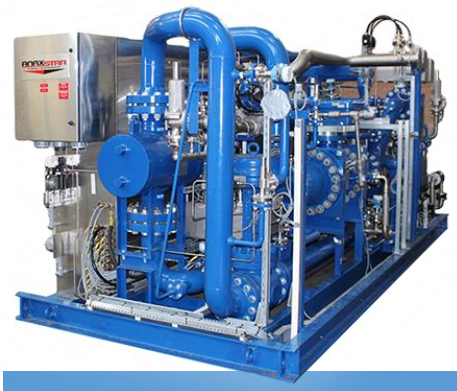
Anax-Star Turboexpander (ASTE)

Reducing Natural Gas Pressure: Wasted Energy, Missed Opportunity!

Natural Gas Pressure Regulating Stations maintain acceptable operating pressure in hundreds of thousands of miles of pipelines across the U.S. These stations makeup an integral part of the country's natural gas infrastructure, but are inefficient and **waste easily-accessible, lucrative energy**.

Gas Letdown Generators (GLGs) generate renewable energy from the flow of natural gas through pressure regulating stations. By employing an inline turboexpander, these systems generate electricity by expanding natural gas to an appropriate outlet pressure and temperature. Despite the benefits, **this technology has yet to achieve widespread adoption** due to high cost, safety risks, and an inability to handle fluctuating inlet pressures.



By harnessing wasted energy in pressure regulating stations, the ASTE improves overall efficiency in the natural gas supply chain. The renewable electricity from the ASTE can be fed directly into the power grid or can be used to offset the captive load of large natural gas and electricity customers, **making it an integral part of corporate sustainability goals.**

The ASTE can unlock new business models that boost profitability through cost savings and increased revenue. By converting the flow of natural gas to electricity, gas companies (and end-users of natural gas) maximize the return on their natural gas, without increasing risk. ASTE systems can **increase a company's bottom line by anywhere from $100k to +$1M per year** by generating 400kW to 2+ MW of electricity. Possible arrangements to achieve this benefit include power purchase agreements, revenue sharing, electricity cost savings, renewable energy credits, and other financial models. Furthermore, GLGs qualify for lucrative state and federal tax credits, infrastructure grants, renewable energy credits, and other renewability incentives that improve the system's ROI.

Since the ASTE generates electricity from the flow of natural gas, pressure reduction, and waste heat recovery, rather than combustion, **the system reduces overall natural gas emissions.** ASTE benefits to the environment include:

- Zero carbon emissions
- Improved natural gas efficiency
- Distributed generation that creates a more resilient energy grid
- Less reliability on dirty peaker generating plants
- Provides reliable backup to other clean-energy resources such as wind and solar

Safety & Performance

The ASTE is installed in-parallel with the existing regulating station and works in-tandem with the pressure regulating station to maximize safety. **Parallel installations ensure redundancy and reliability for both the pipeline and the end user of natural gas.**

Safety measures on the ASTE include pressure control valves, bypass valves, and fast-acting shutoff valves that regulate gas inlet pressure and isolate the ASTE by redirecting flow through the existing pressure regulating station if something goes wrong. The machine's ability to generate power while maintaining pressures, and handle controlled and fast stop scenarios such as shaft overspeed/imbalance, loss of utility grid power,

The Anax-Star Turboexpander (ASTE) was field evaluated by GTI at the DNV GL Flow Centre in the UK, and it overcame obstacles that have prevented widespread adoption of GLGs.

In its field performance evaluations, GTI verified the machine's ability to generate maximum power while maintaining pressures, and handling controlled and fast stop scenarios such as shaft overspeed/imbalance, loss of utility grid power, loss of external heat, loss of bearing pressure, loss of instrument air, and other safe operating scenarios.

For more information regarding GTI's testing, contact Tim Kingston at 847-768-0936 or tim.kingston@gastechnology.org

