CRYOGENIC INDUSTRIES

FROSTBYTE

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The Energent Variable Phase Turbine expands liquids or supercritical fluids used in refrigeration

Expansion of a liquid or supercritical fluid into the two-phase region is used in refrigeration processes for cooling or to produce liquid cryogenic products. The component which is commonly applied for this service is a pressure letdown valve, or Joule-Thomson (J-T) valve. While simple, the J-T valve results in a frictional dissipation of the available pressure energy, producing heating and less liquid product than would result from an isentropic expansion.

This result is illustrated on the temperature-entropy diagram of Figure 1. An isenthalpic, J-T, expansion from liquid, state point 1, into the two-phase region, state point 2, is shown. The liquid fraction is a/c. An isentropic expansion from state point 1 to state point 3 would result in a liquid fraction of b/c where b>a. For many processes the vapor generated by the flashing must be recompressed. By the reduction of the vapor fraction produced, from 1-(a/c) to 1-(b/c), the two-phase isentropic expansion reduces the compressor size and power.

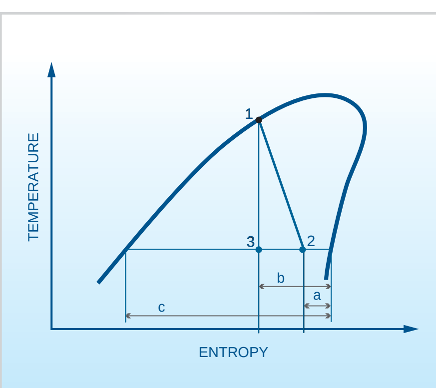

Figure 1: Comparison of Isentropic and Isenthalpic Two-Phase Expansions

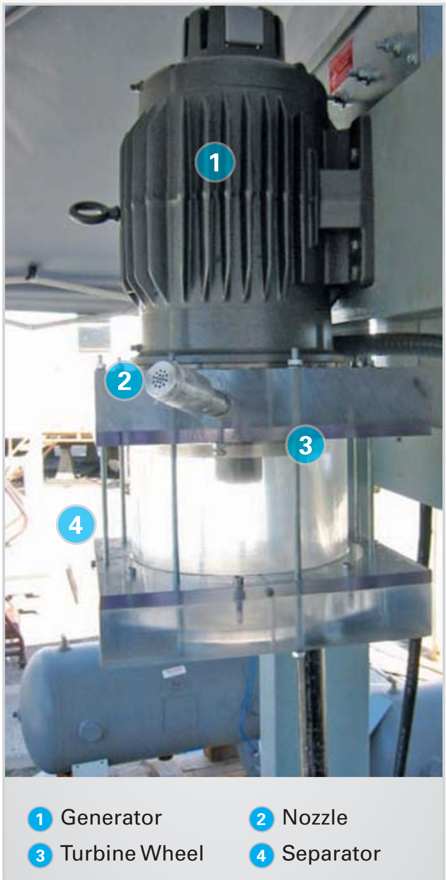

Figure 2: LN_2 Variable Phase Turbine Test Setup

Energent has developed a turbine which efficiently expands liquids or supercritical fluids into the two-phase region. This turbine, the Variable Phase Turbine (VPT) generates shaft power from the available pressure energy. The shaft power is removed from the process, increasing the cooling relative to a J-T valve and generating useful power as a byproduct. Hermetic units having process fluid cooled bearings and generator are being designed.

Figure 2 shows a small, 1.5 kW, VPT which was operated with liquid nitrogen. The inlet LN2 stream was liquid at -177 degC. This stream was flashed in the VPT to atmospheric pressure. The small size required only a single two-phase nozzle, resulting in partial admission losses. However, the measured efficiency was still 56%, with a rotor efficiency of 77%. The vapor production in the expansion was reduced by 7% compared to expansion in a J-T valve.

Figure 3 shows a comparison of the measured power to that predicted using two-phase nozzle and turbine design codes. The measured power agrees well with that predicted over a range of turbine speed.

