



PRODUCT SHEET

Ni resin

Main applications

- Separation of nickel

Packing

Order N°.	Form	Particle size
NI-B25-A, Ni-B50-A	25g and 50g bottles NI resin	100-150 µm
NI-C20-A, NIC50-A, NI-C200-A	20, 50 and 200 2 mL NI resin columns	100-150 µm
NI-R50-A	50 200 2ml cartridges NI resin	100-150 µm

Physical and chemical properties

Density : 0,25 g/ml

Capacity : 4 mg Ni/g resin NI

Conditions of utilization

Recommended T of utilization : /

Flow rate : A grade: 0.6 – 0.8 mL/min

Storage : Dry and dark, T<30°C, can be stored for 1 year

For additional information see enclosed literature study

Methods*

Reference	Description	Matrix	Analytes	Support
NIW01	Ni in water	water	Ni	columns

*developped by Eichrom Technologies Inc.

LITERATURE STUDY

NI RESIN

The Nickel Resin is dedicated to the separation of nickel from the other elements. The Nickel Resin consists in dimethylglyoxime extractant coated on an inert support. Unlike our other extraction chromatographic resins, it is based on an on-column precipitation of nickel with dimethylglyoxime (abbreviated DMG, figure 1) at pH 8-9.

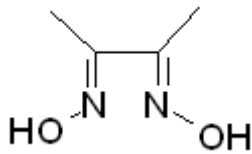


Fig. 1 : dimethylglyoxime (DMG)

During the precipitation reaction two molecules of dimethylglyoxime react with Ni^{2+} ⁽¹⁾ as follows :

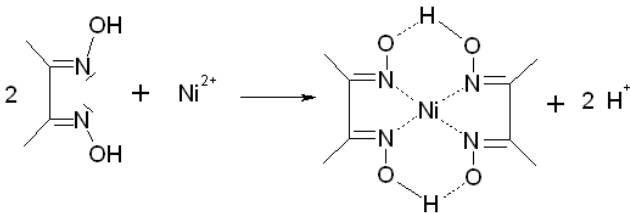


Fig. 2: Precipitation reaction of nickel cation with 2 molecules of dimethylglyoxime, $\text{Ni}(\text{DMG})_2$.

The nickel-dimethylglyoxime ($\text{Ni}(\text{DMG})_2$) complex is insoluble in water and difficult to destroy. Its stability constant, $\log K_1$ is 14,6 ⁽³⁾.

The general outline of nickel separation procedure is as follows ⁽⁴⁾. The sample is traced with a nickel carrier solution (Ni-carrier must not exceed 3 mg Ni/g of dry resin or 2mg Ni/2mL Ni columns). The sample is then evaporated to near dryness and converted to chloride by repeated evaporations with concentrated HCl. The obtained residue is dissolved in 1M HCl. A solution of 0.2M ammonium citrate is added to the sample and the overall solution is adjusted to pH 8-9 with concentrated ammonium hydroxyde. The resin is also preconditioned with a 0.2M ammonium citrate solution adjusted to pH 8-9. When the sample is loaded on the resin, a red precipitate appears. The resin is rinse with the 0.2M ammonium citrate adjusted at pH 8-9. The $\text{Ni}(\text{DMG})_2$ complex is dissolved with a 3M HNO_3 solution, allowing its elution from the resin ^(2,4). After $\text{Ni}(\text{DMG})_2$ elution, the resin colour is changed back to white and the

eluted solution is colourless. At this stage, most of the DMG initially coated onto the inert support has been eluted as the $\text{Ni}(\text{DMG})_2$ complex, making the resin not suitable for re-use.

Ni-63 and Ni-59 can be measured directly by liquid scintillation or X-spectrometry respectively ⁽²⁾. The $\text{Ni}(\text{DMG})_2$ complex eluted can also be reprecipitated and then filtered. Ni-59 activity is measured by counting the precipitate on the filter ⁽⁴⁾. For Ni-63 determination, the filter containing the precipitate is oxidized in a muffle furnace at 500°C. The nickel oxide residue, NiO, can then be dissolved in a minimum volume of *aqua regia*. The sample is converted to chloride form by successive evaporations to dryness of concentrated HCl. HCl is preferred to HNO_3 as NiCl_2 is not volatile compared to $\text{Ni}(\text{NO}_3)_2 \cdot 6\text{H}_2\text{O}$, which ebullition point is 137°C. The nickel residue is then dissolved in a 0.1M HCl solution for its counting in liquid scintillation ⁽⁴⁾.

The preconditioning and conditioning of the Nickel resin can also be done in tartrate solution. The presence of the citrate or tartrate ions prevents any co-precipitation of metals that would precipitate as insoluble hydroxides under the given pH values. High quantities of oxidizing agents can interfere by preventing the precipitation of nickel by *formation of soluble oxidised complex of $\text{Ni}(\text{DMG})_2$* ⁽¹⁾.

