmodyne.com)

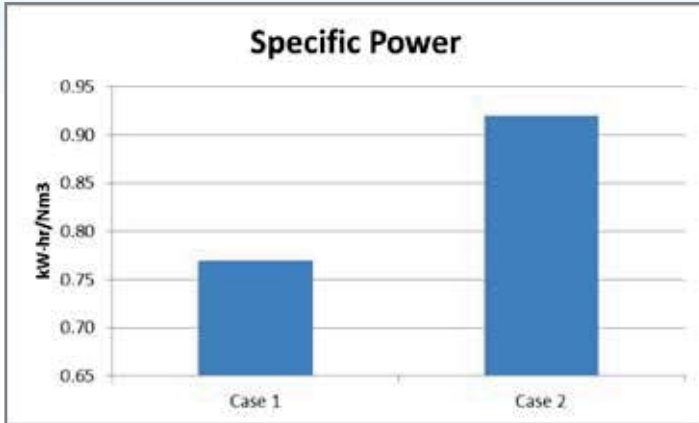


Figure 3 – Specific Power

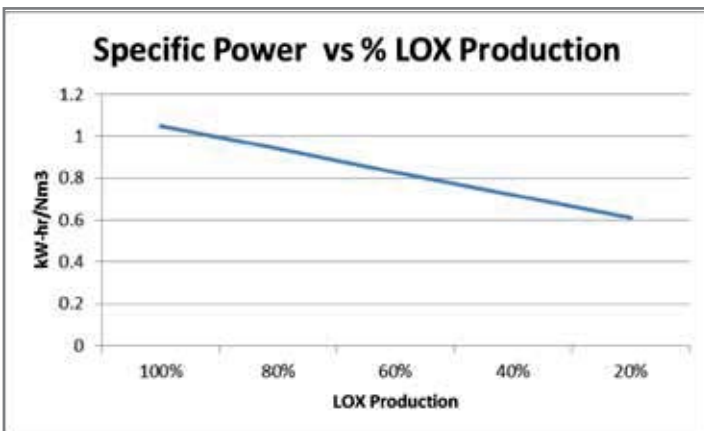


Figure 4 – Effects of LOX production split on Specific Power



## Cold Sump Effect

# Vertical Sealless Pump



All cryogenic pumps face two operational challenges. First is running two phase flow, that is supplying the pump with liquid close to its boiling point, and second is insufficient initial pump cool-down. Either case will lead to cavitation, resulting in pump damage and reduced life.

The solution to both these challenges is to build the cold end of the pump “into a liquid sump”.

ACD’s AC-32 pump has tackled both of these issues resulting in a cold end that

is integral to the motor. The liquid cryogen is circulated through the motor casing, effectively providing a “cold sump” in which the pump cold end is located. The pump is designed to operate with Nitrogen, Oxygen, Argon, LNG or low pressure refrigerated liquefied petroleum fuels.

This design provides two significant benefits over traditional centrifugal pumps. It eliminates the need for a seal on the shaft between the motor and the cold end. Additionally, cooling the pump to a sufficiently cold temperature dramatically increases efficiency. The pump also features virtually wear-free ceramic bearings, eliminating the normal mechanical play found in the shaft. The combination of sealless design coupled with ceramic bearings greatly extends the life of the pump.

The AC-32 is perfectly matched to filling and offloading road tankers at very high flow rates while affixed to the vehicle, or located on-site.

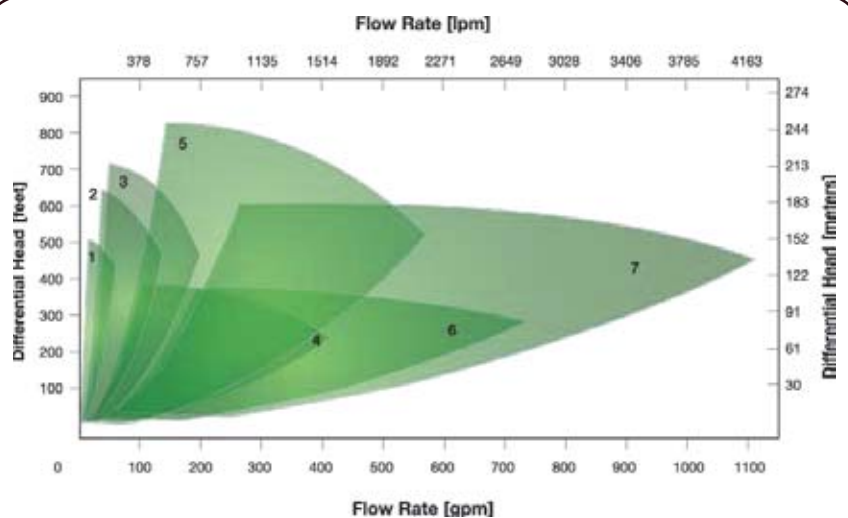
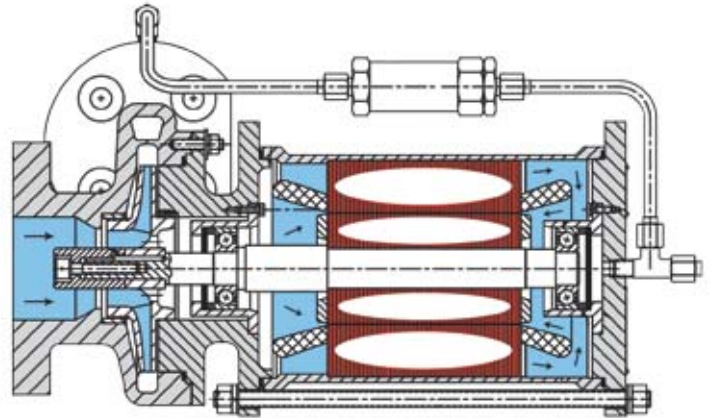
In order to increase pay load on large haul runs, many road tankers do not fit pumps onboard. They connect to a ground mounted pump for unloading. Often the liquid is “warm” and the pump can have

