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THE MOST CONVENIENT METHOD FOR THE PREPARATION OF ALIPHATIC CRYPTANDS

Krzysztof E. Krakowiak, Patrycja A. Krakowiak, and Jerald S.Bradshaw*

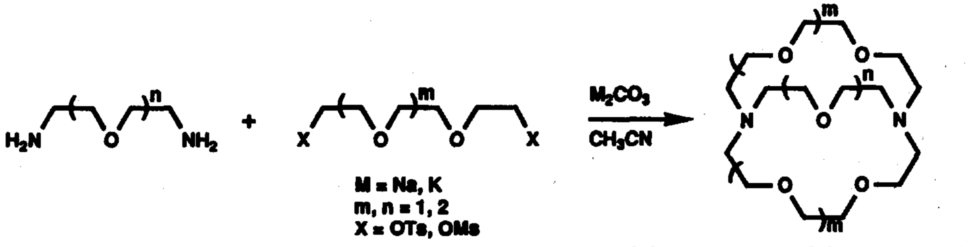
Department of Chemistry, Brigham Young University, Provo, Utah 84602 U.S.A.

Abstract. An important new one-step method for the preparation of aliphatic cryptands from available oligoethyleneoxydiamines and ditosylates is reported.

According to Chemical Abstracts, there have been more than 1200 papers concerning the cryptands published during the past 24 years. At least 800 papers were devoted to the most common aliphatic cryptands such as 2.2.1, 2.2.2, 3.2.2, and 3.3.2.[1] There are no convenient and easy methods for the synthesis of these cryptands[2], and those available cryptands are very expensive.[3] Cryptands were first obtained by J.-M. Lehn and coworkers using many steps.[4,5] Attempts to improve their method have been unsuccessful.[6-8] A one-step bicyclization attempt from 1,8-diiodo-3,6-dioxaoctane and 1,8-diamino-3,6-dioxaoctane gave only 1,10-diaza-18-crown-6 instead of the desired cryptand 2.2.2 even though 1,8-diiodo-3,6-dioxaoctane was used in a large excess.[6-8] A two-step procedure from 1-iodo-8-chloro-3,6-dioxaoctane and 1,8-diamino-3,6-dioxaoctane gave cryptand 2.2.2,[6,7] however, the overall yield was low and the starting iodochloro compound required additional preparative steps.

We have reported one-step procedures for the preparation of cryptands containing propylene bridges between nitrogen and oxygen atoms using diiodo derivatives of various oligoethylene glycols and the appropriate diamines.[8,9] We were not able to obtain cryptands with ethylene bridges such as 2.2.1 and 2.2.2 using the diiodides.[8]

We now report the preparation of cryptands 2.2.1, 2.2.2, 3.3.1, 3.2.2, 3.3.2, and 3.3.3 using a one-step bicyclization process from inexpensive



2.2.1 m, n = 1; **2.2.2** m = 1, n = 2
3.3.1 m = 2, n = 1; **3.2.2** m = 1, n = 3
3.3.2 m = 2, n = 2; **3.3.3** m = 2, n = 3

ditosylate derivatives of triethylene and tetraethylene glycols. Cryptand 2.2.2 was prepared as follows. A mixture of 0.74 g (5 mmol) of 3,6-dioxa-1,8-octanediamine, 4.7 g (10.3 mmol) of the ditosylate derivative of triethylene glycol and 10 g of Na_2CO_3 was refluxed in 150 mL of CH_3CN for 6 days. The cooled mixture was filtered, the solvent evaporated and the residue was mixed with 20 mL of CH_2Cl_2 and filtered. The filtrate was evaporated and the residue was passed through a short alumina column (THF/ethanol:10/1) to decompose the metal ion complex and chromatographed on a silica gel column (CH_3OH/NH_4OH:50/1 graduated to 5/1) to give 0.67 g (36%) of cryptand 2.2.2; mp 70-71°C (recrystallized from hexane) (lit mp 68-69°C).[5] Other cryptands were prepared in the same manner. The reaction does not require high dilution techniques (adding reactants by means of syringe pumps); however, in some cases, the yield using high dilution increased by 10 to 20%. The yields were 36% for 2.2.2, 50% for 3.2.2, and 40% for 3.3.2 without using high dilution conditions. Similar results were obtained when dimesylate starting materials were used. The prepared cryptands exhibited the same physical and spectral properties as those reported.[5] We also proved some of the structures by an X-ray crystallographic study. The ^1H NMR spectrum and elemental analysis for new 3.3.1 were consistent with the proposed structure.

From these preliminary results, it appears that the ditosylate or dimesylate derivatives of the oligoethylene glycols rather than the diiodides should be used in one-step reactions to form the cryptands containing ethylene bridges.[10] The ditosylates are recommended because they can be purchased. This new process provides high yields and cleaner bicyclic products which require only simple purification techniques.

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REFERENCES AND NOTES

(1) Data taken from CAS online (1967-1992).

(2) Krakowiak, K. E.; Bradshaw, J. S., Israel J. Chem. 1992, in press.

(3) The price for cryptand 2.2.1 is $187.60 per gram, and for 2.2.2, $65.00 per gram (Aldrich, 1992).

(4) Dietrich, B.; Lehn, J.-M.; Sauvage, J.-P., Tetrahedron Lett. 1969, 2895.

(5) Dietrich, B.; Lehn, J.-M.; Sauvage, J.-P.; Blanzat, J., Tetrahedron 1973, 29, 1629.

(6) Kulstad, S.; Malmsten, L. A., Tetrahedron Lett. 1980, 21, 643.

(7) Yiao, L.; Zheng, J.; Ma, W., Huaxane Shiji 1985, 446.

(8) Krakowiak, K. E.; Bradshaw, J. S.; Dalley, N. K.; Zhu, C.-Y., Yi, G.-L., Curtis, J. C.; Li, D.; Izatt, R. M., J Org. Chem. 1992, 57, 3166.

(9) Krakowiak, K. E.; Bradshaw, J. S., J Org. Chem. 1991, 56, 3723.

(10) Starting diamine and ditosylate compounds were purchased inexpensively from Aldrich, Fluka or Texaco Chemical Companies. The mesylate derivatives of the oligoethylene glycols were prepared in high yields by a one-step reaction.

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