MIT Nuclear Reactor Laboratory (MIT-NRL) introduces the High Temperature Irradiation Facility

Reactor Description

The MITR is a **5 MW**, tank-type, heavy-water reflected, light-water cooled and moderated nuclear research reactor that utilizes finned, plate-type fuel elements. **An in-core experimental facility can be installed in place of a reactor fuel element which has a cross-sectional area of 27 cm^2 and a length of 66 cm. Peak neutron fluxes are $1.2x10^{14}$ n/cm^2-s fast and $7x10^{13}$ n/cm^2-s thermal.** The approximate dimensions for each experiment are 5 cm diameter by 60 cm high.

High Temperature Irradiation Facility – Meeting the need of Advanced Materials Development

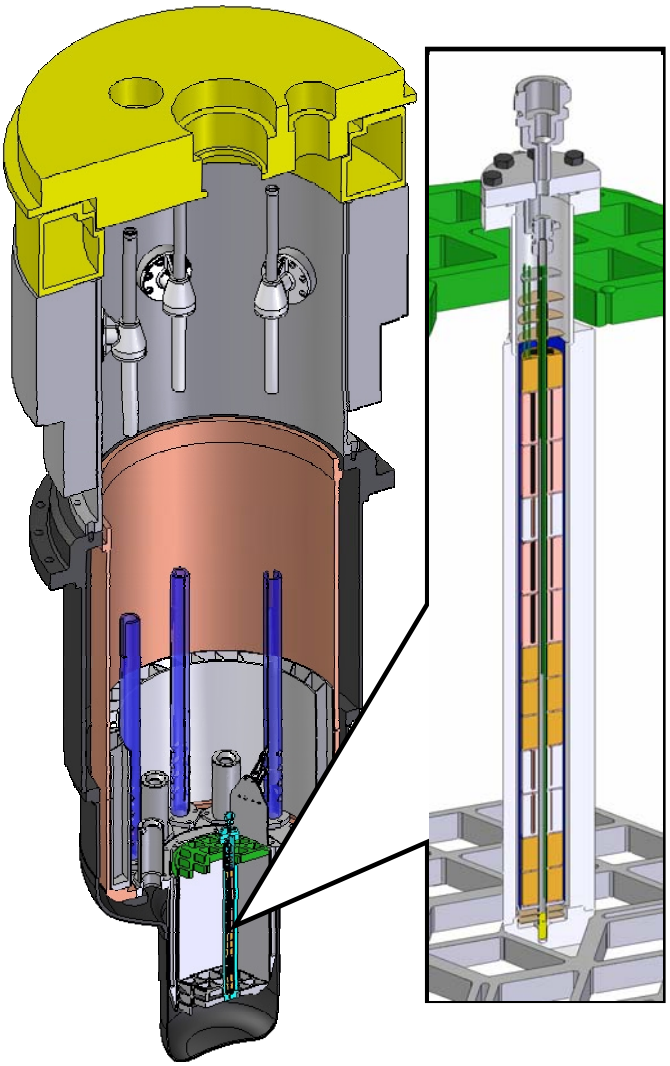
There are limited facilities available to test and develop suitable complementary materials in a very high temperature environment in the presence of neutrons. The HTIF has been developed, and is **capable of irradiation temperatures of 1400°C or even higher.** The facility uses gamma heating in combination with an adjustable helium/neon gas gap to achieve and regulate the desired temperature.

Sample Description

The design makes use of a number of sample "capsules" which are fabricated from a combination of tungsten and graphite. The ratio of tungsten to graphite is adjusted to regulate the amount of gamma heating. Samples are inserted into the capsules.

Tungsten Holders for Bend-Bar and Tensile Specimens

Tungsten Holders Thermal Diffusivity Specimens



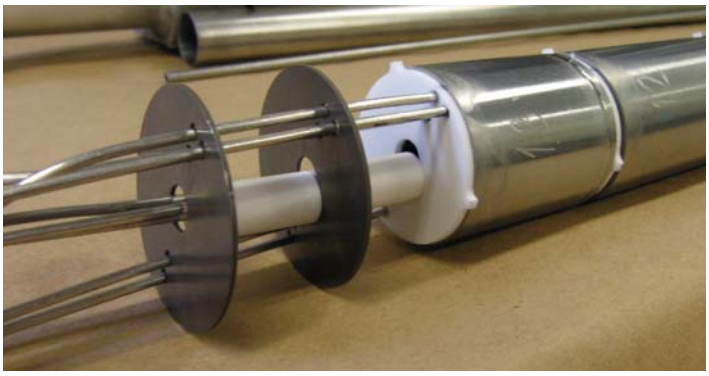
Above: This schematic depicts the HTIF in its in-core position.

