NINETEENTH FUSION ENERGY CONFERENCE

SESSION FT/1

Tuesday, 15 October 2002, at 16:10

Chair: A. KITSUNEZAKI (Japan)

SESSION FT/1: Technology Developments

Paper IAEA-CN94/FT/1-1Ra,b,c,d (presented by A. Kimura)

Discussion

R.J. Goldston: You said that you had performed experiments doping ferritic steel with 600 ppm of helium. Could you tell us what $MW\cdot yr/m^2$ this corresponds to?

A. Kimura: It is 4 $MW\cdot yr/m^2$ when the production rate is 15 appm He/dpa.

R.J. Hawryluk: You mentioned that only ferritic steels will be available for DEMO. How long will it take to qualify vanadium or silicon-carbide?

A. Kimura: The maturity of these advanced materials is far from that of ferritic steels. The point may be industrial engineering basis. At present, industry expects SiC/SiC to be aerospace material, while it appears that vanadium alloys have not been considered as structural material in non-nuclear fields. Furthermore, the database of advanced materials is still limited. It will take more than 15 years to evaluate their qualifications.

Paper IAEA-CN94/FT/1-2 (presented by A. Moeslang)

Discussion

R.J. Goldston: Your schedule indicates that you have complete information for ferritic steels halfway through the design of DEMO. Is that OK?

A. Moeslang: The present EU "roadmap to fusion power" includes the elements "DEMO pre-design" (2020–2023), "DEMO licensing and construction" (2023–2027), and "information complete" (~2026). If IFMIF can start operation in 2016, 80 dpa data on key properties of selected materials would be available in 2023, and data up to 150 dpa in 2026.

K. Lackner: For DEMO the necessary condition for starting design and licensing is assumed to be only 80 dpa. (Of course it is hoped and expected that during DEMO operation, forthcoming information will actually allow operation up to higher fluences.) For the "information complete" milestone, demonstration of resilience up to 150 dpa is assumed. According to the schedule shown, this should also still be possible before actual DEMO construction starts.

J.D. Sethian: What is the overall efficiency of the accelerator?

A. Moeslang: In order to have 120 mA with 40 MeV at the Li target, the source must produce 155 mA D^+ at 95 keV. In that respect, the efficiency is above 80%.

D.D. Ryutov: In one of your first slides, it was stated that no next step fusion facility would satisfy the requirements for an intense neutron irradiation facility. I would think that at least one such facility, namely the GDT neutron source, would in fact satisfy these requirements. In addition, it would boost fusion-related technologies. Would you agree with such an assessment?

A. Moeslang: The exact statement was, "There is presently no neutron source that combines (i) fusion similar spectrum, (ii) high fluence for accelerated testing, and (iii) sufficiently large test volume". As was shown a few years ago, the GDT mirror machine can indeed provide very suitable irradiation conditions for materials testing. However, the generation of a fusion materials database requires soon a technically proven neutron source with high reliability and availability. Because the development of a technically proven GDT-NS with 70% availability certainly exceeds 8–10 years, it would be welcome later to serve, with its reasonably large plasma facing surface of ~1 m^2, as a test bed, e.g. for blanket mock-ups.

Paper IAEA-CN94/FT/1-3Ra,b (presented by W.R. Meier)

Discussion

K. Lackner: What is the estimated limit upon the single microexplosion events tolerable by liquid-wall designs?

W.R. Meier: I do not know what the limit is. Current design studies have target yields of ~400 MJ, but past studies considered yields greater than 1000 MJ. The liquid blanket is made up of many individual jets. Experiments and theory show that this jet array absorbs and dissipates the shock before it hits the first wall.

Paper IAEA-CN94/FT/1-4 (presented by M.O. Ono)

Discussion

D.N. Hill: Do you view the ST as the most cost effective way to produce neutrons for a component test facility, or are there other reasons to pursue the ST as a CTF?

M.O. Ono: We view the ST as a very cost effective way to produce neutrons for a CTF which will test and develop reliable high performance reactor core components such as the blanket module needed for a DEMO. Perhaps more importantly, the limited availability of tritium in the coming decades requires a CTF to consume a minimum amount of tritium. We believe that an ST-based compact CTF is such a facility. I should also note that the NSST facility is a physics facility which is designed to provide the physics basis needed for the design and construction of an ST-based compact CTF in a timely fashion. NSST will also develop advanced physics scenarios to further optimize the CTF capability as well as to provide data to help design attractive DEMOs and power plants. So we believe that the ST has both the near-term and longer-term potentials for fusion energy development.

Paper IAEA-CN94/FT/1-5 (presented by H.R. Wilson)

Discussion

S.A. Sabbagh: $\beta_N = 8$ could be possible in the ST, but should require wall stabilization and/or active feedback. Have you considered this in your design?

H.R. Wilson: It is true that the equilibrium considered requires a conducting wall at ~0.2a (a = minor radius) to stabilize n=1, 2, 3 external kink modes. Stabilization of the resistive wall mode (RWM) will therefore be required, but has not been explored in detail. Nevertheless, the planned 40 MW NBI may be an important tool for RWM stabilization.

G. Logan: Do you agree with the conclusion of the ARIES study that an ST reactor cost of electricity is higher than for an advanced tokamak at a net electric power of 1 GW(e)? Would an ST cost of electricity become less than for an AT reactor for $P_{net} > 3$ GW(e)?

H.R. Wilson: Our cost analysis model has been benchmarked against that of the ARIES team and a recent UK fission plant costing. Applying our cost model to the ST, the cost of electricity is comparable to, but slightly higher than, the ARIES predictions for aggressive advanced tokamak 1 GW(e) power plants. Although we have not done a detailed analysis, one would expect the cost of electricity to be lower in larger power units for both the ST and AT reactors. Whether the cost of electricity from an ST reactor would become less than for an AT reactor at higher powers is a possibility which we have not yet explored.

Paper IAEA-CN94/FT/1-6 (presented by H. Wobig)

Discussion

M. Gasparotto: Does a power plant based on this concept, in order to reach a high tritium breeding ratio, need more space for the breeding blanket?

H. Wobig: This has been taken into account in our power plant HSR4/18, which was presented at the IAEA Conference in Sorrento. In this device the coils had a large distance to the plasma. As a result the magnetic field on the coils increased to 10 T instead of 8.5 T in the proposed ignition experiment.