The Reduction of Schiff Bases with Aluminum Amalgam

Tatsuo TAKESHIMA, Motomu MURAOKA, Hiroe ASABA and Masataka YOKOYAMA

Department of Chemistry, Faculty of Science, Chiba University, Yayoi-cho, Chiba

The Second Laboratory of Organic Chemistry, The Institute of Physical and Chemical Research, Yamato-machi, Saitama

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There are several common methods for the reduction of Schiff bases. Among them, the catalytic hydrogenation seems, in general, to be the most preferred, in part because of its neutral nature.

In the present experiment, aluminum amalgam, which almost fits the neutral conditions, was found to be an effective agent for this reduction. The aluminum amalgam was easily made in the usual way. The reduction was carried out under an atmospheric pressure and at room temperature. In addition, the treatment of the reaction product involved no troublesome manipulation.

The Schiff bases used were conveniently prepared by refluxing ketone with primary amine in the presence of potassium fluoride. Few new secondary amines were obtained besides the known ones.

All of the hydrochlorides of amines obtained showed several typical infrared absorption of NH_2^+ in the region of 2800—2000 cm^{-1} (stretching) and at $\sim$1587 (deformation).[1]

Of the amines prepared, the known ones were identified as hydrochlorides (for melting point,[2] see Table 2). The assignment of the structure of the new amines was based on the results of the elemental analysis and the infrared spectra of the hydrochloride, and on the course of the synthesis. The structures of the Schiff bases prepared were deduced from the course of the synthesis and from the fact that the amines were reduced to the corresponding secondary amines.

The reduction of the Schiff bases was also carried out by means of lithium aluminum hydride. However, this method was not favorable from the standpoint of either the manipulation or the yield.

Experimental

Procedure. The Schiff bases were prepared by refluxing a mixture of the reactants in a ketone: amine ratio of 1 (mol): 1 (mol) in the presence of excess anhydrous potassium fluoride. The secondary amines were obtained by reducing the Schiff bases with an aluminum amalgam in the usual way. The amalgam was prepared by immersing aluminum foil, cut into pieces, in a dilute solution of mercuric chloride (less

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[1] KBr disk.

[2] The melting point of the hydrochloride of VIIA was not depressed on admixture with an authentic specimen; T. Takeshima, T. Hayashi, M. Muraoka and T. Matsuoka, *J. Org. Chem.*, **32**, 980 (1967).

[3] A few specimens of the Schiff base prepared were analyzed with respect to the nitrogen content. The Schiff bases were unstable, especially when exposed to air. The specimens were purified gas chromatographically (NpGS (1.5%)/Shimalite) just before the analyses.

[4] W. D. Emmons, *J. Am. Chem. Soc.*, **79**, 5739 (1957).

[5] a) G. Mignonac, *Ann. Chim.*, **(11) 2**, 225 (1934); b) V. E. Haury, EL Cerrito and S. A. Ballard, U. S. Pat. 2418173 (Apr. 1, 1947); c) E. D. Bergmann, E. Zimkin and S. Pinchas, *Rec. Trav. Chim.*, **71**, 168 (1952); d) H. L. Wehrmeister, *J. Org. Chem.*, **25**, 2132 (1960); e) R. E. Miller, *ibid.*, **25**, 2126 (1960); f) R. Mayer and Jentzsch, *J. Prakt. Chem.*, **23**, 83 (1964).

[6] K. Jewers and J. McKenna, *J. Chem. Soc.*, **1958**, 2209.

[7] G. F. Grail, L. E. Tenenbaum, A. V. Tolstoouhov, C. J. Duca, J. F. Reinhard, F. E. Anderson and J. V. Scudi, *J. Am. Chem. Soc.*, **74**, 1313 (1952).

[8] a) A. Skita and F. Keil in Part with E. Baesler and L. Boente, *Ber.*, **61B**, 1682 (1928); b) G. Wittig and H. D. Frommeld, *ibid.*, **97**, 3548 (1964).

[9] a) G. Breuer and J. Schnitzer, *Monatsh.*, **68**, 301 (1936); b) E. T. Borrows, B. M. C. Hargreaves, J. E. Page, J. C. L. Resuggan and F. A. Robinson, *J. Chem. Soc.*, **1947**, 197; c) C. W. Kruse and R. F. Kleinschmidt, *J. Am. Chem. Soc.*, **83**, 213 (1961).

[10] D. G. Norton, V. E. Haury, F. C. Davis, L. J. Mitchell and S. A. Ballard, *J. Org. Chem.*, **19**, 1054 (1954).

Table 1. Schiff bases prepared

Starting substances	The Schiff bases prepared	Bp °C/mmHg	Yield %	Anal. (Found, N%)[3]	Reported Bp °C/mmHg
Acetone *n*-Hexylamine	*N*-Isopropylidene-hexylamine	71—74/17	*ca.* 70	9.31	53—55/5[4]
Acetone Cyclohexylamine	*N*-Isopropylidene-cyclohexylamine (IIS)[10]	67—69/17	*ca.* 40		180.6/760[10]
Methyl ethyl ketone *n*-Hexylamine	*N*-*s*-Butylidene-hexylamine (IIIS)	85—86/16	*ca.* 70	9.15	
Methyl ethyl ketone Cyclohexylamine	*N*-*s*-Butylidene-cyclohexylamine (IVS)	84—86/18	*ca.* 40	8.93	
Cyclohexanone *n*-Hexylamine	*N*-Cyclohexylidene-hexylamine (VS)	111—116/7	*ca.* 65		
Cyclohexanone Cyclohexylamine	*N*-Cyclohexylidene-cyclohexylamine (VIS)[5b,c,d,e,f]	99—104/6	*ca.* 60	7.86	135.7/20[5b] 136—137/15[5c] 92— 94/ 2[5d] 93— 95/ 2[5e] 135—140/17[5f]
2-Methylcyclohexanone, Cyclohexylamine	*N*-2-Methylcyclohexylidene-cyclohexylamine (VIIS)	114—115/7	*ca.* 50		
Cyclopentanone *n*-Hexylamine	*N*-Cyclopentylidene-hexylamine (VIIIS)	89—91/5	*ca.* 80		
Cyclopentanone Cyclohexylamine	*N*-Cyclopentylidene-cyclohexylamine (IXS)[5f,6]	92—94/5	*ca.* 60		