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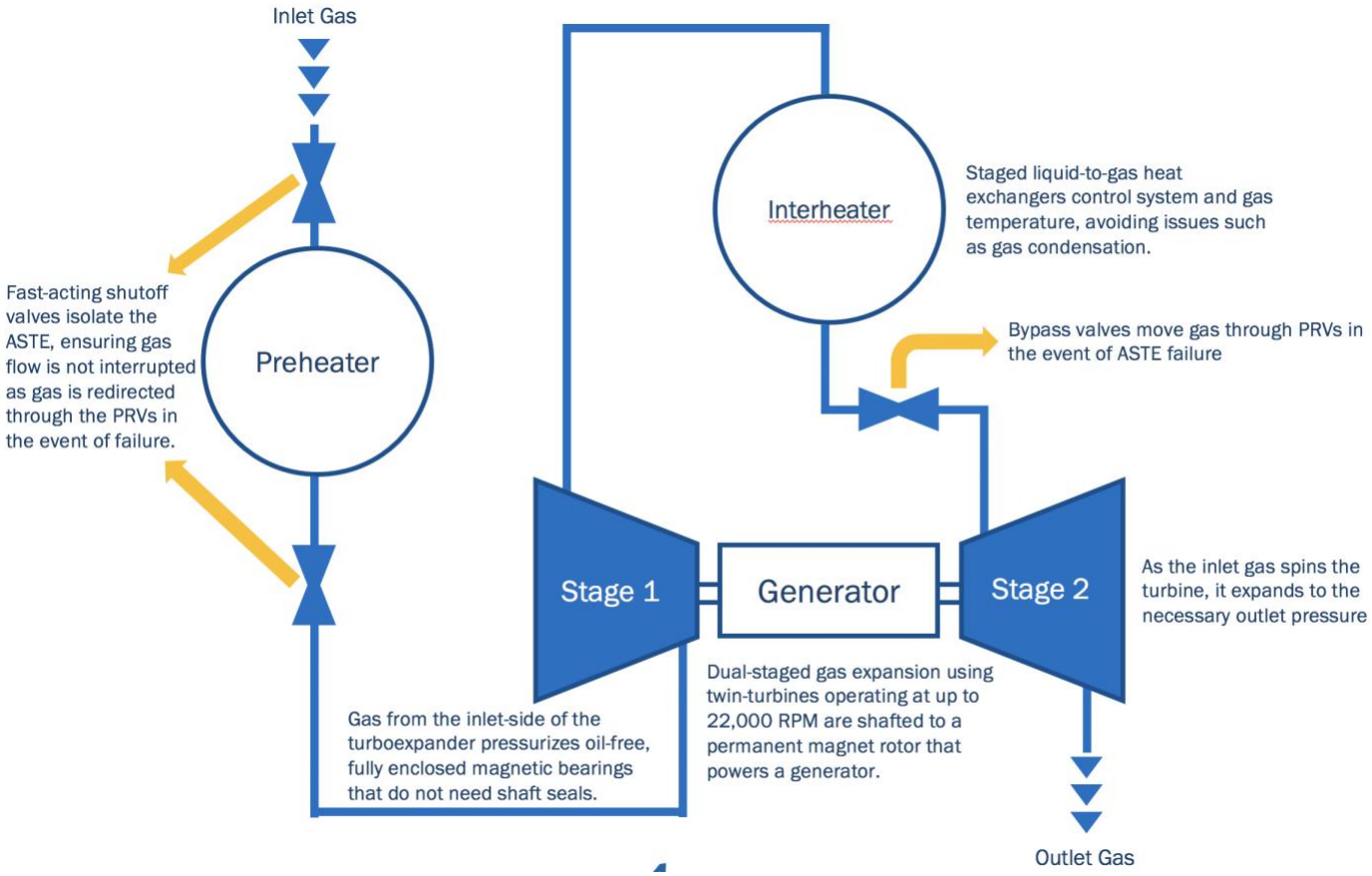
These safety valves protect the machine and ensure reliable gas delivery no matter what happens on the gas or electrical side. In addition to safety, these valves also **maximize the efficiency and maintain stable gas outlet pressure.** Finally, the ASTE has full remote control and remote monitoring of critical operational metrics.



Gas Requirements

The ASTE is designed for inlet pressures from 200 to 1,200 psig, with pressure ratios from about 1.4:1 to 4.0:1. In order to achieve 400kW power output at those pressure ratios, gas flow must be greater than 20,000 scfm. This unit also uses low-grade waste heat to ensure appropriate gas outlet temperature.

The ASTE overcomes obstacles that have prevented widespread GLG adoption by utilizing:

- **Active magnetic bearings** enable the ASTE to handle fluctuating inlet pressures without losing stability. Additionally, these bearings contain no oil lubrication and eliminate the risk of cross-contamination with the gas.
- **Dual-stage heating** maximizes the ASTE's efficiency by increasing the amount of energy that can be generated from natural gas pressure-reduction.
- **Increased electrical output** minimizes the machine's cost and provides the best ROI of any turboexpander on the market.
- **25-30 year lifespan** ensures a long-term, value-generating asset, with minimal maintenance.
- **Zero downtime** ensures the ASTE will generate electricity 24/7, provided gas is flowing.

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