If the samples contain high quantity of iron, it is necessary to remove the iron before the precipitation of the nickel ⁽⁴⁾. If the quantity of residue during the sample evaporation step is negligible or small, the iron removal can be performed on TRU Resin :

- 1/ Dissolve residue in 8M HNO_3
- 2/ Add Fe carrier ($\leq 1.5\text{mg Fe per g dry TRU Resin}$)
- 3/ Load solution on TRU resin
- 4/ Rinse TRU resin with 8M HNO_3

However, if the quantity of residue is large, the iron removal has to be performed on an anion exchange resin, e.g. 1x8 type:

- 1/ Dissolve residue in 12M HCl
- 2/ Add Fe carrier ($\leq 1.5\text{mg Fe/g resin}$)
- 3/ Load solution on the anion exchange resin
- 4/ Rinse the resin with 12M HCl

In both cases, the iron stays on the resin while the nickel is eluted. The eluates are repeatedly evaporated with concentrated HCl for the preparation of the sample before the loading onto the Nickel resin.

LITERATURE STUDY

A study on the decontamination factors of different radionuclides with respect to Ni was performed by D.F. Cahill and L. M. Peedin⁽⁵⁾. The results are given in table 1.

The same authors compared their standard Ni separation method with the method using Eichrom Nickel resin, for the analysis of Ni-59/63. Their standard method was as follows:

- 1/ Addition of Ni carrier to the sample
- 2/ Acidification/evaporation
- 3/ Precipitation with $Fe(OH)_3$
- 4/ Centrifugation/filtration
- 5/ Adjustment of pH to 8-9
- 6/ Precipitation of $Ni(DMG)_2$
- 7/ Centrifugation/rinsing of the precipitate
- 8/ Dissolution of the precipitate
- 9/ 2nd precipitation of $Ni(DMG)_2$
- 10/ Centrifugation/rinsing of the precipitate
- 11/ Dissolution of $Ni(DMG)_2$
- 12/ Destruction of $Ni(DMG)_2$ / Conversion to NiO
- 13/ Dissolution and liquid scintillation counting

Comparisons between the two methods were performed for different types of samples analyzed in their laboratories. The results obtained are presented in table 2. They show that the two methods give similar results. However, in the case of the Nickel Resin separation, the manipulation time is 1 to 1,5 days against 2 to 2,5 days for their standard method.

The Nickel Resin exists in 100-150 μm particle size. The 2 mL preconditioned columns of Ni Resin are delivered in a 0.15M ammonium citrate solution buffered at pH 9 with ammonium hydroxide.

Radionuclides	Decontamination factors
Cr-51	3,5E+02
Mn-54	8E+03
Fe-55	4E+02
Co-58	1E+03
Co-60	1,1E+03
Nb-95	1,3E+02
Cs-134	2,8E+03
Cs-137	3E+03

Table 1 : Decontamination factors obtained on Nickel resin for different radionuclides compared to nickel⁽⁴⁾.

Sample type	Standard method	Nickel resin
TL/HS tank	8,510E-02	8,810E-02
Lab waste tank	9,842E-02	9,213E-02
WECT tank	1,595E-01	1,543E-01
Ni-63 spike	1,876E+01	1,980E+01
Ni-59 spike	3,700E+02	3,396E+02
DAW Smears	1,547E+03	1,713E+03
Radwaste filter	2,738E+04	2,882E+04
RWCU Resin	6,771E+04	7,585E+04

Table 2 : Comparison of Ni-63 results obtained for two nickel separation methods (4). Activities are in Bq/unit.

Bibliography

- (1) Kirby L. J.; *The Radiochemistry of Nickel*, November 1961, NAS-NS 3051.
- (2) Rajkovich S., Cahill D., Peedin L., Wheland S., Lardy M., Eichrom Cincinnati Users' Seminar, OH - USA (1996); Référence Eichrom RS196.
- (3) Furia T. E., *CRC Handbook of Food Additives; Chapter 6 – Sequestrants in Foods*, 2nd ed. (1972).
- (4) Strebin R., Orr R., Kaye J., Fadeff S., *Nickel-59 and Nickel-63 Determination in Aqueous Samples*. Pacific Northwest Laboratory, Richland, WA – DOE Methods Compendium RP300; Référence Eichrom RP300.
- (5) Cahill D. F., Peedin L. M., *A comparison of Standard and Extraction Chromatography Methods of Analysis for Nickel-59/63 and Tritium*; 41st Annual Conference on Bioassay, Analytical and Environmental Chemistry, Eichrom workshop, Boston, MA – USA, (1995); Référence Eichrom CD195.