mined, resulting from beta decay of the primary reaction products. Indeed, longlived isotopes will increase the long term radiotoxicity of the system. These studies could provide information on the radiation shield designs for accelerators.

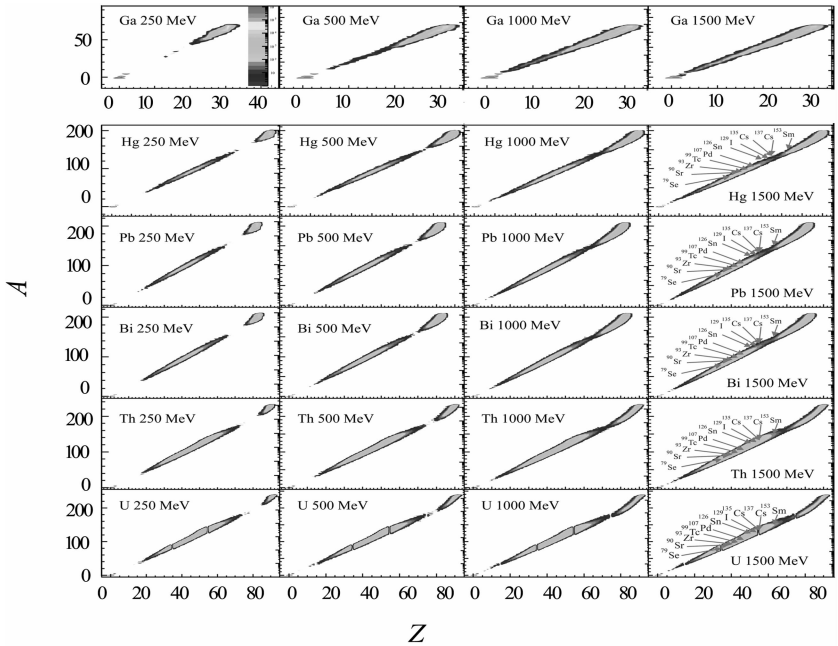


Fig. 2 $Z$(charge number) vs $A$(mass number) distributions for proton induced fission and spallation products of various targets.

## References

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# 2 - 32 Kinetic Study of Uranium Biosorption by Calcium Alginate Beads

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Calcium alginate (CaAlg) beads are potential biosorbent for radionuclides removal as they contain carboxyl groups. However, until now limited information is available concerning the uptake behavior of uranium by this polymer gel, especially when sorption kinetics is concerned.

The kinetic results of uranium sorption by CaAlg beads at different temperatures are illustrated in Fig. 1. From Fig. 1, it can be observed that fast uranium sorption happened in the first 30 min, then gradually slowed down and reached equilibrium after 70 min. Higher sorption rate at initial period (first 30 min) may be due to an increased concentration gradient between adsorbate in solution and adsorbate in adsorbent surface. This increase in concentration gradient tended to increase uranium sorption rate at the initial stage. As time proceeded, this gradient reduced because of the accumulation of uranium ions in the vacant sites, leading to a decrease in sorption rate at the later stage[1].

Kinetic data obtained under different temperatures were simulated by pseudo-first-order and pseudo-second-order kinetic models. The calculated model parameter values are listed in Table 1.

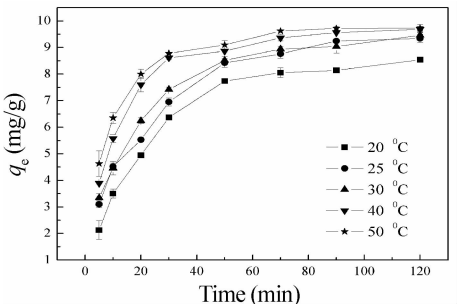


Fig. 1 Kinetic curves of uranium sorption by CaAlg beads.

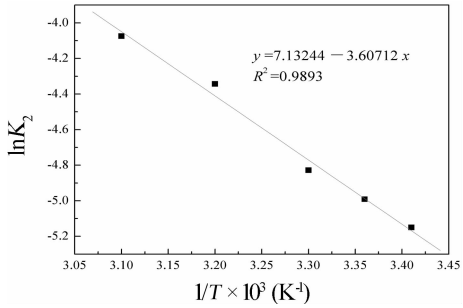


Fig. 2 The linearized Arrhenius relationship plot of uranium sorption by CaAlg beads.

**Table 1 Simulated kinetic model parameters at different temperatures**

| $T$(℃) | Equations | | | | | |
|---|---|---|---|---|---|---|
| | $\log(q_e-q_t)=\log q_e-K_1 t$ | | | $t/q_t=1/(K_2 q_e^2)+t/q_e$ | | |
| | $K_1$ | $q_e$ | $R^2$ | $K_2$ | $q_e$ | $R^2$ |
| 20 | 0.049 | 10.1 | 0.90 | 0.0058 | 9.87 | 1.00 |
| 25 | 0.052 | 11.2 | 0.92 | 0.0068 | 10.5 | 1.00 |
| 30 | 0.051 | 10.6 | 0.87 | 0.0080 | 10.4 | 1.00 |
| 40 | 0.052 | 7.58 | 0.95 | 0.013 | 10.3 | 1.00 |
| 50 | 0.057 | 5.11 | 0.98 | 0.017 | 10.3 | 1.00 |

Both pseudo-first-order and pseudo-second-order kinetic models were well matching with the experimental kinetic data. However, the pseudo-second-order kinetic model was more relevant to explain the kinetics of uranium sorption onto CaAlg beads, as its correlation coefficients were higher than that of the pseudo-first-order kinetic model. Pseudo-second-order kinetics assumes chemical sorption may be the rate limiting step[2].

The relationship between the pseudo-second-order rate constant $K_2$ and temperature can be expressed by Arrhenius equation:

$$K_2 = A_0 \exp \frac{-E_A}{RT} \tag{1}$$

where $A_0$ is the frequency factor, $R$ is the gas constant, 8.314 J/(mol K), $T$ is the absolute temperature (K) and $E_A$ is the sorption activation energy (kJ/mol).

Fig. 2 shows the linearized Arrhenius equation plot of $K_2$ versus $1/T$, a high correlation coefficient of 0.989 was obtained. The $E_A$ value derived from the slope of this plot was 30.0 kJ/mol. The activation energy for physical adsorption is usually less than 4.2 kJ/mol, since the forces involved in physical adsorption are weak. There are two kinds of chemical adsorption, activated and, less frequently, nonactivated. In the activated chemical adsorption, the rate varies with temperature according to finite activation energy between 8.4 and 83.7 kJ/mol. In the nonactivated chemical adsorption, sorption occurs very rapidly, suggesting the activation energy is near zero[3]. From the above analysis, it can be concluded that uranium sorption by CaAlg beads was an activated chemical sorption process.

## References

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