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Addendum to [Giaccardi et al., 2024]: On the definition of the escape rate coefficient

For the sake of clarity in definitions of parameters commonly used in the open literature concerning the description of the release of fission products from the failed cladding towards the coolant, we would like to provide a brief addendum to our publication (Giaccardi et al., 2024). The *escape rate coefficient* ε_i (s^{-1}) of the i-th isotope is formally defined from a gas balance in the fuel rod free volume (Beraha et al., 1980; Eq. 8 in Giaccardi et al., 2024)

$$\frac{dn_i}{dt} = q_i - \varepsilon_i n_i - \lambda_i n_i \quad (1)$$

where n_i (at m^{-3}) is the mean concentration in the fuel rod free volume, q_i (at $m^{-3}\ s^{-1}$) is the release rate of the i-th isotope from the fuel into the free volume, λ_i (s^{-1}) is the decay constant of the i-th isotope.

Following (Lewis et al., 1986), one can assume "steady-state" operating conditions, i.e., $dn_i/dt = 0$, for which we obtain the release rate from the fuel rod free volume R_i ($m^{-3}\ s^{-1}$) as (Eq. 5 in Lewis et al., 1986)

$$R_i = \varepsilon_i n_i = \frac{\varepsilon_i q_i}{\lambda_i + \varepsilon_i} \quad (2)$$

Obtaining the escape rate coefficient is the critical point of such formulation, and several indications in this direction are provided in (Veshchunov, 2019) in different operational regimes.

In our previous work (Giaccardi et al., 2024), we assumed "no accumulation" of gas in the free volume, i.e., $q_i = \varepsilon_i n_i$. with the notation of Eq. (1), which is valid for long-lived isotopes, $\lambda_i \ll \varepsilon_i$ (and becomes applicable to all measured isotopes in the case of a relatively large value of the escape rate coefficient, $\varepsilon_i \gg 10^{-4}\ s^{-1}$). This allows using values of n_i and q_i predicted from fuel performance calculations to estimate ε_i in this limit (Table 1 in Giaccardi et al., 2024). Given the different underlying assumptions and definition, in this context we propose to refer to this quantity (denoting it $\widehat{\varepsilon}_i$) as *evacuation rate at equilibrium*, instead of escape rate coefficient, and with such naming we hope to clarify the notation in our previous paper. Notably, such *evacuation rate at equilibrium* is not dependent on the decay rate, whereas this dependency has been experimentally observed for the escape rate coefficient of long-lived isotopes. Each of these two quantities is suitable for specific experimental conditions and for specific modeling approaches of the release rate from the fuel rod free volume (e.g., interpretation of experimental data, use in a predictive model for release from defective fuel rods, further modelling the escape rate itself and its relation to the release rate from the fuel rod free volume).

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

No data was used for the research described in the article.

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