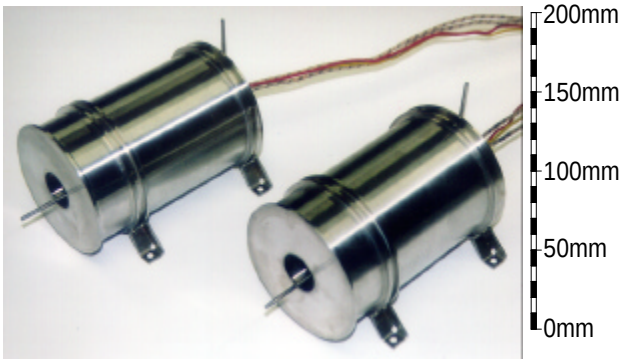
Water Resistojet for Small Satellites

The Surrey Satellite Technology Resistojets are low cost thrusters for drag compensation in low orbits, minor orbit manoeuvres and station keeping. The water resistojet, from the SSTL resistojet series, will be qualified on the USAF MIGHTYSAT II programme in 2000.

The SSTL water resistojet is a thruster designed to produce maximum performance for minimum cost. Use of commercial, flight proven, components and low cost construction techniques lead to low cost hardware. Ground operations and handling costs are also kept low as water is a non-toxic propellant and is stored in low-pressure vessels. Apart from the the Nitrous Oxide flown on UoSAT-12, SSTL is also researching other forms of resistojets. Contact SSTL for further details.

The resistojet is operated by controlling the power supply to the heater. Prior to operation the resistojet is heated, typically for 15 minutes, to achieve a minimum temperature throughout the chamber. De-ionised water then is fed into the thruster and is converted into superheated steam at 1000 K. The steam is expelled through the outlet nozzle to produce a thrust in the order 10 - 100 mN, depending on feed pressure. The resistojet is thermally insulated in order to keep the interior chamber temperatures even and isolate the spacecraft from these high temperatures. Internal temperatures can be monitored via a thermocouple.

The design is very flexible and the parameters specified can be varied over a large range to customise the thruster to suit a wide range of mission requirements. The water thruster has been tested extensively at sea level and under vacuum conditions. The water resistojet can be modified to operate at higher power levels of up to around 600 Watts. Raising the power also increases efficiency, giving an I_{SP} of 220 seconds and up to 270mN of thrust. SSTL can also supply a full feed system and system to support all resistojet applications.



Engineering unit for MIGHTYSAT II programme

Water Resistojet Features

- **Low cost** parts and construction inherent to design
- **Non-hazardous** propellants reduce handling costs and safety requirements
- **Low pressure** system reduces hardware, handling costs and safety requirements
- **Piggyback launches** - the combination of non-hazardous gases and low pressure makes the system inherently compatible with piggyback launches
- **Alternative liquid fuels** to suit applications - Nitrous Oxide, Ammonia, Carbon Dioxide, Propane etc.
- **Testing and PA** plans available. Environmental and Acceptance Testing and PA plans can be tailored to suit customer

Applications

Low-thrust thruster suitable for small satellites:

- Drag compensation
- Phase manoeuvring (e.g. constellation placement)
- Minor Orbit Adjustment
- Station Keeping

Specifications

- Propellant: De-ionised water
- Thrust: typically 45 mN
- Specific Impulse: 152 s @ 100 W
- Feed Pressure: 10 bar
- Flow Rate: 0.03 g/s
- Throat Diameter: 0.3 mm
- Restartable
- Lifetime: Propellant is typically the limiting lifetime factor

Options

- Variable Power Supply: 100 to 600 W
- Variable Working Fluids: Water, Nitrous Oxide, Ammonia, Carbon Dioxide, Propane and others
- Available as part of an integrated system
- Heated System for low temperature applications

