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Data Sheet

2s362K Cryocooler

The 2s362K is a low vibration, no maintenance, highly reliable, acoustic Stirling (pulse tube) cryocooler for applications requiring cooling loads up to 1000 watts at 77k. Each unit is driven by two Qdrive renowned STAR linear reciprocating motors with clearance seal pistons, providing wear free operation with no lubrication required.

Qdrive's design is completely absent of cold moving parts or seals, eliminating maintenance that is required of most other technologies. The dual opposed motor/piston design within the pressure wave generator (PWG) is naturally balanced, reducing vibration and noise. If vibration at the cooled point is of concern Qdrive's remote head system (FAR) separates the PWG from the coldhead via a flexible transfer line and isolates the coldhead from any moving parts. To improve power consumption and increase versatility, each cooler is designed to be adjusted "on-the-fly" to match varying cooling load requirements. These advantages are accompanied by competitive pricing in both small and large quantities, making them ideal not only for laboratory use but also for HTS, medical, liquefaction, military and aerospace applications.



Figure 1: 2s362W (Pressure Wave Generator) with 1 of 3 241-class Coldheads

Operating Principle

The base cryocooler unit consists of a pressure wave generator driven by patented STAR linear reciprocating motors and an acoustic Stirling (pulse-tube) coldhead. The acoustic Stirling coldhead consists of a warm heat exchanger, a regenerator, a cold heat exchanger, a thermal buffer tube, a hot heat exchanger, an inertance tube, and compliance tank. Figure 2 below is shown as an inline configuration for clarity, but the actual coldhead is “folded over” at the cold heat exchanger to create a salient cold zone.

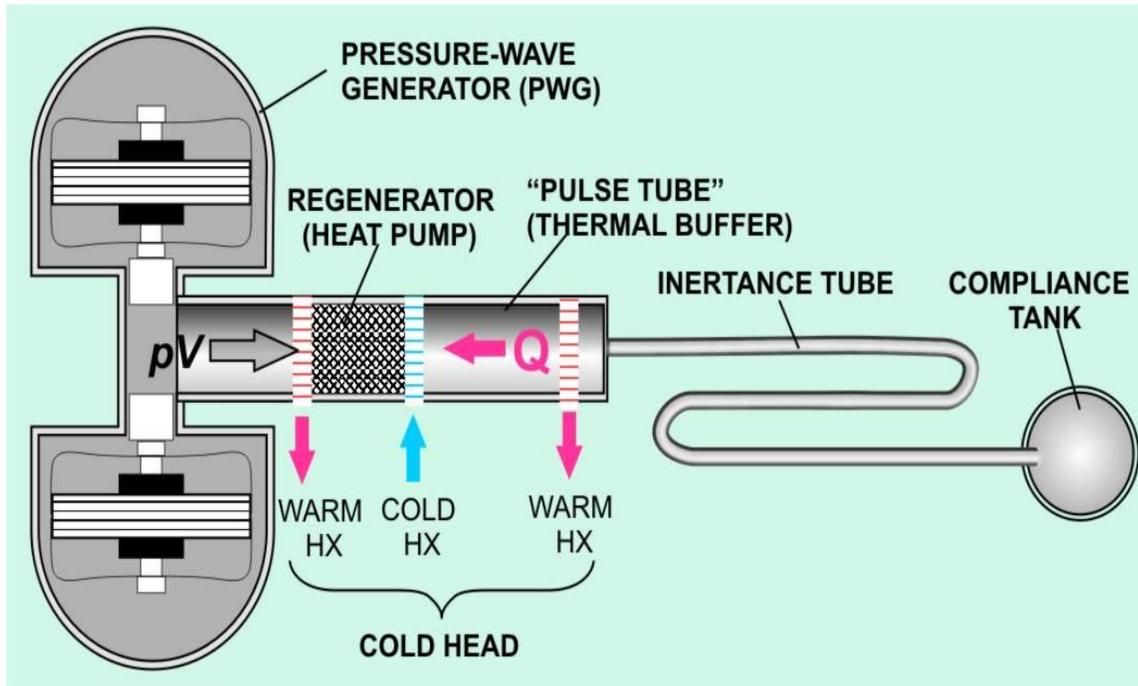


Figure 2: Thermoacoustic (pulse tube) Diagram

- 1) Pressurized helium gas is cyclically compressed and expanded relative to the mean pressure (charge pressure) by the pistons of the PWG.
- 2) With each forward stroke of the pistons, the gas moves through the aftercooler, or warm heat exchanger, where heat is removed. The gas parcel continues through the regenerator, which precools it before reaching the cold heat exchanger.
- 3) As the gas moves toward the cold heat exchanger, gas in the acoustic network (thermal buffer tube, hot heat exchanger, reservoir) also moves in the same direction. Even as the driven gas stops advancing, when the pistons reach their upper limits, the network's gas continues moving, driven by its own inertia in the high-speed inertance tube. This acts like a virtual piston, moving away from the cold exchanger, which expands the gas in that area. As it expands, it gathers heat from the surroundings (the area or substance to be cooled).
- 4) The pistons begin withdrawing and helium then moves back through the regenerator and aftercooler. Still delayed by its inertia, the gas in the network follows and the cycle begins again.
- 5) The cryocooler motors and heat exchangers are cooled by local air, water, or an optional closed water loop that consists of a reservoir, a pump, and a liquid-to-air heat exchanger.

