SESSION FT2

Friday, 23 October 1998, at 10.50 a.m.

Chairman: M. Seki (Japan)

FUSION TECHNOLOGY 2

Paper IAEA-CN-69/FT2/1 (presented by O. Motojima)

DISCUSSION

G.H. NEILSON: Congratulations on the successful construction and rapid commissioning of LHD! Regarding the rapid change of trim coil currents for coil protection tests, do you have a capability for varying these currents in normal operation for dynamic control of plasma configuration, and on what timescale?

O. MOTOJIMA: Thank you very much for your warm encouragement. LHD is operated essentially in a steady field. However, poloidal coil currents can be changed for physics experiments at a rate of about 0.1 ~ 0.2 T/s, and this corresponds to a 20% maximum change of coil currents in 5 s.

H. ZUSHI: My question concerns the safety procedure for the SC coil quench system. LHD has many high power heating systems which create noises that could lead to false triggering of the quench system. What technique do you foresee to avoid these noises?

O. MOTOJIMA: The quench detector can produce two kinds of signal: 1Q and 2Q. 2Q is initiated immediately after the signal is detected and works to stop the heating systems. If, after 3 ~ 5 s the quench detector still recognizes the signal for unbalanced coil voltage, then the 1Q signal, for current ramp down in 20 s, is initiated. The coils have sufficient capability to withstand this process. For example, the noise from the heating systems can be filtered for a short time following initiation of the 2Q signal.

Paper IAEA-CN-69/FT2/2 (presented by M.A. Pick)

DISCUSSION

N. NODA: What is the major gaseous component with tritium in the exhaust and what is the fraction of tritiated hydrocarbon? Do you apply tritium reprocessing to tritiated hydrocarbons, such as tritiated methane?

M.A. PICK: I cannot give you an exact percentage but the hydrocarbon fraction is certainly very small. Tritium reprocessing is applied to the hydrocarbon component.

Paper IAEA-CN-69/FT2/3 (presented by T. Hirai)

DISCUSSION

N. NODA: You discuss the depth distribution of damage on the molybdenum surface in relation to the energy spectrum of CX neutrals - but only for the high temperature mode. Have you tried applying the same method to the low temperature mode? Is the distribution different from that in the high temperature case?

T. HIRAI: We have carried out the specimen-probe experiments in the low ion temperature plasma in TRIAM-1M. However, the specimens were mounted on an athermal system and the temperature was not measured. It is difficult to make a direct comparison of the depth distribution of defects in low and high ion temperature plasma experiments because of the thermal diffusion of defects. It was, however, observed that the depth distribution in the low ion temperature plasma irradiation was shallower than in the high ion temperature plasma irradiation.

Paper IAEA-CN-69/FT2/4 (presented by A. Möslang)

DISCUSSION

E.P. KRUGLYAKOV: It is known that the IFMIF does not have an adequate spectrum in comparison with 14 MeV fusion neutrons (there is an energetic tail of neutron energies above 14 MeV). Right in the vicinity of 14 MeV, there is dramatic growth of the activation cross-sections of many materials. Are you sure that you will be able to explain all the test results?

A. MÖSLANG: Indeed, the IFMIF neutron spectrum is peaked at 14.6 MeV with a higher energy tail with a rapidly reducing density. Based on extended (0-50 MeV) data libraries, extensive neutron transport calculations (MCNP code) and nuclear inventory calculations (benchmarked ALARA code) have shown that, with respect to the most important transmutations H and He, IFMIF exactly meets the related production rates of DEMO blankets. With respect to mechanical properties, isotopes with a threshold just above 14 MeV do not play a significant role in all the relevant material classes currently under investigation (reduced activation ferritic/martensitic (RAFM) steels, vanadium alloys, SiC/SiC). In RAFM steels, for example, the dose rate (Sv/h) of IFMIF irradiated specimens is less than 30% above that of DT-neutron irradiated specimens (P. Wilson, Ph.D. thesis, 1998, FZK Karlsruhe).

