

# 63

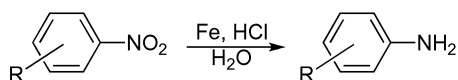
---

## *Béchamp Reduction*

### A. GENERAL DESCRIPTION OF THE REACTION

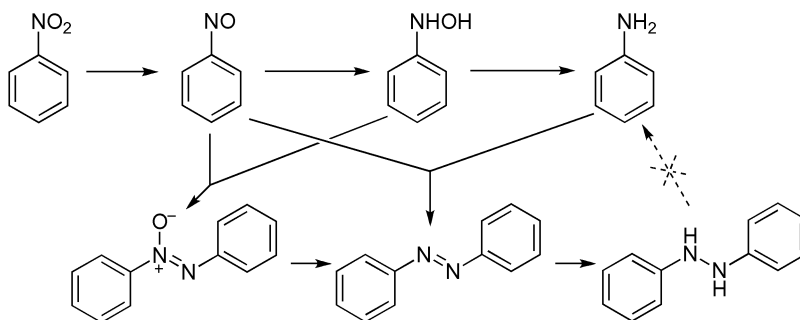
This reaction was first reported by Béchamp in 1854.<sup>1</sup> It is the reduction of aromatic nitro compounds to the corresponding aromatic amines by iron, ferrous salts, or iron catalyst in aqueous acid. Thus this reaction is generally referred to as the Béchamp reduction.<sup>2</sup> Besides iron, zinc and tin are often used to reduce the aromatic nitro compounds in the presence of an acid;<sup>3</sup> however, the reduction of aromatic nitro compounds often stops at an intermediate stage, yielding hydroxylamines,<sup>4</sup> hydrazines,<sup>5</sup> azoarenes,<sup>6</sup> or azoxyarenes.<sup>7</sup> These intermediates definitely indicate some aspects of the mechanism. Although the main drawbacks of the Béchamp reduction include the slow reaction rate and costly steam distillation compared with the catalytic hydrogenation of aromatic nitro compounds, the Béchamp reduction usually shows higher selectivity to the desired product.<sup>8</sup> In addition, this reaction might give much better results if some neutral organic solvents were added to the aqueous reaction mixture, such as acetonitrile and propylene carbonate.<sup>9</sup> Recently, a highly chemoselective catalytic hydrogenation of nitrobenzenes using homogeneous iron complex catalysts has been reported.<sup>10</sup> The Béchamp reduction has been reviewed.<sup>11</sup>

### B. GENERAL REACTION SCHEME

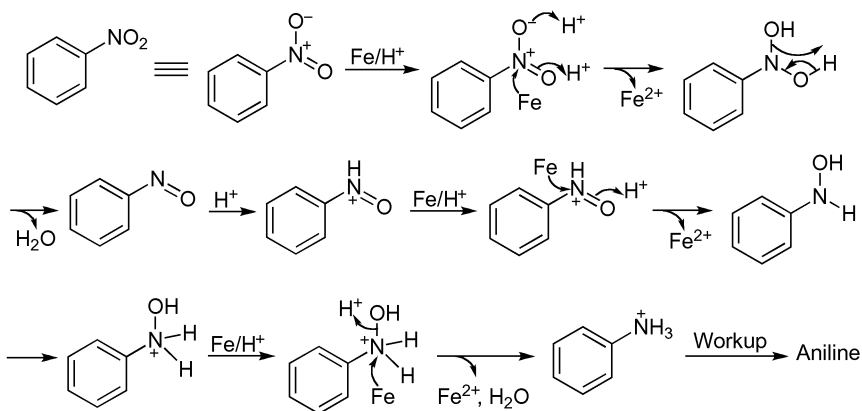


### C. PROPOSED MECHANISMS

It is proposed that the nitro group is reduced via a multistep process, as shown below.<sup>10,12</sup>



A tentative mechanistic detail of the Béchamp reduction is also illustrated below.



