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Understanding roles of neutrons in advanced fusion reactors

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The Deuterium-Tritium (DT) reaction is the key reaction in fusion reactors; leading to neutron and helium production. Most of the fusion energy (>80%) in such reaction is carried away by neutron. Conversion of neutron kinetic energy to any other usable form is very important for power generation in fusion reactors. The successful reactor design is thus highly dependent on this energy conversion. Only a few nuclides are effective for such purpose. On the other hand, neutrons as uncharged particle does not feel the Coulomb interaction and hence undergo nuclear reactions with materials surrounding the reactors, namely, the innermost wall which facing DT plasma, structural materials, vacuum vessel, magnets, etc. Some of these reactions lead to hydrogen and helium production in the materials. With the reactor working conditions, bubbles are formed accordingly, and embrittlement takes place in turn; therefore, shortening the lifetime of reactor materials. With the neutron fluence reaching 10^{22} n/m^2 in many advanced reactor design, these adverse effects cannot be simply ignored. Understanding its roles will help balancing the two faces of neutrons; thus better energy conversion and extending the materials performance. This contribution summarizes some of the latest updates about energy-converted materials and activation reduced materials.

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