Separation Science and Technology
Publication details, including instructions for authors and subscription information:
http://www.informaworld.com/smpp/title~content=t713708471

Modeling of Nickel Extraction with Decanal Oxime

Mariusz B. Bogacki[a]; Gérard Cote[b]; Jan Szymanowski[a]
[a] INSTITUTE OF CHEMICAL TECHNOLOGY AND ENGINEERING POZNAN TECHNICAL UNIVERSITY, POZNAN, POLAND [b] LABORATOIRE DE CHIMIE ANALYTIQUE (UNITE ASSOCIEE AU CNRS 437), ECOLE SUPERIEURE DE PHYSIQUE ET DE CHIMIE DE PARIS, PARIS, CEDEX, FRANCE

To cite this Article Bogacki, Mariusz B. , Cote, Gérard and Szymanowski, Jan(1993) 'Modeling of Nickel Extraction with Decanal Oxime', Separation Science and Technology, 28: 9, 1783 — 1788

To link to this Article: DOI: 10.1080/01496399308019042
URL: http://dx.doi.org/10.1080/01496399308019042

SEPARATION SCIENCE AND TECHNOLOGY, 28(9), pp. 1783–1788, 1993

NOTE

Modeling of Nickel Extraction with Decanal Oxime

MARIUSZ B. BOGACKI
INSTITUTE OF CHEMICAL TECHNOLOGY AND ENGINEERING
POZNAN TECHNICAL UNIVERSITY
PL. SKLODOWSKIEJ-CURIE 2, 60-965 POZNAN, POLAND

GÉRARD COTE
LABORATOIRE DE CHIMIE ANALYTIQUE (UNITE ASSOCIEE AU CNRS 437)
ECOLE SUPERIEURE DE PHYSIQUE ET DE CHIMIE DE PARIS
10, RUE VAUQUELIN, 75231 PARIS CEDEX 05, FRANCE

JAN SZYMANOWSKI
INSTITUTE OF CHEMICAL TECHNOLOGY AND ENGINEERING
POZNAN TECHNICAL UNIVERSITY
PL. SKLODOWSKIEJ-CURIE 2, 60-965 POZNAN, POLAND

ABSTRACT

Extraction of nickel with decanal oxime is modeled in systems with countercurrent and combined flows. Systems with combined flows are more advantageous than those with countercurrent flows and give a higher transfer of nickel. The transfer depends significantly upon the flow ratio of the aqueous to the organic phase in the stripping stages, and it should exceed the critical value.

INTRODUCTION

Nonchelating oximes are well known as nickel and copper extractants from chloride media (1–11). Groves and Redden of the U.S. Bureau of Mines recently proposed the use of decanal oximes (DOX) for nickel extraction from nickelous-chromic solutions in a typical continuous countercurrent circuit that involves three extraction and six stripping stages (12).

Rod (13) and later Hughes (14) analyzed the entire system composed of the extraction and stripping circuits. Processes with countercurrent, crosscurrent, and combined flows were considered. Analysis of the entire process has an advantage over analysis of extraction and stripping carried out separately because it takes into account any mutual interactions between these steps.

We have found that higher degrees of copper extraction with hydroxyoximes from sulfate solutions can be obtained by using process schemes with crosscurrent and combined flows (15, 16). Moreover, such flows are very convenient for the extraction of one or more metals with different extractions in various loops (17).

The aim of the present work is to study the effect of the flow type upon nickel extraction from concentrated chloride solution with decanal oxime (DOX). In this case the extraction occurs according to the following solvating mechanism (12):

$$\mathrm{Ni(H_2O)_4Cl_2 + 4DOX \rightarrow Ni(DOX)_4Cl_2 + 4H_2O}$$

The stripping of nickel can be achieved with water or dilute hydrochloric acid.

Such a process is quite different compared to those previously studied for copper extraction with chelating extractants in which acidification and deacidification of the aqueous phase occur during extraction and stripping, respectively.

EXPERIMENTAL

The results presented by Groves and Redden (12) were used for modeling. The organic phase contained 1.0 M decanal oxime in kerosene. The aqueous feed contained 12.0 g/L Ni(II) and 200 g/L $\mathrm{Cl^-}$. The strip solution contained 7.5 g/L HCl.

The model of the process used for its analysis was described in our previous work (15, 16).

The equilibrium isotherms were obtained by matching the polynomial spline functions of the third order to the experimental data given in Figs. 4 and 5 of the work of Groves and Redden (12).

The spline functions and their use to model extraction equilibria were also presented in our previous work (15, 16).

RESULTS AND DISCUSSION

The spline functions are very powerful tools to approximate experimental data. Using these functions, an excellent matching of the experimental data of Groves and Redden was obtained. Smooth curves with negligible deviations were obtained for both the extraction and stripping isotherms.

For the typical countercurrent process, the computing results are the same as those presented by Groves and Redden on McCabe–Thiele diagrams. Two extraction and five stripping stages appear to be necessary for A (aqueous)/O (organic) flow ratios equal to 1.0 and 0.37 in extraction and stripping circuits, respectively.