E.P. KRUGLYAKOV: Why do you not examine the $H+T \rightarrow n$ reaction where there is no energetic tail in the neutron spectrum?

A. MÖSLANG: The T+H reaction does indeed give a favourable neutron spectrum. For example, S. Cierjacks et al., have made a detailed investigation of such a source (tritium beam on H_2O jet) and proposed it as an alternative to the D-Li reaction. Despite the ideal neutron spectrum of the latter, a D-Li based source has been preferred, mainly because of the technological risk and safety arguments.

R.J. GOLDSTON: Some of the important issues for fusion systems are concerned with joining technologies and also with interactions between different materials. Can these issues be addressed adequately in IFMIF?

A. MÖSLANG: The basic thrust of IFMIF at present is to qualify materials (including small welds, for example) rather than components. Mock-ups could follow at a later stage. Large components based on the materials database, however, will have to be tested in another timescale in volumetric neutron sources.

H. MATSUI: Firstly, I would like to congratulate the international IFMIF team on its tremendous achievements during the CDA and CDE phases. IFMIF's primary task is, of course, to qualify material for DEMO. I think it is also very important to perform tests to validate the idea that, for instance, reduced activation ferritic steel, F82H, will be suitable for DEMO. On the basis of the current data, we know that He effects are probably not too serious to limit the performance of F82H in a fusion environment. However, in the absence of a fusion-relevant irradiation environment, this may be just wishful thinking. I think it is necessary to validate this “wishful thinking” before starting time-consuming material qualification tests.

Another issue that I consider important is the effect of non-steady irradiation conditions, which are anticipated in DEMO and commercial reactors. This may have a tremendous impact on material performance. These issues are apparently to be addressed in the initial phase of IFMIF operation, where the beam current may not necessarily be 250 mA. Can you comment on this?

A. MÖSLANG: Thank you for those important comments. The present reference test matrices, which already include 11 different types of alloys, are indeed only proposals and subject to modification, depending on knowledge and progress. In addition, a materials database would also include low and medium dose irradiated specimens that could be used for mechanistic investigations or to study, for example, transient effects.

Even from a technical point of view, IFMIF would not start right away with 250 mA. The user community will certainly be welcome during the start-up phase to qualify test modules, instrumentation, etc., or to perform lower dose rate experiments. If a “staged approach” towards full performance of IFMIF became part of the official IFMIF schedule, the users would have even more opportunity to perform experiments for a limited period, e.g. at a beam current of 50 mA for beam cycling tests. At a later stage, lower or medium dose experiments will be possible at any time, e.g. using the medium flux test modules. In this flux region the test modules could be modified to allow for “non-steady” irradiation conditions.

D.D. RYUTOV: You indicate that the accelerator will be a hands-on maintenance facility. This implies that the halo current will be very small. Do there exist prototypes with the required current and energy to satisfy this constraint?

A. MÖSLANG: With regard to the accelerator and beam lines (0-40 MeV) system, hands-on maintenance is presently based on beam transport calculations and experience from 52 MeV deuteron beams at FZK, Karlsruhe, Germany. However, experimental verification of the IFMIF accelerator system has not yet been carried out. I should add that the IFMIF design does not exclude remote handling in the event that hands-on maintenance fails.

Paper IAEA-CN-69/FT2/5 (presented by R.J. Kurtz)

DISCUSSION

J. SHEFFIELD: You indicate that swelling at 200 dpa in a ferritic steel was < 2%. Is 2% swelling of first wall/blanket elements acceptable in a power plant? A limit of < 0.2%, i.e. 2 mm per metre, would seem more reasonable as a design goal.

R.J. KURTZ: I cannot say what level of swelling is acceptable for the first wall/blanket components, as this is primarily a design issue. Certainly, lower swelling is preferable, and it may be possible to define a design window that avoids unfavourable swelling regimes.

Paper IAEA-CN-69/FT2/6 (presented by K. Abe)

There was no discussion.