

Radiochemical Methods in Radionuclide Production at a Cyclotron

Ingo Spahn^{1*}, Bernhard Scholten¹, Stefan Spellerberg¹, Syed M. Qaim¹, Bernd Neumaier¹

¹Institut für Neurowissenschaften und Medizin, INM-5: Nuklearchemie, Forschungszentrum Jülich, Jülich, Germany

*E-mail: i.spahn@fz-juelich.de

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The research on radionuclide development, be it for measurement of nuclear data or for clinical scale production, often demands the removal of unwanted bulk material and the isolation of the desired radionuclide in a pure no-carrier-added form. Specific radiochemical methods have to be applied to reach this goal, which have to take into account the individual demands on purity and specific activity as well as the subsequent processing of the radionuclide. In the following an overview of typical radiochemical methods shall be given, which have been used in nuclear chemistry research at the Research Centre Jülich in Germany.

A common method for separation and purification is the use of ion-exchange resins of all kinds. In this field significant progress could be observed in the past years, allowing fast isolation of trace amounts of radioactivity in rather small volumes of eluent, e.g. ^{52}Mn formed via the $^{52}\text{Cr}(\text{p},\text{n})$ -reaction [1] or ^{64}Cu formed via the $^{64}\text{Ni}(\text{p},\text{n})$ -reaction [2]. Alternatively, solvent extraction can be employed as the separation method, which also leads to the phase transfer of the produced radionuclide from an acidic or basic solution into an organic solvent. Often a combination of those methods is used. A limiting factor can be the solubility of the bulk target. Here, electrolytic de-composition may come into play for certain materials. By inverting the electrolytic procedure small amounts of metallic target materials can be transferred into a solution very quickly. This technique can be very advantageous when dealing with enriched target material, e.g. ^{58}Ni to produce ^{55}Co via the $^{58}\text{Ni}(\text{p},\alpha)$ -reaction [3]. In the opposite case, the dissolution of a bulk target may require the use of rather large volumes of solvent, which represents a serious obstacle for the fast and effective separation of trace amounts of a radionuclide. In that case the co-precipitation using a non-isotopic carrier can be put ahead of any further separation methods. A subsequent purification of the precipitated product radionuclide is always necessary when following this route. An example is the purification of ^{86}Y formed via the $^{86}\text{Sr}(\text{p},\text{n})$ -reaction on a $^{86}\text{SrCO}_3$ target [4]. A different separation scheme was adopted for $^{193\text{m}}\text{Pt}$ formed via the $^{192}\text{Os}(\alpha,3\text{n})$ -reaction [5]. At first the bulk target material was removed by distillation and then the desired radioplatinum was purified by solvent extraction. Finally, the radiochemical separation via dry distillation or thermo-chromatography will be discussed. The essential prerequisite to use this method is a sufficiently large difference of the sublimation temperatures of the produced radioisotope and the target material. A well-known example for the use of this technique is the production of radioiodine ($^{120,123,124}\text{I}$) from highly enriched tellurium targets ($^{120,123,124}\text{Te}[\text{TeO}_2]$), leading to the isolation of pure no-carrier-added product in about 1 hour leaving the enriched target material unharmed [4]. Similarly radiobromine is separated from a NiSe target [6] and radiotechnetium is advantageously separated from a MoO_3 target via thermochromatography.

References

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