Figure 1 shows the effect of the flow ratios upon the percentage of transfer of nickel from the feed to the aqueous strip liquor in a typical countercurrent process with two extraction and four or six stripping stages.

A strong effect of the flow ratios upon nickel transfer is observed, while the effect of the number of stripping stages is negligible.

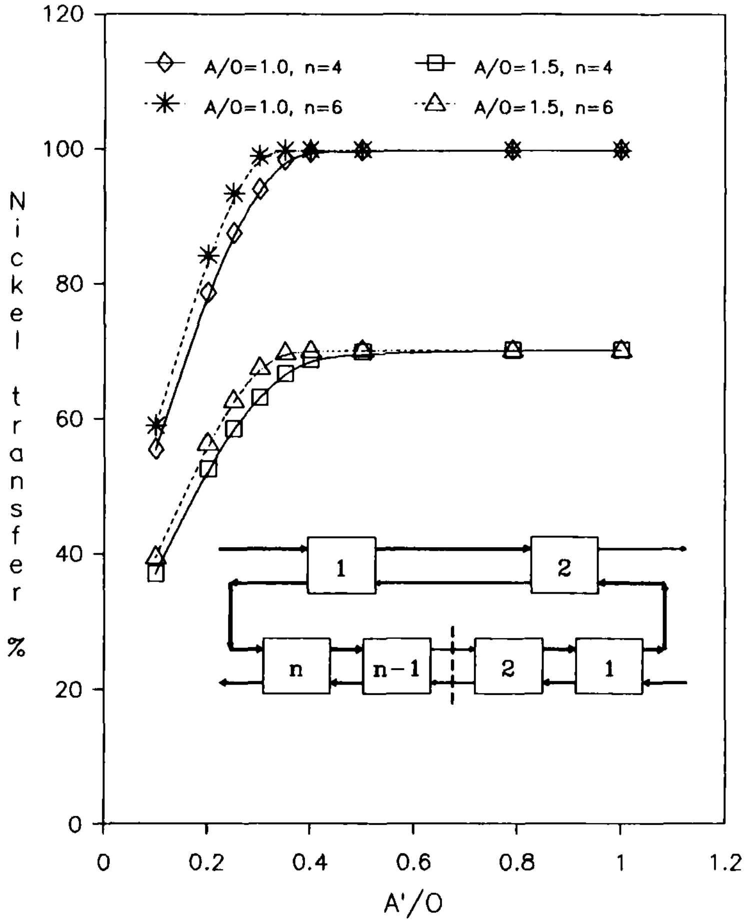

FIG. 1 Effect of flow ratios in the stripping (A'/O) and extraction circuits (A/O) upon nickel transfer from the feed to the strip liquor in a typical countercurrent process (A = aqueous; O = organic; n = number of stripping stages; two extraction stages).

TABLE 1
Critical A′/O Flow Ratios (two extraction stages, A/O = 1.0)

	Countercurrent flows		Combined flows	
Stripping stages	$(A'/O)_{crit}$	Average nickel transfer, % above $(A'/O)_{crit}$	$(A'/O)_{crit}$	Average nickel transfer, % above $(A'/O)_{crit}$
2	—	—	0.34	99.54
4	0.30	98.45	0.25	98.58
5	0.28	98.47	0.25	99.17
6	0.28	99.56	—	—

The effect of the flow ratio in the extraction circuit is obvious, and a higher percentage of transfer of nickel is obtained for A/O = 1.0 than for A/O = 1.5. The organic phase is loaded almost completely, and it cannot load more nickel.

The effect of the flow ratio in the stripping circuit upon the nickel transfer is very characteristic and similar for all cases considered. The curves in Fig. 1 are concave and monotonic. The intercept points of the asymptotes drawn to the curves in the region of low and high A′/O ratios are given in Tables 1 and 2. Almost the same values were obtained for all the cases considered. The average value of $(A'/O)_{crit}$ is equal to 0.29. Thus, the process should be carried out for $A'/O > (A'/O)_{crit}$, where the effect of this parameter is small or even negligible.

Similar effects are observed for a scheme with combined flows in which the stripping (1–3 stages) is carried out after each extraction stage (Fig. 2).

The critical (A′/O) flow ratios are similar to those obtained for the scheme with countercurrent flows.

