Synthetic Reactions using Transition Metal Complexes. Conversion of Amide Oximes into Amidines by Pentacarbonyliron and Evidence for Imine Intermediates in the Deoximation of Ketoximes

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Summary *N*-Alkyl and *N*-arylbenzamide oximes, when treated with pentacarbonyliron in dry tetrahydrofuran undergo reductive fission of the N–O linkage to give the corresponding amidines in high yields; an identical reaction takes place with methyl mesityl ketoxime which gives the corresponding imine.

OWING to the ready availability of oximes as synthetic intermediates and as derivatives for the protection of the carbonyl function, several methods are known for the regeneration of carbonyl compounds from the corresponding oximes.[1] Among the methods employing transition metals as complexes or ions in low-valence states, it has been reported[2] that $[Fe(CO)_5]$ in the presence of a catalytic amount of BF_3 causes the reductive deoximation of oximes under anhydrous conditions. If, however, a chlorine atom is bonded to the azomethine carbon, a different reaction takes place since treatment of benzohydroximoyl chlorides with $[Fe(CO)_5]$ gives the corresponding nitriles, very likely through nitrile oxide intermediates.[3] We now report that the amide oximes (**1**) undergo reductive cleavage of the N–O bond with $[Fe(CO)_5]$ to give the corresponding amidines (**2**). Specifically, treatment of *ca.* 0·5 M solutions of the *N*-alkyl and *N*-arylbenzamide oximes† (**1a**—**f**) with ⩾ 1 mol. equiv. of $[Fe(CO)_5]$ in refluxing dry tetrahydrofuran (THF) gave the following benzamidines‡ in 70—90% yield: (**2a**),[4] m.p. 116—117°; (**2b**), m.p. 173·5—174·5°; (**2c**), m.p. 183—184°; (**2d**), m.p. 117·5—118·5°; (**2e**),[5] m.p.

84—85°; (**2f**), b.p. 62° at 0·1 mmHg, picrate m.p. 135—136°. All products (**2**) were adequately characterized by elemental analyses and spectroscopic methods; specifically, the mass spectra contained the expected molecular ion, the i.r. spectra (CCl_4–C_2Cl_4–CS_2) showed typical absorptions[6] at 1640—1580, 3300—3400, and 3500 cm^{-1} [the latter was absent in the spectra of (**2e**) and (**2f**)], and the ^1H n.m.r. spectra ($CDCl_3$), besides other resonances, showed a broad N*H* peak at δ 4·5—6·5, the exact position of which varied with substitution at the amidic nitrogen.

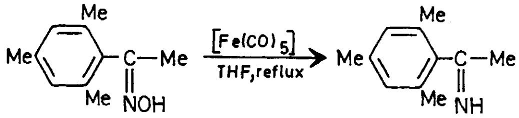
$$R\cdot C(X)=NOH \xrightarrow[\text{THF, reflux}]{[Fe(CO)_5]} R\cdot C(X)=NH$$

(**1**) (**2**)

	R	X		R	X
a;	Ph	NHPh	**d**;	Ph	NHC_6H_4Cl-*p*
b;	2,4,6-$Me_3C_6H_2$	NHPh	**e**;	Ph	NMePh
c;	*p*-$O_2NC_6H_4$	NHPh	**f**;	Ph	NMe_2

Although the scope of the reaction has not been fully investigated, there seem to be no limitations of reactivity as far as simple amide oximes bearing aromatic and/or aliphatic groups are concerned. Hence, besides its potential for the preparation of amidines,[5] this reductive dehydroxylation of amidoximes appears more promising because of its simplicity, high yields, and work-up procedure than similar reactions using catalysts and hydrogen under pressure.[7]

Moreover, this reductive fission appears not to depend on the presence of the amidic group linked to the azomethine carbon. We have in fact observed that methyl mesityl ketoxime (**3**) under the same conditions as for the amide oximes (**1**) gives the corresponding imine (**4**) which was identified by mass, i.r., and n.m.r. spectroscopy and isolated as its hydrochloride[8] (65%). A small amount of methyl mesityl ketone was identified by v.p.c. after the work-up of the reaction mixture. In contrast, appreciable amounts of cyclohexanone were formed from cyclohexanone oxime (t.l.c. and i.r. of the reaction mixture) which was isolated as its 2,4-dinitrophenylhydrazone in 55% yield, although it has been claimed[2] that no reaction takes place without BF_3 as a catalyst. The apparent different reactions of these ketoximes can be explained by the well known moisture sensitivity of ketimines and their easy hydrolysis to ketones, this reaction being largely prevented by steric hindrance.[9] These results match those reported for the conversion of ketoximes into ketones by tervalent titanium[1b] and also give evidence for imine intermediates in the deoximation by $[Fe(CO)_5]$.



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† Prepared by 1,3-addition of amines to nitrile oxides (O. Exner, V. Jehlička, A. Dondoni, and A. C. Boicelli, *J.C.S. Perkin II*, 1974, 567; A. Dondoni, L. Lunazzi, P. Giorgianni, and D. Macciantelli, *J. Org. Chem.*, in the press). The new compounds (**1c**) and (**1f**) had m.p. 185—186° (from benzene) and 126—127° (from ethanol) respectively.

‡ Reactions were monitored by t.l.c. (silica, ether–light petroleum, 1 : 1). The products were isolated by evaporation of THF under reduced pressure and recrystallized from benzene or benzene–light petroleum.

[1] (a) E. J. Corey and J. E. Richman, *J. Amer. Chem. Soc.*, 1970, **92**, 5276 and references therein; (b) G. H. Timms and E. Wildsmith, *Tetrahedron Letters*, 1971, 195.

[2] H. Alper and J. T. Edward, *J. Org. Chem.*, 1967, **32**, 2938.

[3] N. A. Genco, R. A. Partis, and H. Alper, *J. Org. Chem.*, 1973, **38**, 4365.

[4] F. C. Cooper and M. W. Partridge, *Org. Synth.*, 1963, Coll. Vol. IV, 769.

[5] S. R. Sandler and W. Karo, 'Organic Functional Group Preparations,' Academic Press, New York, 1972, Vol. III, ch. 6.

[6] J.-A. Gautier, M. Miocque, C. C. Fauran, and A.-Y. Le Cloarec, *Bull. Soc. chim. France*, 1970, 200.

[7] R. P. Mull, R. H. Mizzoni, M. R. Dapero, and M. E. Egbert, *J. Medicin. Pharm. Chem.*, 1962, **5**, 651; H. J. Barber and A. D. H. Self, U.S.P. 2,375,611, May 8, 1945 (*Chem. Abs.*, 1945, **39**, 3544).

[8] C. R. Hauser and D. S. Hoffenberg, *J. Amer. Chem. Soc.*, 1955, **77**, 4885.

[9] S. R. Sandler and W. Karo, 'Organic Functional Group Preparations', Academic Press, New York, 1972, Vol. II, ch. 12, p. 258; R. W. Layer, *Chem. Rev.*, 1963, **63**, 489.