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First Wall Lifetime Extension with Flowing Liquid Zone for Fusion Reactors

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The structural material should have the properties given briefly as below:
• Low neutron absorption cross sections.
• Adequate mechanical properties before and after irradiation.
• Operation at a wide temperature window.
• Working at high temperatures.
• Resistant to atomic displacement and helium generation damage.
• Low activation property under 14 MeV neutrons.
• High thermal conductivity.
In this work, different structural materials were subject of investigations. The calculations are conducted for a fusion power generation of 1 GWel over 30 years of reactor operation with a thermos-dynamical conversion efficiency of 35 % leading to 2.857 GWth by a capacity factor of 100 %. One of the candidates as structural material is the oxide dispersed steel (ODS). At first, a fusion-fission (hybrid) with a multi-layered spherical blanket has been investigated, which is composed of a first wall made of oxide dispersed steel (ODS, 2 cm); neutron multiplier and coolant zone made of LiPb; ODS-separator (2 cm); a molten salt Flibe coolant and fission zone; ODS-separator (2 cm); graphite reflector. In the second phase, LiPb coolant zone behind the first wall has been removed. But instead, a flowing liquid protective first wall is included in front of the solid first wall in order to reduce material damage and residual radioactivity after final disposal of the latter.
SS-304 type steel, SiC and graphite were also selected as structural materials of a magnetic fusion energy (MFE) reactor. Different types of liquid coolant with tritium breeding capabilities (FLIBE, Li17Pb83, natural lithium, all with natural lithium component) are investigated to protect the first wall from neutron- and bremsstrahlung radiation and fusion reaction debris.

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Turkey

Primary author: Prof. ŞAHIN, Sümer (ATILIM University)

Presenter: Prof. ŞAHIN, Sümer (ATILIM University)

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