TABLE 2
Critical A′/O Flow Ratios (two extraction stages, A/O = 1.5)

	Countercurrent flows		Combined flows	
Stripping stages	$(A'/O)_{crit}$	Average nickel transfer, % above $(A'/O)_{crit}$	$(A'/O)_{crit}$	Average nickel transfer, % above $(A'/O)_{crit}$
2	—	—	0.48	87.13
4	0.30	69.93	0.43	96.36
5	0.28	70.01	0.43	97.32
6	0.28	70.02	—	—

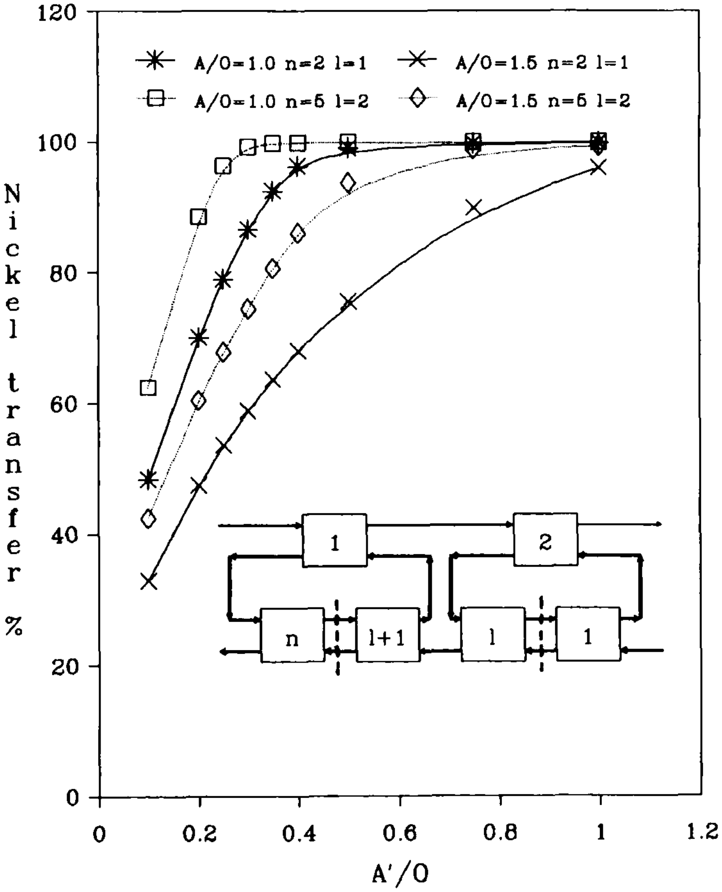

FIG. 2 Effect of flow ratios in the stripping (A'/O) and extraction circuits (A/O) upon nickel transfer from the feed to the strip liquor in a combined process (the key is the same as in Fig. 1; l = number of stages in the second stripping loop).

Comparison of schemes with countercurrent and combined flows indicates a higher percentage of transfer of nickel in systems with combined flows. The effect is particularly strong in systems with high flows of the aqueous phase in the extraction stages (Table 2).

Nonchelating aliphatic oximes degradate in extraction–stripping circuits to give nonreactive aldehydes or ketones. However, such oximes can be regenerated by contacting the stripped solvent with a $NH_2OH\cdot HCl-Na_2CO_3$ solution (12). Hence, a regeneration stage must be added to the circuit to regenerate the extractant.

ACKNOWLEDGMENT

This work was supported by Polish Research Grant KBN No. PB 843/3/91.

REFERENCES

1. J. S. Preston, *Hydrometallurgy*, *9*, 115 (1982).
2. J. S. Preston, *Ibid.*, *10*, 187 (1983).
3. J. S. Preston, *Proc. ISEC'83*, Denver, American Institute of Chemical Engineers, 1983, p. 357.
4. J. S. Preston, *Hydrometallurgy*, *11*, 105 (1983).
5. N. M. Rice and D. C. Smith, *Proc. ISEC'86*, Vol. 2, DECHEMA, Munich, Germany, 1986, p. 633.
6. K. Inoue, Y. Baba, T. Oka, M. Takagi, and K. Dohtsu, *Solv. Extr. Ion Exch.*, *4*, 237 (1986).
7. Y. Baba, K. Inoue, and Y. Nakashima, *Proc. Symp. Solv. Extr.*, p. 107 (1986).
8. K. H. Soldenhoff, *Solv. Extr. Ion Exch.*, *5*, 811 (1986).
9. K. Inoue, Y. Baba, and Y. Nakashima, *J. Chem. Eng. Jpn.*, *21*, 363 (1986).
10. J. Szymanowski, A. Jakubiak, and K. Alejski, *Colloids Surf.*, *57*, 283 (1991).
11. G. L. Pashkov, N. P. Bezrukova, V. N. Volk, I. Yu. Fleitlich, N. I. Pavlenko, G. E. Selutin, and E. D. Korniyets, *Solv. Extr. Ion Exch.*, *9*, 549 (1991).
12. R. D. Groves and L. D. Redden, *Hydrometallurgy*, *24*, 271 (1990).
13. V. Rod, *Chem. Eng. J.*, *29*, 77 (1984).
14. M. A. Hughes and N. J. Parker, *J. Chem. Technol. Biotechnol.*, *35A*, 255 (1985).
15. M. B. Bogacki and J. Szymanowski, *Ind. Eng. Chem. Res.*, *29*, 601 (1990).
16. M. B. Bogacki and J. Szymanowski, *Inz. Chem. Proc.*, *4*, 601 (1991).
17. M. B. Bogacki and J. Szymanowski, *Ind. Eng. Chem. Res.*, *31*, 328 (1992).

Received by editor June 8, 1992