Specifications

General:

Qdrive's complete zero-oil resonant acoustic cryocooler-liquefier, model 2s362K, is comprised of triple high-frequency coldheads on a matched pressure wave generator (PWG) drive, with support systems, according to the specifications outlined below. Unit is powered by two STAR™ 1s362M motors, each capable of 10 kW (mechanical) output at 60 Hz, mounted nose-to-nose in a common vessel at mean pressure. Both motors use clearance seal pistons on Qdrive's Commuter™ thin-flexure suspension. For safety and protection each PWG is equipped with an accelerometer for vibration measurements, however, no monitoring or control is included. The coldheads are coaxial finger form, with optional copper cold exchanger for GOX/LOX/LN2/LNG liquefaction, and include receivers with vacuum insulation shells. Base unit is supplied with bracketing to support components, but no weather housing. Interfaces for optional liquefier process fluid are flare tube or O-seal fitting (inlet) and Linde-style bayonet (outlet).

The triple head design with the 2s362 PWG can provide up to 1000 watts cooling at 77K. Mean pressure is 2.5-3.0 MPa. Capacity is variable by adjusting motor strokes externally via voltage. Maximum strokes are 32 mm rated, 36 maximum, controlled by the user. Basic cooler mass is approximately 390 kg. Inclusion of options increases mass up to approximately 550 kg for complete enclosed stand-alone liquefier with Drive Electronics (DE Option). Dimensions of full system are approximately 30W x 48L x 60H (inches), 76W x 122L x 152H (cm), with all options (except closed-loop cooling).

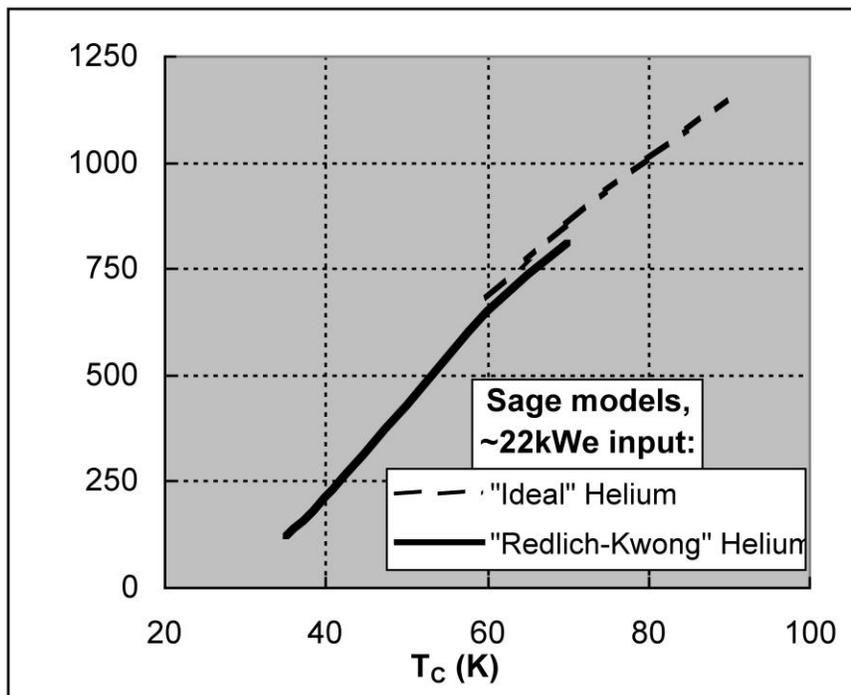


Figure 3: 2s362 Typical Load Curve (single head design available early 2013)

Motor Rating (subject to change as required):

- 10,000 x 2 kWe peak output at 60 Hz, 34 mm stroke
- Core Impedance @ 380VAC winding: 0.4 ohm DC, (6 ohm @ 60 Hz)
- Stator Inductance @ 380VAC winding: 17mH
- Nominal BL product @ max voltage winding: 60 N/Ampere
- Rated Operating Voltage: 380 VAC 1ø rms @ 60 Hz
- Rated Operating Current: 38 Amperes rms (0.85 power factor)
- Intrinsic Stiffness 200,000 N/m
- Damping, Rm 70 N-s/m (approximate)



Motor Mechanical:

- SS 720 multi-strap suspension
- M-19 laminated stator construction
- 45-50 MGOe FeNdB magnets or equivalent
- Magnet wire bobbin-wound coils
- 362 mm diameter x 120 mm length
- Stroke limit 36 mm (30 mm operation must be centered within 2 mm)
- Moving mass: approximately 11.2 kg

Piston & Gas Management:

- Clearance seals, Rulon buffers
- Inertance balance tube for drift management
- Bolted vessel for 3.0 MPa maximum allowable working (mean) pressure operation

Thermal Management:

- Direct conductive motor cooling to external liquid cooling loop in parallel with coldhead aftercooler (coolant supply & pump optional with -CL Option)
- 50 litre/minute required flow for full load. Less than 500 kPa pressure drop (internal)

