An analytic expression for the tritium burnup fraction in burning plasma devices

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Abstract. The tritium burnup fraction, f_{burnup}, can strongly affect the design of a fusion reactor since it influences the size of the tritium reprocessing plant, on-site tritium inventory, and hence the licensing requirements and cost of the entire plant. In this paper a simple analytical expression for f_{burnup} is derived and then applied to typical parameters proposed for three possible fusion devices: ARIES-AT, FDF, and ITER. We find that for these parameters the burnup fraction is most strongly affected by the global recycling coefficient (through the global replacement time), and fueling efficiency. The latter term may be the most easily influenced by plant design such as high field side pellet injection, for example. Due to the hotter edge plasmas in these devices compared to present day tokamaks, the recycling coefficient will be lower, reducing the tritium burnup fraction. While this may not adversely affect ITER, which is limited to 400 second pulses for the inductive scenario, the tritium reprocessing for nearly continuous operation of devices such as ARIES-AT must be carefully considered in the overall plant design.