### D. MODIFICATION

N/A

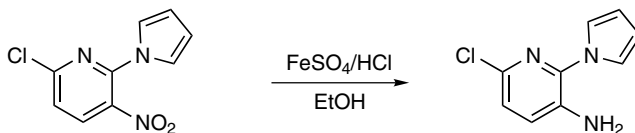
### E. APPLICATIONS

This reaction is generally used to reduce aromatic nitro compounds into aromatic amines.

### F. RELATED REACTIONS

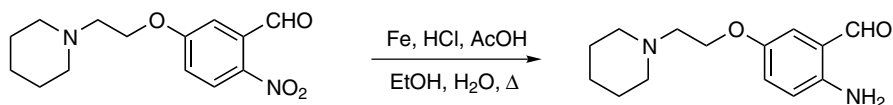
N/A

## G. CITED EXPERIMENTAL EXAMPLES



Reference 13.

To 300 mL EtOH was added 9.27 g 6-chloro-3-nitro-2-pyrrolopyridine (41 mmol), followed by 115.25 g  $\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$  (414 mmol), 0.5 mL 10 N HCl, and 5 mL water. The mixture was heated at  $80^\circ\text{C}$  for 90 min, while a 30% ammonia solution was added in little fractions to maintain a basic pH. After cooling, EtOH was evaporated under vacuum. The residue was poured in 100 mL water and extracted with  $\text{Et}_2\text{O}$ . After the usual treatment, the first amount of the product was obtained. The aqueous phase was alkalinized with ammonia solution and extracted with EtOAc. Finally, 4.59 g 3-amino-6-chloro-2-pyrrolopyridine was obtained as a beige powder, in a yield of 57%, m.p.  $89^\circ\text{C}$  (recrystallization from 80%  $\text{Et}_2\text{O}$  and 20% *n*-hexane).



Reference 14.

To mixture of 1.2 g iron (21.6 mmol), 0.25 mL 10 N HCl, 10 mL acetic acid, 10 mL ethanol and 5 mL water was added 1.0 g 2-nitro-5-(2-piperidin-1-ylethoxy)benzaldehyde (3.6 mmol). The mixture was refluxed for 15 min with stirring, and iron was removed by filtration. The product was worked up as usual.

Other references related to the Béchamp reaction are cited in the literature.<sup>15</sup>

## H. REFERENCES

1. Béchamp, A. J., *Ann. Chim. Phys.*, **1854**, 42, 186.
2. (a) Lund, R. B. and Brown, G. W., *Eur. Pat. Appl.*, **1987**, June 5, 221,021. (b) Vojir, V., *Chem. Prumysl*, **1981**, 31, 74. (c) Terc, J.; Vokal, J. and Prachensky, J., *Chem. Prumysl*, **1981**, 31, 20. (d) Medvedeva, V. S. and Belotsvetov, A. V., *Zh. Org. Khim.*, **1972**, 8, 1335.
3. (a) Coleman, G. H.; McClosky, S. M. and Suart, F. A., *Org. Syn. Coll.*, **1955**, 3, 668–670. (b) Hartman, W. W.; Dickey, J. B. and Stampfli, J. G., *Org. Syn. Coll.*, **1949**, 2, 175–178.
4. (a) Rondestvedt, C. S. and Johnson, T. A., *Synthesis*, **1977**, 850. (b) Entwistle, I. D.; Gilkerson, T.; Johnstone, R. A. W. and Telford, R. P., *Tetrahedron*, **1978**, 34, 213. (c) Oxley, P. W.; Adger, B. M.; Sasse, M. J. and Forth, M. A., *Org. Synth Coll.*, **8**, **1993**, 16. (d) Yanada, K.; Yamaguchi, H.; Meguri, H. and Uchida, S., *J. Chem. Soc., Chem. Commun.*, **1986**, 1655. (e) Feuer, H.; Bartlett, R. S.; Vincent, B. F. and Anderson R. S., *J. Org. Chem.*, **1965**, 30, 2880.
5. (a) Furst, A. and Moore, R. E., *J. Am. Chem. Soc.*, **1957**, 79, 5492. (b) Olah, G. A., *J. Am. Chem. Soc.*, **1959**, 81, 3165.