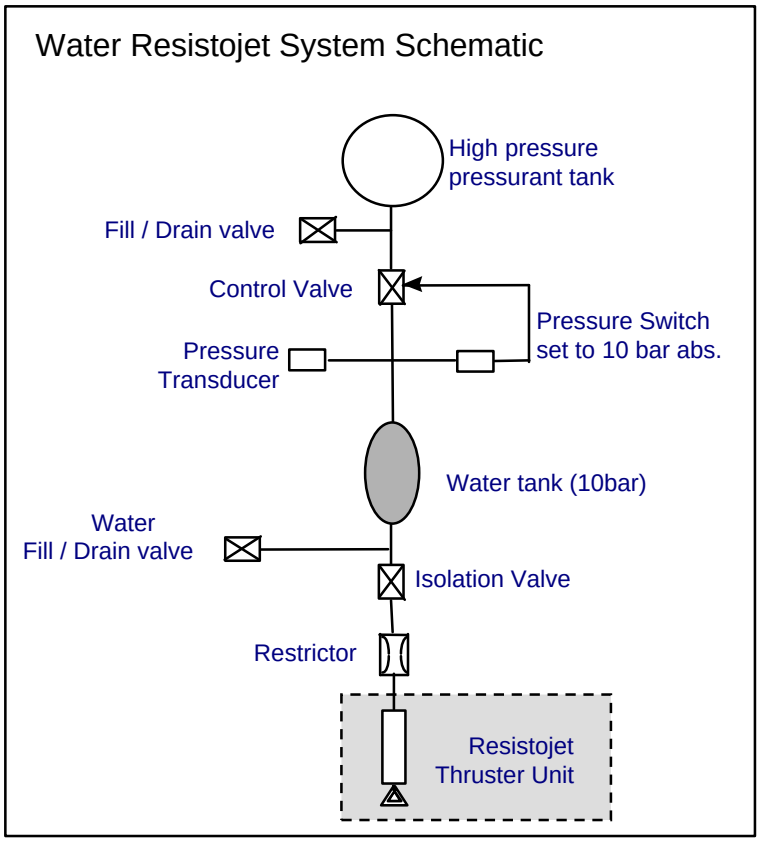
Qualification / Heritage

- Water resistojet to be qualified on MIGHTYSAT II in 2000
- 354 hours of test firing on similar 190W unit.
- Nitrous Oxide resistojet flown on UoSAT-12, launched 1999

Water Resistojet for Small Satellites

Integrated System

A typical water resistojet system schematic is shown below. A high pressure gas source is used to expel water from its storage tanks. The water tanks require either a bladder or a surface tension management device to maintain bubble free propellant at the outlet.



Other SSTL Products

- **Resistojets** based on Nitrous Oxide, Ammonia, Carbon Dioxide, Propane propellants
- **Complete propulsion systems** based on cold gas, resistojet and hybrid (under development) technologies
- **Complete low cost small satellite solutions**, based on SSTL range of nano, micro, enhanced micro and mini satellites, including know-how transfer and rapid and affordable access to space
- **ADCS**: magnetometers, Sun and Earth sensors, star mappers, wheels, magnetorquers
- Other **sub-systems** (CD&H, Power, Communications) and **payloads**

affordable access to space

Environmental (Acceptance Level)

- Random Vibration: 6 g rms for 120 s (designed for higher)
- Thermal:
  - Non-Op: 0 ºC to +50 ºC
  - Op: +5 ºC to +50 ºC
- Radiation: Not radiation sensitive.
- EMC: as per MIL-STD-462

Physical Characteristics

- Dimensions: 95 mm, 141mm length
- Mounting Interface: 4 x M4.5 clearance holes
- Mass: 1.24 kg including 0.5 m flying lead

Power Supply

- Power Consumption: 100 W
- Power Supply: 28 V

Contact

Surrey Space Centre
University of Surrey
Guildford, Surrey GU2 7XH
United Kingdom

Tel: +44 (0)1483 879278
Fax: +44 (0)1483 879503
E-mail: info@sstl.co.uk
www: www.sstl.co.uk

Issue Number & Notice

SSTL-9003-03. 26-02-2002.