The Experimental Engineering Section
UTS Advanced Physical Technologies

Gianluca Benamati
UTS Principal Activities:

ENERGY:
- Fusion Technology
- Accelerator Driven System development
- Solar energy studies.

ENVIRONMENT:
- ICE core drilling in Antarctica
- Radio-chemistry laboratory
UTS Competencies:

Remote maintenance

Liquid metal technologies

Materials for high temperature applications

Materials corrosion and protection (liquid metals, water, gas)

Component development and testing

Advanced joining techniques
Fusion Technology project

Remote Maintenance

Divertor Test Platform

- Formal operations with the ITER Duct Equipment in the DTP
- Final preparations and actual installation of the CEA/Cybernetix MAESTRO hydraulic servo-manipulator in the DTP.
- Formal operations for the Second Cassette Carrier system in the DTP using an integrated operator environment.
Old cassette mock-up

Fusion Technology project

Remote Maintenance

Divertor Refurbishment Platform

- Final operational trials with the multilink cassette-PFC attachment method in the DRP (and report)
- Technological tests (mechanical and high-current) on the multilink system (and report)
Fusion Technology project

Vacuum chamber and Shield

Friction tests

Friction Coefficient Fiberslip B40
Vacuum value = 4.9 x 10^-6 mbar
p = 100 MPa    T° = 77K
Fusion Technology project

Vacuum chamber and Shield

Fabrication of a first wall panel
Fusion Technology project

Vacuum chamber and Shield

Mechanical testing of the shear keys to be used in the magnet system under cyclic shear loading conditions at cryogenic temperature

Testing equipment:

• Press machine
• Nitrogen cooling tank
• Stress and displacement measurement system
• Temperature monitoring system
• Computerised process and data acquisition system
**ADS project**

**Compatibility test in flowing LBE with a low oxygen activity**

- Corrosion tests
- Tensile tests (after liquid metal exposure)

**Pb-BI FLOW RATE = 4 m³/h**
**Tmax = 500 °C**
**PRESSURE = 4 bar**

![Diagram of ADS project setup](image)
**ADS project**

**Compatibility test in flowing LBE with a low oxygen activity**

### Corrosion tests results

- **AISI 316L** exhibited mainly a Ni depletion
- **T91** shows an uniform attack
- Tensile properties of **AISI 316L** seem to be unaffected by corrosion
- **T91** shows a decrease of ductility

### Tensile tests results

![Graph showing tensile tests results for T91 steel as received and exposed to PbBi for 1500 h.](image)

T91 steel as received

T91 steel exposed to PbBi for 1500 h
ADS project

Compatibility test in flowing LBE with a high oxygen activity

• Corrosion tests
• Oxygen control techniques
**ADS project**

**Compatibility test in flowing LBE with a high oxygen activity**

**Corrosion tests results**

- Both AISI 316L and T91 exhibited weight gains, and an oxide scale formed on the surface of specimens.

- This oxide layer prevented further attack induced by dissolution.

- T91 shows an oxide scale thicker and more uniform than AISI 316L.

- Sensors for oxygen activity measurement have been qualified.

**Oxygen control techniques**
**ADS project**

**Large scale experiments: CIRCE facility**

- Investigation of the hydraulic, chemical and mechanical issues related to the development of the LBE - cooled XADS in a pool configuration
- Thermal hydraulic data base creation

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**Main Vessel (S100) characteristics**

- Outer diameter: 1200 mm
- Wall thickness: 15 mm
- Height: 8500 mm
- LBE inventory: 70 tons
- Temperature range: 200 – 550 °C
- Electric heaters (planned) for core power simulation: 1 MW
The obtained information allowed to calibrate the CIRCE measuring system and to verify the accuracy and repeatability of the measurements.
Large scale experiments: calibration of a flow meter

- Tests to calibrate the Venturi-Nozzle flow meter that will be used during the enhanced circulation test have been performed

