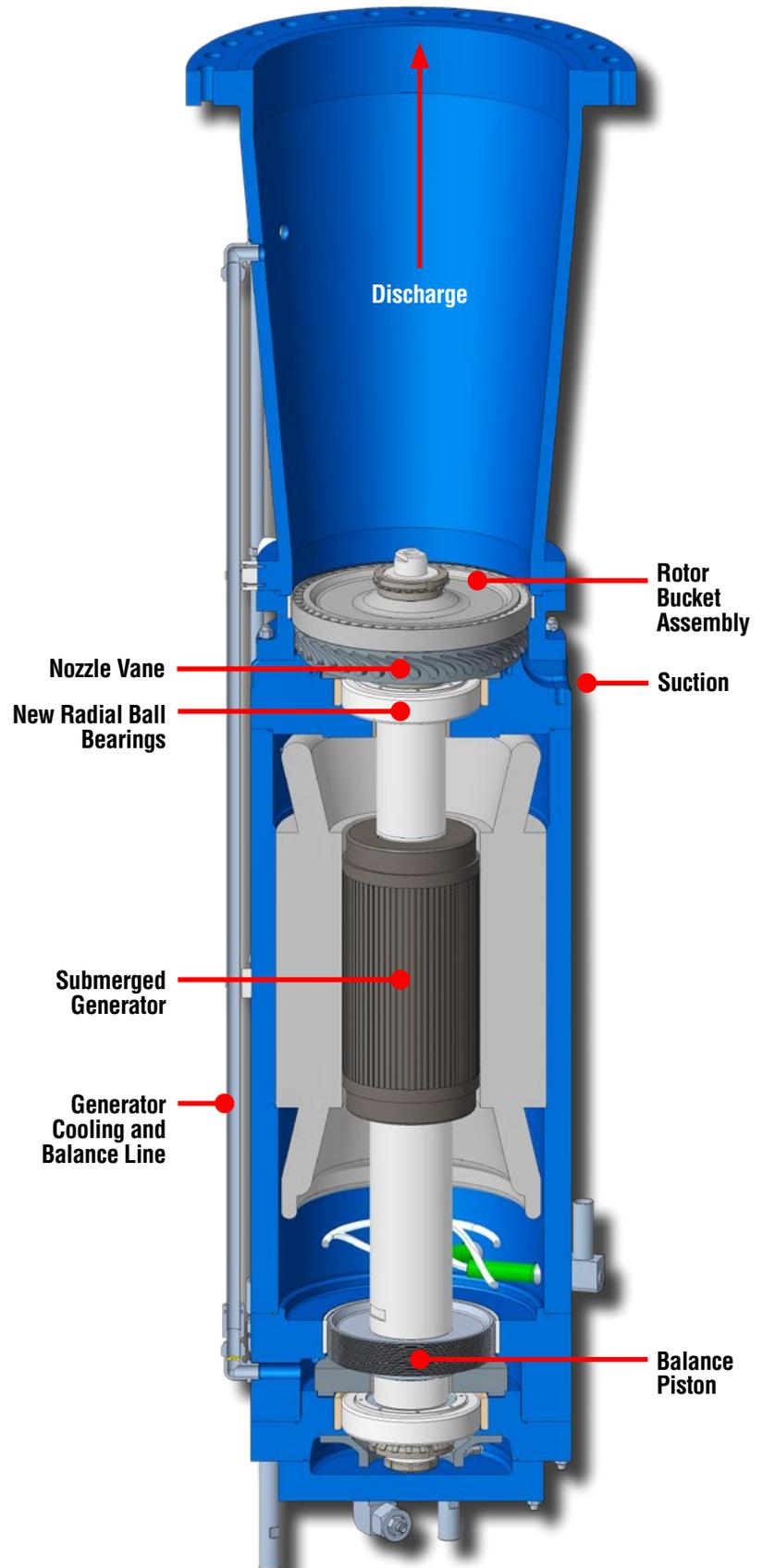




Impulse-Type, Two-Phase Cryogenic Expander

Elliott's impulse-type, two-phase cryogenic expander allows for the expansion of liquefied gases into two-phase mixtures. Harnessing the energy of two-phase expansion increases the expander's generator output, reduces boil-off losses, and improves the overall liquefaction and cooling processes. Each expander is custom-designed and built to meet customer specifications for use in LNG liquefaction, refrigeration, and separation processes, as well as improve overall efficiency.

The impulse-type, two-phase cryogenic expander has optimized staging to minimize axial load at the radial ball bearings and tolerates a high content of vapor mass. Elliott has been offering axial flow impulse-type expanders since 1947 for steam applications using single-stage turbines. This expander is based on proven impulse turbine blade technology, and is offered for liquefaction and refrigeration processes with relatively high vaporization capability in cryogenic hydrocarbon applications. The isentropic efficiency of these units is estimated at around 60 to 70%, depending on the mass flow rate and unit pressure drop. They do not require a Joule Thomson (JT) valve at the downstream as compared to a Francis-type expander. Impulse-type, two-phase cryogenic expanders have generator nameplate ratings ranging from 300 kW to 2.2 MW for a single unit. If the process requires high-flow output, these units can be installed and operated in parallel configuration.

