Jül-Conf-45 C4

I C A N S - V

MEETING OF THE INTERNATIONAL COLLABORATION ON

ADVANCED NEUTRON SOURCES

June 22-26, 1981

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Summary of Session A4: "Radiation Effects in Targets and Structure Components"

There were two contributions under this direct heading: by W Lohmann of KFA (Jülich) on "Remarks on the Irradiation Effects on the Performance of a Rotating Tungsten Target for the SNQ" and C Tschalär (SIN) on "The SIN Liquid Metal Target". In addition the meeting heard an interesting paper by Prof M Heindler of the University of Graz on "Spallation in a Nuclear Energy System".

The present SNQ reference target is a rotating wheel, 2.5 m in diameter and containing some 9000 target elements of lead clad with aluminium. Total heat generation is about 5MW and cooling is obtained by flowing light water between the target elements. Wolfgang Lohmann presented a modificaiton to the basic wheel concept of replacing the lead target elements with unclad tungsten ones. The advantages of such a system were:

- Cooling need only be provided above and below the target elements, which simplifies the cooling channels; moreover the proton beam no longer passes through the coolant.

- Safe to operate, with low temperatures and stresses on the elements.

- Easy to make, with simple tungsten rods produced from powder metallurgy, possibly with Re alloying. This contrasts with the aluminium cladding required for the lead, with the need to prove integrity.

- No significant degradation of neutronic performance.

Radiation damage effects were discussed in detail and damage data were presented for proton and neutron irradiations, for example, after 2 years' operation 7.3 dpa, 440 appm He and 4000 appm H. We note for comparison that for IPNS-1 dpa are 7.2/year and for SNS, dpa 440, 0.3 ℓ He, 1.6 ℓ H_2 (per year averaged over the whole target). The consequences of radiation gas production were discussed and the need to test He released from sintered tungsten was noted. No, or very little, void swelling was expected. The changes of mechanical properties were discussed, but there is a saturation of mechanical changes after 0.5 dpa and there should be no problems by strength increase. However under irradiation there may be a shift of DBTT to higher temperatures, so that DBTT should be kept as low as possible, perhaps by alloying. It was proposed to do tests on this under SNQ-type conditions.

The proposal to use tungsten target elements was well received by the participants: indeed it was felt at this, and at the special Heidelberg meeting to review SNQ, that it could well replace the "lead target" as the SNQ reference target design.

A discussion of radiation damage was also contained in the presentation by Chris Tschalär in session A7 on Liquid Metal Targets, and summarised by him in section C 6. Several examples of practical materials under proton irradiation in operating conditions were considered, notably

- reactor graphite (60 mA-h/cm^2, SIN, 600 MeV)
- pyrolytic graphite ($\gtrsim$ 800 mA-h/cm^2, LAMPF, 800 MeV)
- Inconel 718 (400 mA-h/cm^2, LAMPF, 800 MeV)
- Stainless Steel ($\sim$ 50 mA-h/cm^2, TRIUMF, 500 MeV)

where the numbers in brackets indicate the operation lifetime or experience. Fuller details are given in the paper by Dr Tschalär, but questions were raised of further materials, eg glassy carbons. The continued study and testing of possible structural materials for use in the various neutron sources, in building or being planned, is of vital interest.

The final paper of the Target Station session was by Professor Martin Heindler of the University of Graz on "Spallation in a Nuclear Energy System". The outstanding problems associated with fission are a) limited fuel resources, b) reprocessing and proliferation, c) radioactive waste and d) public acceptance. This last problem is in many ways the most "difficult", however Professor Heindler felt that if a), b) and c) could be solved d) would become "easy"!

We are looking for a synergetic system which might utilise the spallation process or fusion. Spallation based systems could breed fuel, or incinerate radioactive waste or provide full cycle rejuvenation, whereas fusion systems could provide fast fission breeding. At best we are seeking an overall synergetic system in which there is an overall energy output. No solutions exist yet which include engineering and economic feasibility and practicability.

Professor Heindler discussed the case of ENB based on the symbiont system of a thermal reactor plus large linac (of typically 1.5 GeV, 300 mA). Support ratios were given for various kinds of reactors and, in general, about 1.5 t/a per GW of beam power was required; a figure of merit was also described as effectively Power available/Power produced. Domains of efficiency against several parameters including annual growth were shown.

There was much discussion related to the various types of thermal reactor that might be involved in such a system; there was also felt a need of hard economic values rather than parameterisation (eg how many kW-hrs per dollar?). Large linacs at such high currents are difficult and expensive machines to operate and require much further detailed study as does a target arrangement in such a system.

Overall the whole business of ENB is a very exciting one, with many problems to satisfy the accelerator and target station builders, with the ultimate goal of serving mankind with a safe, fuel efficient energy source.