6. Hutchins, R. O.; Lamson, D. W.; Rua, L.; Milewski, C. and Maryanoff, B., *J. Org. Chem.*, **1971**, 36, 803.
7. (a) Osuka, A.; Shimizu, H. and Suzuki, H., *Chem. Lett.*, **1983**, 1373. (b) Azoo, J. A. and Grimshaw, J., *J. Chem. Soc., Sect. C*, **1968**, 2403. (c) Ohe, K.; Uemura, S.; Sugita, N.; Masuda, H. and Taga, T., *J. Org. Chem.*, **1989**, 54, 4169. (d) Ogata, Y. and Mibae, J., *J. Org. Chem.*, **1962**, 27, 2048. (e) Hutton, J. and Waters, W. A., *J. Chem. Soc. B*, **1968**, 191. (f) Porta, F.; Pizzotti, M. and Cenini, S., *J. Organomet. Chem.*, **1981**, 222, 279.
8. Mukhopadhyay, S.; Gandi, G. K. and Chandalia, S. B., *Org. Proc. Res. Dev.*, **1999**, 3, 201.
9. (a) Kolchinski, A. G. and Alcock, N. W., *J. Org. Chem.*, **1998**, 63, 4515. (b) Riesgo, E. C.; Jin, X. and Thummel, R. P., *J. Org. Chem.*, **1996**, 61, 3017.
10. Deshpande, R. M.; Mahajan, A. N.; Diwakar, M. M.; Ozarde, P. S. and Chaudhari, R. V., *J. Org. Chem.*, **2004**, 69, 4835.
11. (a) Vogt, P. F. and Gerulis, J. J., "Amines, Aromatic" in *Ullmann's Encyclopedia of Industrial Chemistry*, 5th ed.; Gerhartz, W., ed., VCH, Weinheim, **1985**, A2, pp. 37–55. (b) Hamilton, C. S. and Morgan, J. F., *Org. React.*, **1944**, 2, 428.
12. Yu, C. Z.; Liu, B. and Hu, L. Q., *J. Org. Chem.*, **2001**, 66, 919.
13. Prunier, H.; Rault, S.; Lancelot, J.-C.; Robba, M.; Renard, P.; Delagrange, P.; Pfeiffer, B.; Caignard, D.-H.; Misslin, R.; Guardiola-Lemaitre, B. and Hamon, M., *J. Med. Chem.*, **1997**, 40, 1808.
14. Perzyna, A.; Marty, C.; Facompré, M.; Goossens, J.-F.; Pommery, N.; Colson, P.; Houssier, C.; Houssin, R.; Hénichart, J.-P. and Bailly, C., *J. Med. Chem.*, **2002**, 45, 5809.
15. (a) Blaser, H. U. and Studer, M., *Appl. Catal.*, **1999**, 189, 191. (b) Courtin, A., *Helv. Chim. Acta*, **1980**, 62, 2280. (c) Knifton, J. F., *J. Org. Chem.*, **1976**, 41, 1200. (d) J. R. Geigy A.-G., *Belgian Pat.*, **1962**, 611,833 [*Chem. Abstr.*, **1962**, 57, P16578h]. (e) Yagi, S.; Miyauchi, T. and Yeh, C. Y., *Bull. Chem. Soc. Jpn.*, **1956**, 29, 194. (f) Smith, L. I. and Opie, J. W., *Org. Syn. Coll.*, **1955**, 3, 56. (g) Wertheim, E., *Org. Syn. Coll.*, **1949**, 2, 16. (h) Werner, J., *Ind. Eng. Chem.*, **1949**, 41, 1841. (i) Werner, J., *Ind. Eng. Chem.*, **1948**, 40, 1575. (j) Brown, H. P. and Hamilton, C. S., *J. Am. Chem. Soc.*, **1934**, 56, 151. (k) Ehrlich, P. and Bertheim, A., *Ber.*, **1907**, 40, 3292. (l) Béchamp, A. J., *Compt. Rend.*, **1863**, 56, 1172.