Left: Samples used in the first operation of the HTIF.

Below: The HTIF Rig during final assembly.

Temperature Measurement

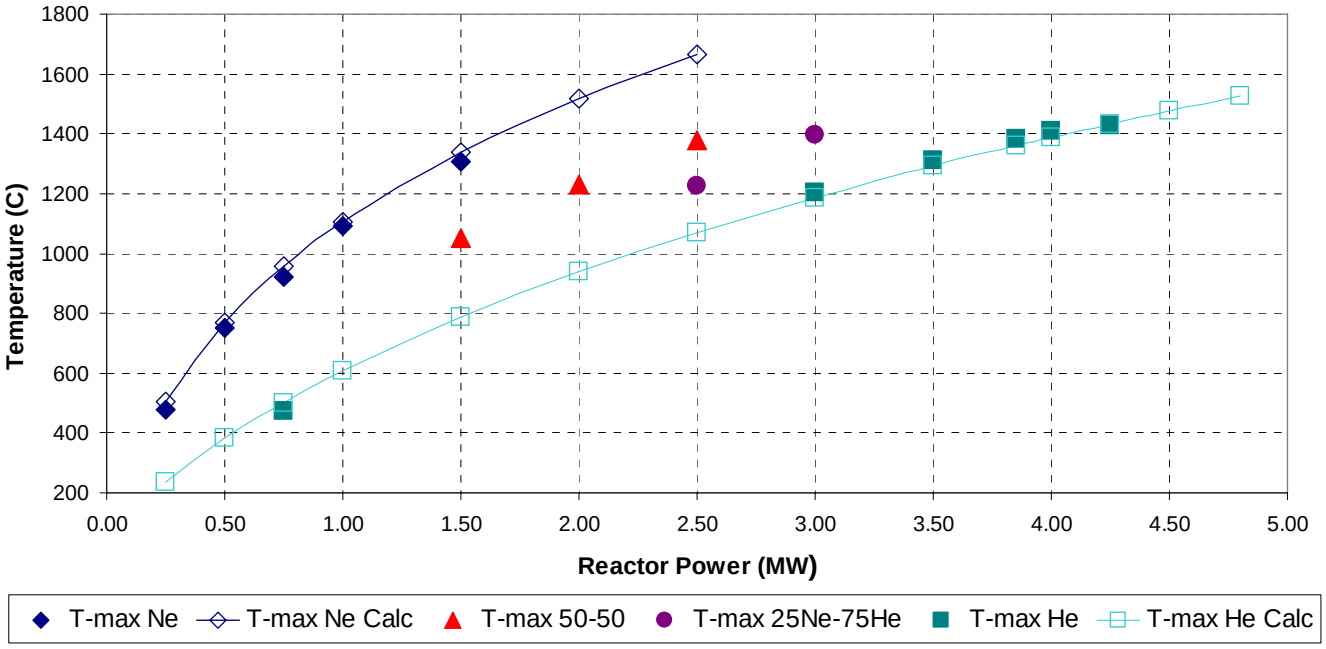
A total of eight thermocouples were installed for the initial run of the HTIF. Of these, three were routed down the central hole of the support spine to axial locations at the bottom sample capsule, the seventh sample capsule (just below the axial midpoint of the core) and the twelfth capsule, which is second from the top. During initial exposure, the relationships between the temperatures at various locations was established and a thermal model for the specific sample capsule/sample configuration was benchmarked.



High Temperature Irradiation Facility – Initial Results

Initial Operation

The facility was installed in the MITR on November 30, 2005. The first "run" is a 3 month irradiation to develop experience and to prove system reliability. Since the He/Ne gas mixture and reactor power can be varied independently within the operating window, a significant degree of flexibility exists. This ability to control temperature and flux independently is very useful for materials testing where dynamic mechanical (creep, etc.) behavior is being investigated.



Above: This is a graphical display of the relationship between the highest temperature capsule and reactor power as a function of He/Ne gas ratio. Calculated and actual values are displayed for comparison.

Below: This is the temperature vs. time profile during the initial insertion period. Several tests were conducted during this period to verify calculations that were used in initial design of the facility and to satisfy the safety analysis. Reactor power was increased in increments with the He/Ne gas ratio adjusted to explore the control band range for the system.