difficulties priming and pumping efficiently.

The sump on the AC-32 enables the vapor to be removed from the liquid resulting in higher efficiency. Some fueling locations fill tankers regularly several times a day and need to start pumps quickly. In this case, the sump can be maintained full of cryogenic liquid, and ready for immediate start up.

Cryogenic Industries affiliates ACD and Cryoquip, have worked together on this project. ACD engineered the pump and Cryoquip designed and built the sumps.

It is this synergistic collaboration and team work that sets Cryogenic Industries apart and allows them to provide innovative solutions to the gas industry’s challenges. [www.acdcom.com](http://www.acdcom.com).



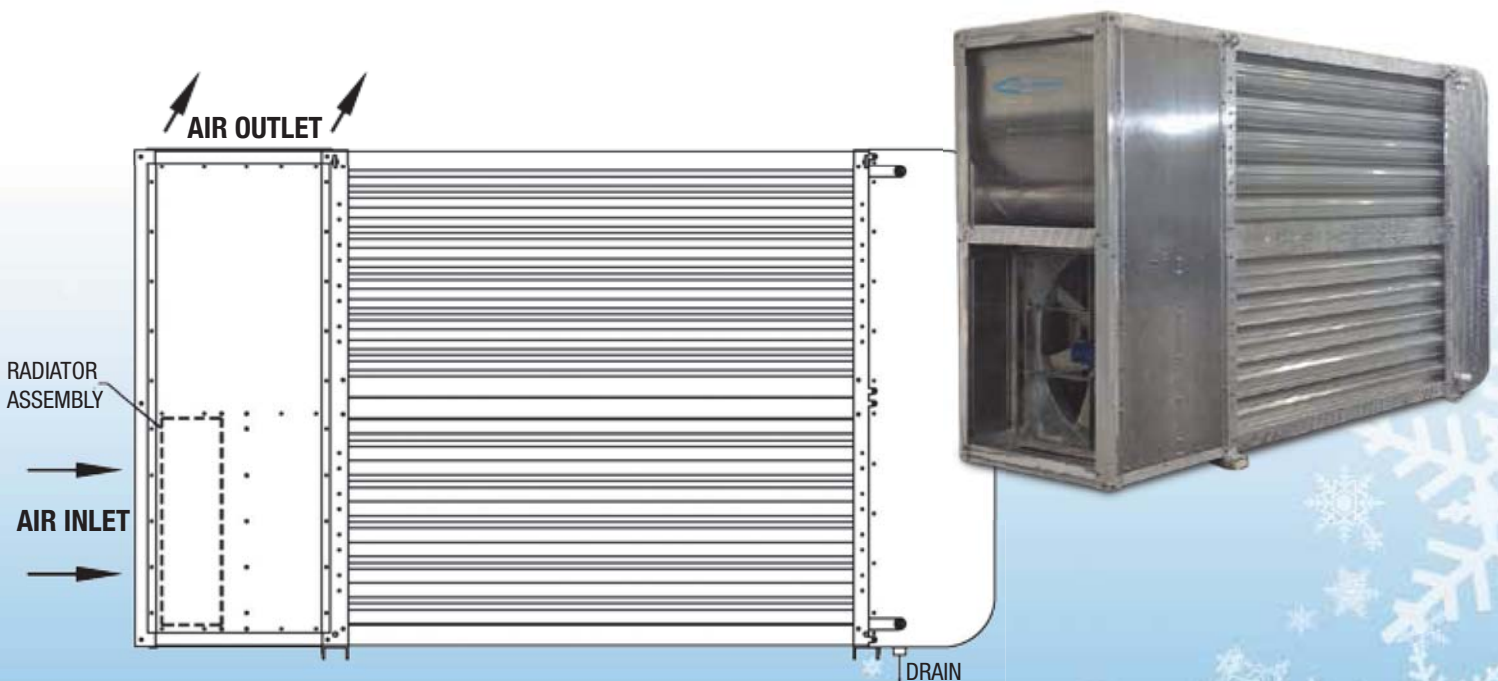
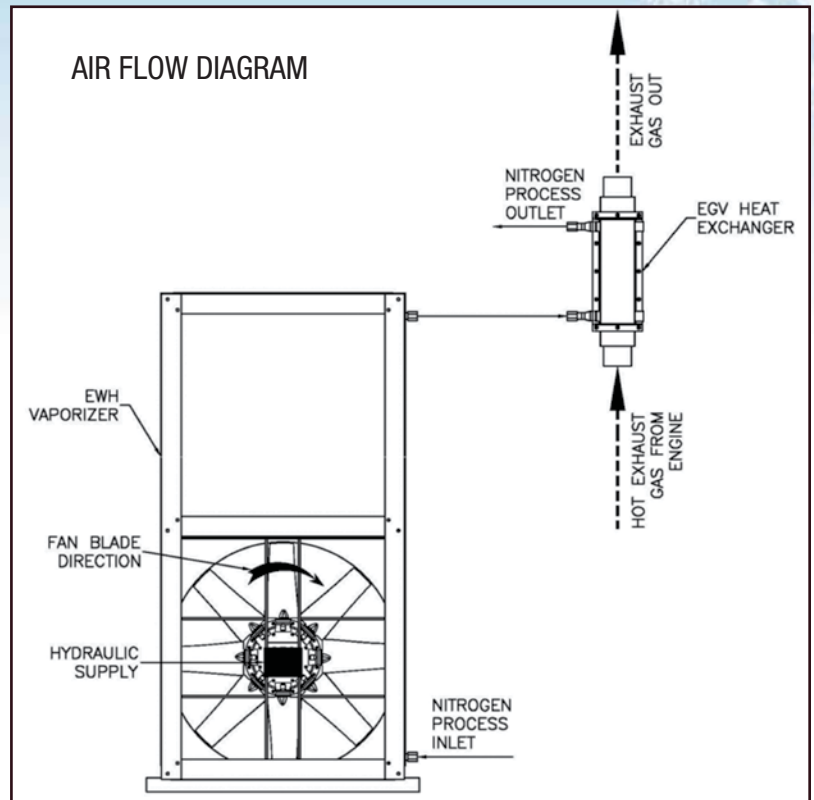
|               |  |   |
|---------------|--|---|
| <b>Speed</b>  | <b>1:</b> 1 x 2 x 4.5.....1,500 to 7,000 rpm | <b>5:</b> 2 x 4 x 8.5 ..... 1,500 to 7,000 rpm  |
| <b>Range:</b> | <b>2:</b> 1 x 2 x 6.....1,500 to 7,000 rpm   | <b>6:</b> 3 x 5 x 8.5 ..... 1,500 to 5,000 rpm  |
|               | <b>3:</b> 1.5 x 3 x 6.....1,500 to 7,000 rpm | <b>7:</b> 4 x 5 x 10.5 ..... 1,500 to 5,000 rpm |
|               | <b>4:</b> 2 x 4 x 6.....1,500 to 7,000 rpm   |   |

# New Offshore Nitrogen Vaporizers for Gas & Oil Well Service

Cryquip has developed a new hybrid fan assisted vaporizer which utilizes waste heat from an on board engine systems to warm and vaporize nitrogen. The new unit uses forced draft ambient air supplemented with heat from a radiator assembly mounted on the air inlet by the customer. This allows for efficient use of engine waste heat from the exhaust stream. The radiator assembly can be used to capture the energy from the many waste heat streams that are available onboard. Typical deck engine systems can have as many as four heat sources that can be utilized without drawing any parasite power for the vaporizer. The fan is powered by the customer's available hydraulic system.

The exhaust gas heat exchanger and radiator assembly may be positioned in any orientation. Normally the EGV unit would be placed in series with the main engine waste heat vaporizer (downstream) in the Nitrogen circuit.

Oil and gas well enhancement has created an ever increasing need for high pressure nitrogen. These new vaporizers have been developed with this demand in mind while maintaining a green approach. To date these energy sources have been wasted. The utilization of this "free" energy efficiently improves vaporizer performance while lowering the client's carbon footprint. For more information please visit [www.cryquip.com](http://www.cryquip.com)





## Engineering The Future of Cryogenics

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