Table 2. Secondary amines prepared

Starting substances	The amines prepared	Bp °C/mmHg	Yield %	Appearance and mp (°C) of the hydrochloride	Reported mp of the hydrochloride, °C
IS	*N*-Isopropylhexylamine (IA)[7]	57—59/12	54	Colorless long plates (from dioxane) 147—148	
IIS	*N*-Isopropylcyclohexylamine (IIA)[8]	60—62/15	54	Colorless square plates (*n*-amyl alcohol) 208—209	204—205[8a]
IIIS	*N*-*s*-Butylhexylamine (IIIA)	74—75/12	63	Colorless long plates (from dioxane) 167	
IVS	*N*-*s*-Butylcyclohexylamine (IVA)[8a]	79/15	55	Colorless square plates (from dioxane) 212—213	211[8a]
VS	*N*-Cyclohexylhexylamine (VA)[9]	87—93/13	34	Colorless plates (from *n*-amyl alcohol) 241—242	240[9b]
VIS	*N*-Cyclohexylcyclohexylamine (VIA)	103—104/6	57	Colorless needles (from ethanol) 334—335 (in sealed tube)	
VIIS	*N*-2-Methylcyclohexylcyclohexylamine (VIIA)	119/11	55	Colorless square plates or cubic crystals (from *n*-amyl alcohol) 246—245 (in sealed tube)	
VIIIS	*N*-Cyclopentylhexylamine (VIIIA)	95—100/11	44	Colorless plates (from *n*-amyl alcohol) 210 (in sealed tube)	
IXS	*N*-Cyclopentylcyclohexylamine (IXA)[6]	130/33	59	Colorless plates (from *n*-amyl alcohol) 276—277 (in sealed tube)	

than 1%) for a short time; the amalgamated aluminum was then collected, washed with water and then ethanol, and used immediately. An example is described below.

Preparation of IS. A mixture of acetone (30 g, *ca.* 0.5 mol), *n*-hexylamine (50 g, *ca.* 0.5 mol) and potassium fluoride (80 g, *ca.* 1.3 mol) was refluxed for *ca.* 12 hr. When the reaction mixture, freed from the inorganic portion, was then distilled (preferably in an atomosphere of nitrogen), a fraction distilling at 71—74°C/17 mmHg was collected; colorless liquid with a characteristic smell, yield *ca.* 55 g (*ca.* 70%).

Preparation of IA. A mixture of IS (10 g), an aluminum amalgam (10 g), and methanol (70 *ml*) was shaken under cooling with water. After *ca.* 10

TABLE 3. ANALYSES OF THE AMINE HYDROCHLORIDES

		Calcd (%)				Found (%)			
		C	H	N	Cl	C	H	N	Cl
IA·HCl	$C_9H_{22}NCl$	60.14	12.34	7.79	19.73	60.13	12.08	7.85	18.85
IIA·HCl	$C_9H_{20}NCl$	60.82	11.34	7.88	19.95	61.17	11.06	7.86	20.15
IIIA·HCl	$C_{10}H_{24}NCl$	61.98	12.48	7.23	18.30	61.82	12.26	7.19	18.50
IVA·HCl	$C_{10}H_{22}NCl$	62.63	11.57	7.31	18.49	62.76	11.36	7.33	18.78
VA·HCl	$C_{12}H_{26}NCl$	65.57	11.92	6.37	16.13	65.75	11.76	6.30	16.67
VIA·HCl	$C_{12}H_{24}NCl$	66.18	11.11	6.43	16.28	66.51	11.38	6.85	15.95
VIIA·HCl	$C_{13}H_{26}NCl$	67.35	11.31	6.04	15.30	67.26	11.29	6.33	15.19
VIIIA·HCl	$C_{11}H_{24}NCl$	64.20	11.76	6.81	17.23	64.20	11.90	6.80	17.28
IXA·HCl	$C_{11}H_{22}NCl$	64.84	10.89	6.86	17.40	65.14	10.73	6.96	16.29

min, the initial evolution of heat subsided. Then water (*ca.* 12 m*l*) was added, portion by portion, over a period of *ca.* 10 hr with shaking at room temperature. When the reaction was complete, an aqueous solution of sodium hydroxide (100 g of a 25% soln.) was added to dissolve the aluminum hydroxide produced. The whole was then filtered, sodium chloride was added, and the mixture was extracted with ether. The extract was concentrated, dried over potassium hydroxide, and distilled. A fraction which distilled at 57—59°C/12 mmHg was collected; colorless liquid, yield 5.4 g (*ca.* 54%).

The hydrochloride of the amine was prepared by passing dry hydrogen chloride into a solution of the amine in ether. The precipitates produced were recrystallized from hot dioxane to give long, colorless plates, mp 147—148°C.

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