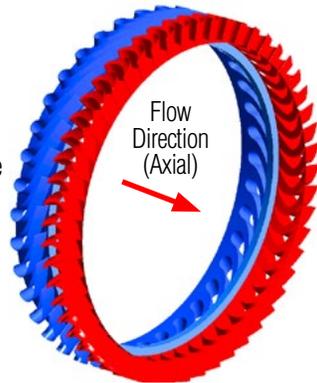


Benefits

- ♦ Improves the efficiency of the liquefaction process with an estimated LNG production gain of 5% to 7% by reducing boil-off
- ♦ Electrical power generation by converting the process fluid's mechanical energy to electricity
- ♦ Enthalpy change through generation of electricity
- ♦ Investment payback achieved in months

Hydraulic Components

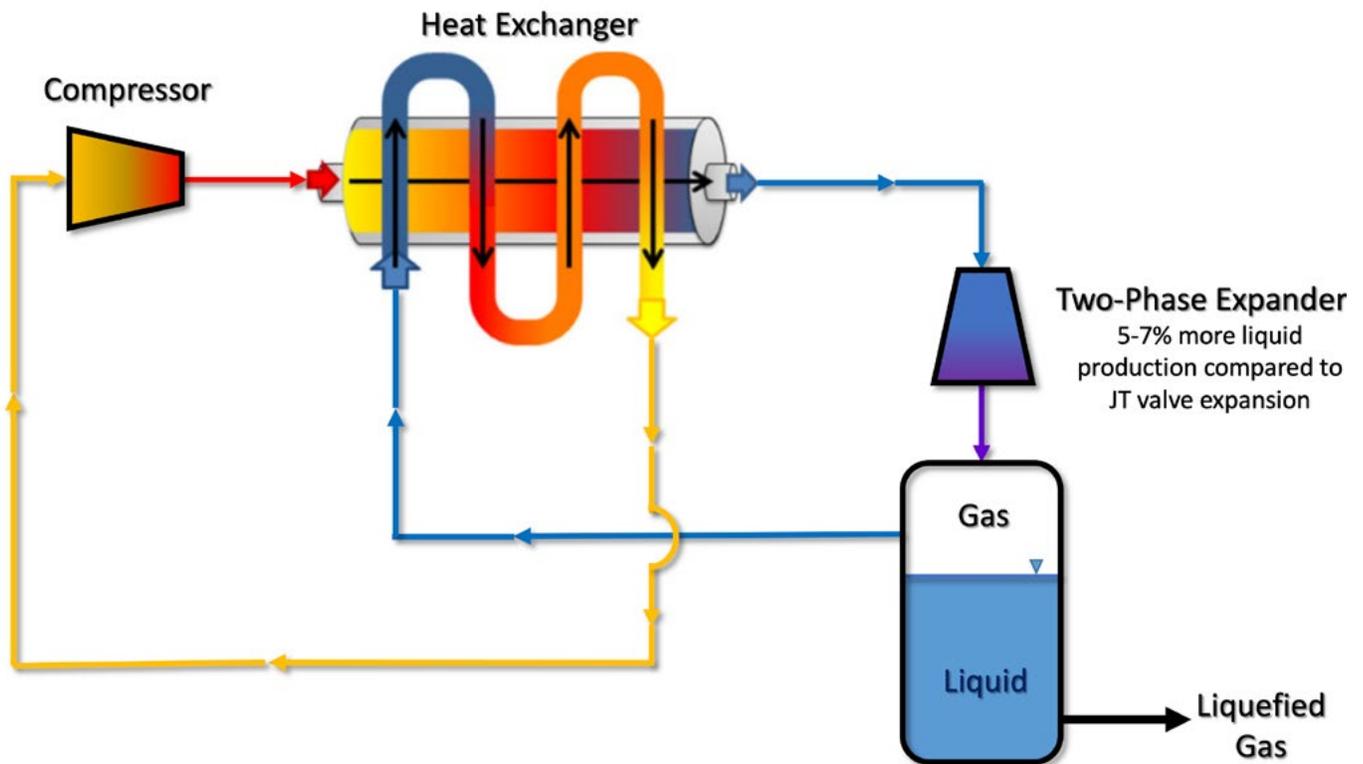
Axial Nozzle Vane
(Stationary)



Rotor Bucket Assembly
(Rotating Component)

Features

- ♦ Achieves same pressure drop as expansion valve (JT valve)
- ♦ Flashing expander that can handle high volumes of vapor formation (vapor mass fraction > 0.3)
- ♦ Axial flow impulse design with reduced overhung design and stage reaction
- ♦ Vertically suspended upward flow configuration
- ♦ Single-shaft compact design with submerged generator
- ♦ Cryogenic radial ball bearings with high contact angle to overcome axial load
- ♦ Cooling and balance lines to adjust pressure and flow to efficiently cool submerged generator and lubricate ball bearings
- ♦ Variable speed operation to optimize the work transfer and performance based on process requirements
- ♦ Can be retrofitted to existing LNG liquefaction and cooling applications



901 North Fourth Street
Jeannette, PA 15644-1473
Phone: 724-527-2811
Fax: 724-600-8442

Email: info@elliott-turbo.com

www.elliott-turbo.com

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