



FURNACE FOR ON-ORBIT REDWIRE GAS-QUENCH EXPERIMENTS (FORGE)

PRODUCT DESCRIPTION

FORGE is a gas quench tube furnace designed for operation onboard the International Space Station. It contains three independently controllable tube furnaces within a single enclosure. As a gas quench furnace, the system is capable of rapidly cooling samples if desired. The gas cooling system is also helpful to ensure that the inactive tube furnaces remain cool.

The furnace is a fully contained system during transport and operation. The uninterrupted containment strategy alleviates many safety concerns related to performing furnace experiments in a crewed environment.

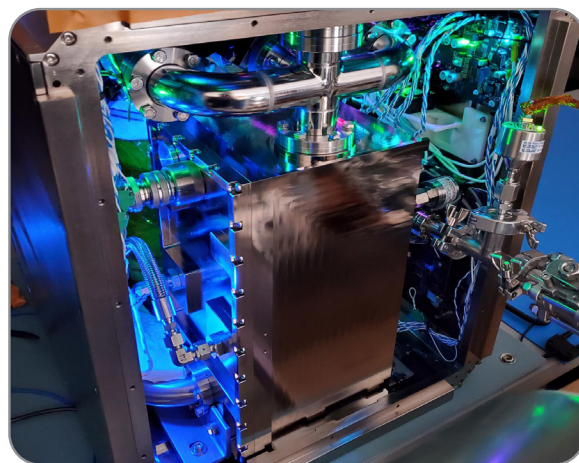


Figure 1: A peek at the inside of FORGE during operation.

OPERATING SPECIFICATIONS

	Inactive Core Cooling OFF	Inactive Core Cooling ON
Maximum Operating Temperature ¹	1300°C	1200°C
Minimum Operating Temperature	200°C	
Heating Ramp Rate ^{1,2}	Untested	20°C per minute
Quench Rate ^{1,3}	-30°C per minute	
Tube Length/Diameter	7 inch length / 1 inch ID	
Standard Sample Length	110 mm	
Standard Fixturing	2X M5x0.8 - 15mm Ceramic fasteners	
Operating Pressure Range ⁴	0 - 760 torr	
Maximum Heater Power	440 watts	440 watts



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NOTES:

1. Values assume operating pressure of 150 torr in argon atmosphere with a nickel-based alloy sample 110 mm long and 12.7 mm in diameter. Other operating pressures, sample types and/or sample dimensions are supported, but will impact operating limitations of the furnace.
2. Reported as a linear average over the course of a 1 hour long heating ramp starting at room temperature.
3. Reported as a linear average over the course of a complete quench cycled from max temp down to 100°C.
4. In practice minimum operating pressure is limited by each experiment's unique operating conditions. Lower pressure allows for higher achievable temperature, but at the expense of quench rate. The reverse of that statement is also true – higher operating pressure causes lower achievable maximum temperature but allows for faster quench rate. Maximum operating temperatures are further limited at operating pressures below 50 torr to avoid heating element damage, and temperature-dependent vapor pressure of samples shall never be permitted to exceed the chamber pressure to avoid boiling. For each experiment chamber pressure is set at the beginning of each experiment and thereafter the chamber operates as a closed pressure system (i.e., chamber pressure is not actively regulated). For safety purposes FORGE's vacuum volume must never exceed 760 torr during processing.

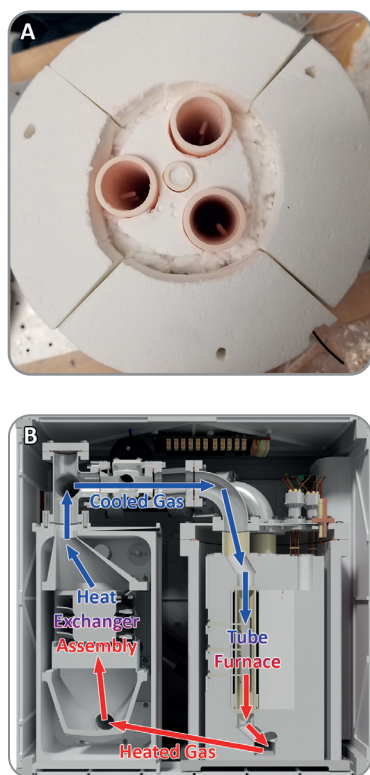


Figure 2: (A) FORGE contains three independently controllable tube furnaces. (B) A closed loop heat exchanger allows for gas quench experiments to be performed while preserving sample containment.

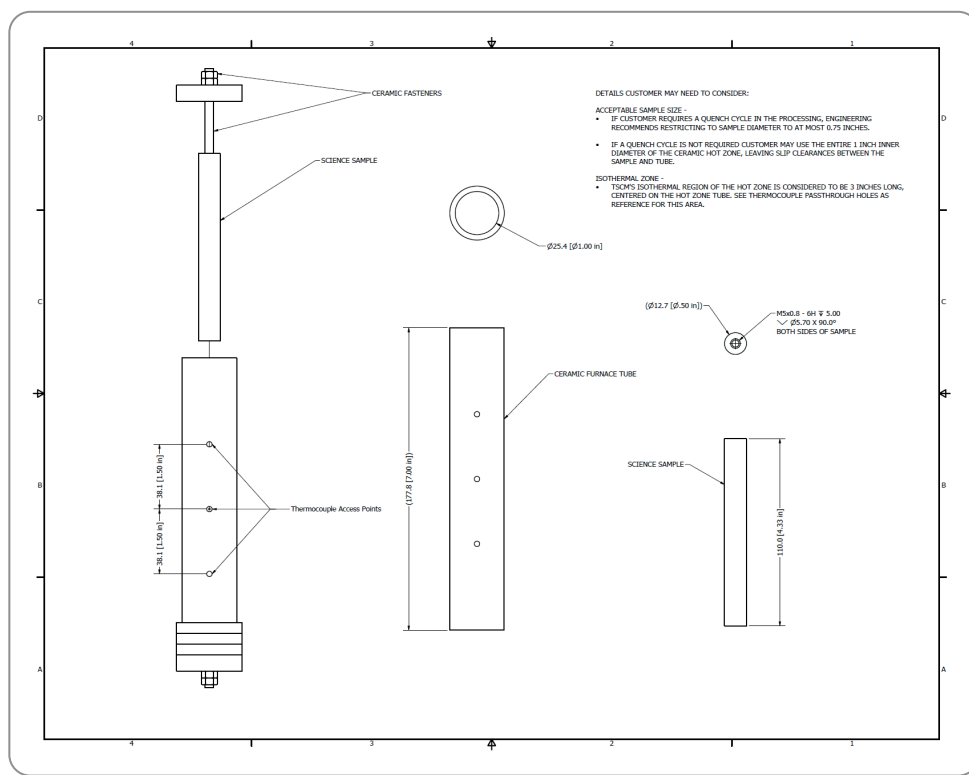


Figure 3: Sample sizing information for interfacing with FORGE.

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