Breeding

K.S. Rajan

Professor, School of Chemical & Biotechnology

SASTRA University

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1 Quiz

1.1 Questions

1. Determine the reproduction factor in a fast reactor operating with a pure fuel whose fission and absorption cross sections are 1.85 b and 2.11 b respectively. The average number of neutrons produced per fission is 2.98

2. The following data pertain to a nuclear reactor utilizing enriched uranium (N_{U-235}/N_{U-238}=0.025) and operating in thermal spectrum:

U-235	U-238
σ_f = 586 b σ_a= 681 b υ = 2.42	σ_f = 0 b σ_a= 2.7 b υ = 0

Determine the reproduction factor.

3. The following data correspond to Pu-239 in a thermal reactor.

σ_f = 752 b
σ_a= 1022 b
υ = 2.87

Determine the reproduction factor if the fuel is pure.

4. Consider the answers for reproduction factor in the example problems 1 to 3 & assignment problems 1 to 3. Identify whether breeding is impossible/possible but not probable/possible and probable.

Problem	Reproduction factor	Scenario
Example-1	2.207	Possible but not probable
Example – 2	1.330	Impossible
Example – 3	2.3	Possible and probable
Assignment – 1	2.61	Possible and probable
Assignment – 2	1.8	Impossible
Assignment – 3	2.11	Possible but not probable

5. If a fast reactor is loaded with U-235 and Pu-239 such that N_{U-235}/N_{Pu-239}=0.25, determine the reproduction factor. Data on cross section and average number of neutrons produced per fission are given below:

U-235	Pu-239
σ_f = 1.4 b σ_a= 1.65 b υ = 2.60	σ_f = 1.85 b σ_a= 2.11 b υ = 2.98

1.2 Answers

1. Recall Eq. (1)

$\eta_0=\upsilon\sigma_f/\sigma_a = \upsilon\sigma_f/(\sigma_c+\sigma_a) = \upsilon/(1+\alpha)$

σ_f = 1.85 b
σ_a= 2.11 b
υ = 2.98

Therefore, reproduction factor (η_0) = 2.61

2. Let '1' and '2' represent the isotopes U-235 and U-238 respectively. Using Eq. (2),

$\eta=(N_1\upsilon_1\sigma_{f1}+N_2\upsilon_2\sigma_{f2})/(N_1\sigma_{a1}+ N_2\sigma_{a2})$

$\eta=(N_1\upsilon_1\sigma_{f1}/ N_2+\upsilon_2\sigma_{f2})/(N_1\sigma_{a1}/N_2+ \sigma_{a2})$

$\eta=(0.025*2.42*586)/(0.025*681+2.7) = 1.80$

Therefore, the reproduction factor under the above circumstances is 1.80

3. Recall Eq. (1),

$\eta_0=\upsilon\sigma_f/\sigma_a$

Substituting the data in Eq. (1), reproduction factor is obtained as 2.11

4.

Problem	Reproduction factor	Scenario
Example-1	2.207	Possible but not probable
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5. Let '1' and '2' represent the isotopes U-235 and Pu-239 respectively. Using Eq. (2),

$\eta=(N_1\upsilon_1\sigma_{f1}+N_2\upsilon_2\sigma_{f2})/(N_1\sigma_{a1}+ N_2\sigma_{a2})$
$\eta=(N_1\upsilon_1\sigma_{f1}/ N_2+\upsilon_2\sigma_{f2})/(N_1\sigma_{a1}/N_2+ \sigma_{a2})$
$\eta=(0.25*2.6*1.4+2.98*1.85)/(0.25*1.65+2.11) = 2.55$

Therefore, the reproduction factor under the above circumstances is 2.55