First analysis on the obtained results show a good agreement with the theoretical curve supplied by the constructor.
Liquid metal and hydrogen technologies

Lead lithium / water interaction, activity on LIFUS 5 plant

- water injection pressure: 60, 100, 155 bar
- water sub-cooling: 30, 50 °C
- liquid metal temperature: 330, 350 °C

LIFUS 5 FACILITY
**Liquid metal and hydrogen technologies**

**Lead lithium / water interaction, activity on LIFUS 5 plant**

**Pressure evolution in the reaction and expansion vessels: comparison between test n. 3 and n. 4 on LIFUS 5**

**Temperature evolution in the upper part of the reaction vessel: comparison between tests n. 3 and n. 4 on LIFUS 5**

Test n.3:
- water temperature 295 °C
- liquid metal temperature 330 °C

Test n.4:
- water temperature 325 °C
- liquid metal temperature 330 °C
Liquid metal and hydrogen technologies

Qualification of tritium permeation barriers in Pb-17Li

Operating conditions

- Temperature range 250-500°C
- Hydrogen or Deuterium pressure range 1-1000 mbar
- Permeation measurements in gas phase or in stagnant molten Pb-17Li
- Gas bubbling through the liquid or flowing on the surface
- Two specimens in parallel (tube-shape)
Liquid metal and hydrogen technologies

Qualification of tritium permeation barriers in Pb-17Li

Extensive experimental campaign on aluminised coatings

- Specimens produced with Hot Dipping Technique (FZK) and CVD (CEA) have been tested.

- PRF in gas phase for tubular specimens is lower than for disk samples.
- PRF of the same specimen strongly decreases in Pb-17Li.

Permeability of HD coated specimen in Pb-17Li
Liquid metal and hydrogen technologies

H&D Diffusivity and Permeability through Pb-17Li

Operating conditions:
- Temperature range 250-500°C
- Pb-17Li thickness precisely controlled
- Hydrogen or Deuterium pressure range 1-1000 mbar

Calibration of the device LEDI has been performed; Tests at 400 and 500 °C were carried out; Modelling of the hydrogen transport phenomena in Pb-17Li was improved
Liquid metal and hydrogen technologies

Hydrogen permeation through materials

Operating Conditions:

- Temperature range 150°C-800°C (upgraded version)
- Hydrogen or deuterium pressure range 1-1000 mbar

- W,W-La, Re specimens
- Steels (MANET, F 82H, Eurofer 97)
- Coated materials
Solar thermal energy project

Materials compatibility studies in molten nitrates

- Stagnant compatibility tests on austenitic and ferritic steels (AISI steels and ASTM steel)

The corrosion mechanism have been investigated

Corrosion rates, resistance of welds and stress corrosion behaviour have been evaluated

AISI 321 550°C 6000 hs unwelded

AISI 321 550°C 6000 hs welded
The main objective of European Project for Ice Coring in Antarctica is to drill two new deep ice cores in Antarctica to obtain full documentation of the climatic and atmospheric record changes in the past 500,000 years.

The first core was drilled at Dome Concordia in the Indian Ocean sector of the East Antarctic plateau. The perforation, started in 1997, reached the depth of -3201.03 m in January 2003.
The control of the Epica drill at Dome-C is made by an electronic system that has been developed by the ENEA people of Brasimone Research Center.

It is made of four modules: a communication and power module, a CPU module, a driver motor module and a motor module.

The second core was drilled in Dronning Maud Land, in the Atlantic sector of Antarctica. The perforation, started in 2001, reached the depth of -1564.80 m in January 2003.
THE ENVIRONMENTAL RADIOMETRY LABORATORY OF BRASIMONE
THE ENVIRONMENTAL RADIOMETRY LABORATORY OF C. R. ENEA OF BRASIMONE, WORKS FROM OVER 15 YEARS, INTO THE FIELDS OF:

- measure of naturals and home made environmental radiopollutants
- radiometrical analysis of foods and environmental matrices
- report emission for Import/Export trade certifications