Safety Management (power supplies, readouts and controls not included)

- Accelerometer to monitor PWG vibration
- Two (2) motor temperature sensors
- Two (2) Micro-Epsilon "VIP" piston position transducers (<0.5% linearity, -5C to 80C temperature range) with BNC connector shielded outputs (110VAC in required)

NOTE: MONITORING OF THE SAFETY MANAGEMENT DEVICES IS REQUIRED TO MAINTAIN WARRANTY

OPTIONS:

Driver Electronics (DE):

- IGBT-based servo-control inverter AC power supply (85-90% efficiency at full load),
300-440VAC, 3-phase, 50/60Hz input
125A continuous capacity
25-100 Hz frequency range
- Current limit (voltage foldover), thermal overload, short-circuit fuses
- Air cooled enclosure, NEMA 1 cabinet
- Keypad or potentiometer controls for frequency and voltage/stroke amplitude adjustment
- Face-mounted LED digital meter for current, frequency, hours, and fault codes
- Screw terminal connection points, for attachment of buyer-supplied input power cable

Optional Pressure Switch (-PS option)

- ENDEVCO piezo dynamic pressure tap at connection port (<2% error, <1 deg shift, +/-5V out)
- Typically used only at the PWG level for research applications

Optional Closed-Loop Cooling System (-CL option):

- Integrated liquid-air interface, eliminates user water supply & hookups
- 1/6 hp, 25 gpm @ 1 ft head epoxy-coated circulating pump
- 30" x 30" four row copper tube fin coil, with multiple 650 cfm fans & guard
- Coolant fill port. Antifreeze required for service below 0 C
 - **NOTE: use of closed-loop system typically raises reject temperature and reduces capacity by approximately 100 watts of cooling for every 10C rise in reject (rated performance at 20-C reject water)**

Optional Liquefier Load (-LX option):

- Single-pass, flow-through inert-gas 2nd stream heat exchanger/condenser
- Inlet and outlet fittings to be determined. No storage dewar provided
- Vacuum insulated cold parts and process fluid connections
- Includes common discharge similar to that shown in Figures 4 and 6

Optional Weather Enclosure (-UE option):

- AVAILABLE ONLY TOGETHER WITH-DE &IP installed (CL can also be fitted)
- Anodized or powder-coated metal enclosure for splash water resistance and shipping
- One unit suitable for forklift transport
- Approximate dimensions 30W x 60H x48L inch, including DE, IP auxiliaries

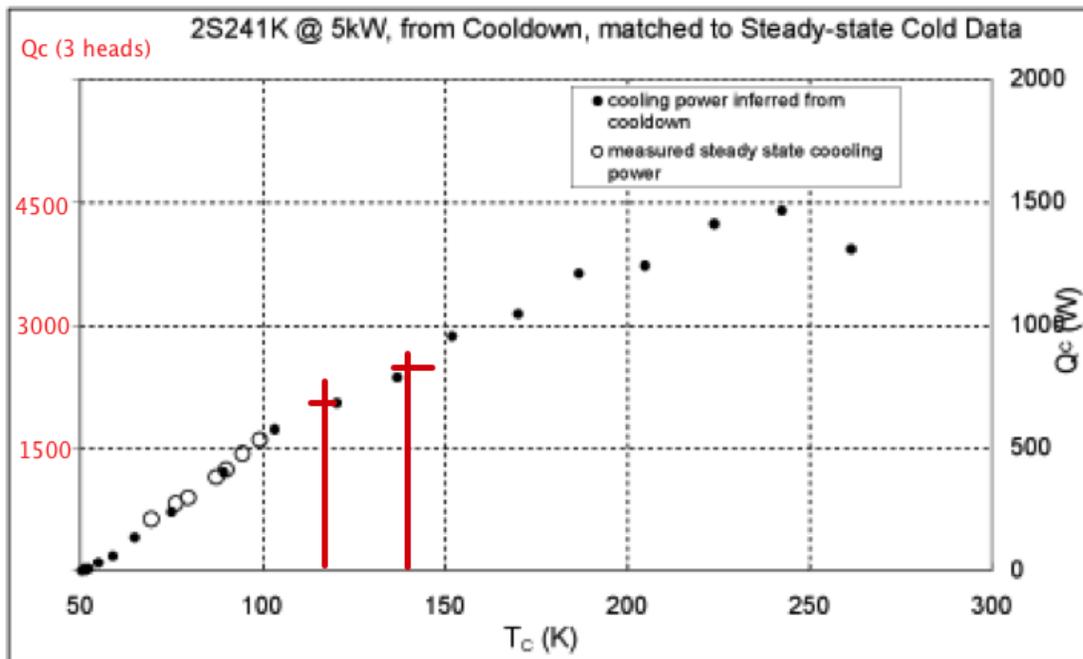


Figure 8: 2s362K Performance Driving (3) 2s241K Coldheads. Left Scale is 3x Single Head

All specifications are the most accurate representation of product at time of offering, subject to change without notice. Purchaser is responsible to verify details of interface requirements.