

Analysis on Initial Tritium Supply for Starting up Fusion Power Reactor FDS-II

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Tritium is one of the fuels used in fusion reactor, and is hardly found in nature. So tritium should be produced in the blanket to make tritium self-sufficient. Because of its radioactivity and violent activity, tritium is very easy to permeate out of the container during the fuel circulation, and this will result in the losing of nuclear fuel and the potential radioactive hazard to workers and publics. In addition, the price of tritium is very expensive. So design and analysis on the initial tritium supply for starting up a fusion reactor to maximize the efficiency of tritium use and reducing the release of tritium into environment are very important for improving the economy and safety of fusion reactor.

FDS-II is a fusion power reactor designed by FDS Team in China to exploit and evaluate potential attractiveness of pure fusion energy application on the basis of conservatively advanced plasma parameters. In this paper, the initial tritium supply for starting up FDS-II were done by using the Tritium Analysis Software (TAS) developed by FDS Team, in which some factors which will affect tritium supply were considered, such as tritium breeding ratio (TBR) in the blanket, tritium fractional burnup in the plasma, the efficiency of tritium extraction system (TES) etc.. The results showed that the initial tritium supply for starting up will be reduced little with increasing the TBR and the efficiency of TES, but it will be reduced obviously with increasing the tritium fractional burnup in the plasma. Considering the sensitive analysis and referring the other reactor designs, the selection of a tritium burn fraction 0.05 is considered to be reasonable for FDS-II. The minimum initial tritium supply for starting up is ~8.88kg, the maximum initial tritium supply is ~18.25kg. Fusion reactor can't make tritium self-sufficient with too low initial tritium supply, but the safety and economy of reactor will be reduced for the high tritium inventory and tritium decay with much high initial tritium supply. Considering the potential malfunction in the fuel cycle system and ensuring the reactor running continuously before solving the malfunction, it is reasonable to keep the initial tritium supply for FDS-II as 18.25kg.

Key words: Fusion reactor; Tritium supply; start up