Larger units, >100 kW, will have a turbine efficiency of greater than 80%. For cryogenic process applications, increases of 10-15% in the output of liquid product are possible for fixed compressor and heat exchanger capacities. Applications include LNG and ethylene production and propane, ammonia, CO_2 and other industrial refrigeration.

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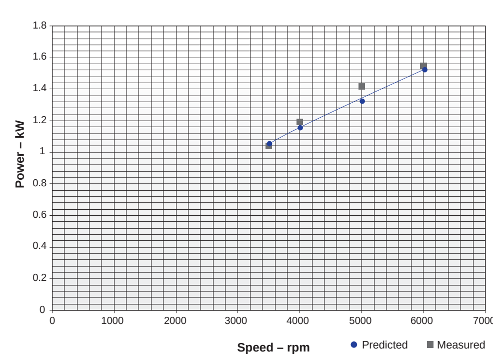


Figure 3: Comparison of Measured and Predicted Power in LN_2 Two-Phase Axial Turbine

Cryoquip-Australia supplies and installs a road tanker filling system for a new nitrogen liquefier

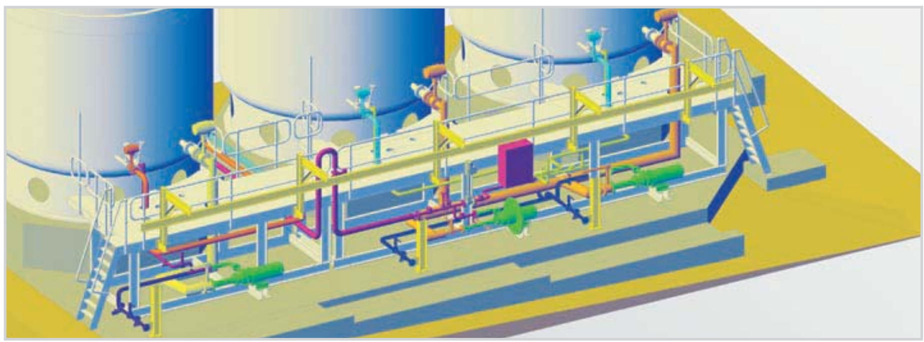
Cryoquip-Australia recently finished a major site installation at Coregas's nitrogen liquefaction facility in Port Kembla, NSW, Australia. The project involved the installation of over 300 m of vacuum insulated pipe work and three major pumping and vessel skids for the road tanker filling system.

The customer required a supplier who could package the pumps and valves in an ergonomic pumping system, allowed operators to easily access valves and instruments on their vessels, and access and maintain pumps while ensuring efficient operation of the system.

Cryoquip was supplied the process and instrument diagrams (P&ID's) for the liquid oxygen, nitrogen and argon system, and from this, designed and specified the valves and pipe work, and produced a 3-D CAD model of the system. The system was approved by the customer and Cryoquip-Australia built the packaged skids in their manufacturing facility in Melbourne, and installed the skids and pipe work on-site. The installation was completed on time and within the budget constraints of the project.

Other systems have been fabricated and ready for on-site installation for BOC in Australia, for their Ausmelt project in remote South Australia, and for Kuwait Industrial Gases.

For more information contact Ralph Day at Cryoquip, +61.3.9791.7888 or rday@cryoquip.com.



The Energent Variable Phase Turbine

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For waste heat recovery use of a Triangle Cycle with a VPT has been shown to result in a 20-40% improvement in power output compared to an organic Rankine cycle. Figure 4 is a photograph of a Triangle Cycle pilot plant for waste heat recovery. The pilot plant operates with high temperature refrigerants such as R245fa to demonstrate cycle efficiency and to provide a test bed for turbine designs. Applications include waste heat recovery from industrial plants, engines and gas turbines and for geothermal power generation.

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1 Variable Phase Turbine

Figure 4: Triangle Cycle Pilot Plant

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