Preparation of Carrier-Free 59Fe

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^{59}Fe is one of the most useful radioisotopes for medical, chemical and metallurgical studies. However, the carrier-free ^{59}Fe has not yet been utilized actually for any kinds of experiments.

O'brien[1] prepared carrier-free ^{59}Fe by means of neutron irradiation and solvent extraction with MIBK(Methyl Isobutyl Ketone) and reported that the fission-neutron cross sections were 1.06±0.012 mb and 0.111±0.013 mb for reactions of $^{59}Co(n,p)^{59}Fe$ and $^{62}Ni(n,\alpha)^{59}Fe$, respectively. According to his results, the yield of ^{59}Fe after irradiation of 1 g cobalt by fission neutrons of the flux = 1.82×10^{14} $n\cdot cm^{-2}\cdot sec$ for 45 days is 26.8 mCi. This method can not be considered convenient, because ^{60}Co of high activity is produced simultaneously through (n,γ) reaction by thermal neutrons.

^{59}Fe can be produced also by $^{59}Co(d,2p)^{59}Fe$ reaction using an accelerator. Measurement of the excitation functions of $^{59}Co(d,x)$ reactions by Bilabel[2] showed that the cross section of $^{59}Co(d,2p)$ reaction is about 1 mb in the range of deuteron energy higher than 20 MeV.

In the present work, a very convenient method of preparing carrier-free ^{59}Fe using $^{59}Do(d,2p)^{59}Fe$ reaction is proposed. Solvent extraction with MIBK and anion exchange method were used in order to separate ^{59}Fe from cobalt.

Cobalt sheet target with nominal purity of 99.99 % was irradiated by 25 MeV deuteron flux for 1 hr. Average current was about 5 μA. Figure 1 shows the gamma-ray spectrum measured on as-irradiated cobalt specimen. The figure indicates that ^{60}Co, ^{58}Co, ^{56}Mn and ^{59}Fe are produced through nuclear reactions of $^{59}Co(d,p)^{60}Co$, $(d,p2n)^{58}Co$, $(d,\alpha p)^{56}Mn$ and $(d,2p)^{59}Fe$, respectively. It is known from the analysis of the gamma-ray spectrum that the yield of ^{59}Fe is 2.6 μCi/μA·hr and larger than 1.9 μCi/μA·hr, the yield estimated from the report by Bilabel.[2]. This fact indicates that $^{59}Co(n,p)^{59}Fe$ reaction proceeds at the same time.

Chemical separation of ^{59}Fe was carried out by solvent extraction with MIBK and the anion exchange method in a medium of hydrochloric acid solution after dissolving the cobalt target electrolytically, by referring the conditions for the separation previously reported by Isshiki et al.[3] and Igaki and Isshiki.[4] Figure 2 shows the gamma-ray spectrum from the ^{59}Fe separated by the anion exchange in the form of $FeCl_3$. This spectrum indicates that the separation of ^{59}Fe by the anion exchange is very effective and the obtained ^{59}Fe is radiochemically pure. Recovery yield of ^{59}Fe is estimated to be more than 90 %. Similar results were obtained in the case of the separation by solvent extraction.

It is concluded that the method developed in the present work is very convenient for the preparation of carrier-free ^{59}Fe.

References

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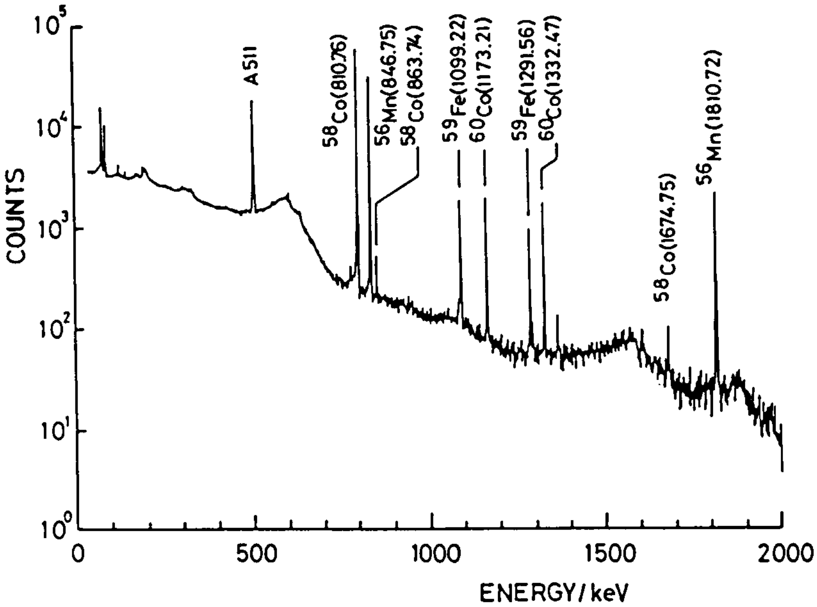

Fig. 1. Gamma-ray spectrum measured on as-irradiated cobalt specimen.

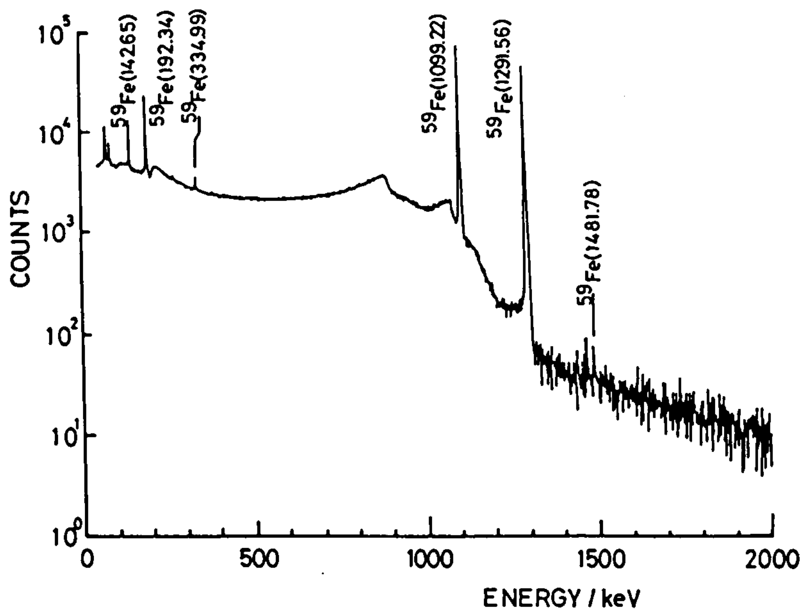

Fig. 2. Gamma-ray spectrum measured on ^{59}Fe separated by anion exchange.