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of Reliable Methods
for the Preparation
of Organic Compounds

Working with Hazardous Chemicals

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These paragraphs were added in September 2014. The statements above do not supersede any specific hazard caution notes and safety instructions included in the procedure.

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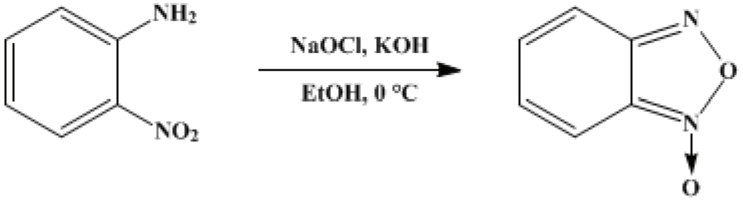
Organic Syntheses, Coll. Vol. 4, p.74 (1963); Vol. 37, p.1 (1957).

BENZOFURAZAN OXIDE

[Benzofurazan 1-oxide]

[I. HYPOCHLORITE OXIDATION OF *o*-NITROANILINE]



Submitted by F. B. Mallory[1]
Checked by T. L. Cairns and H. E. Simmons.

1. Procedure

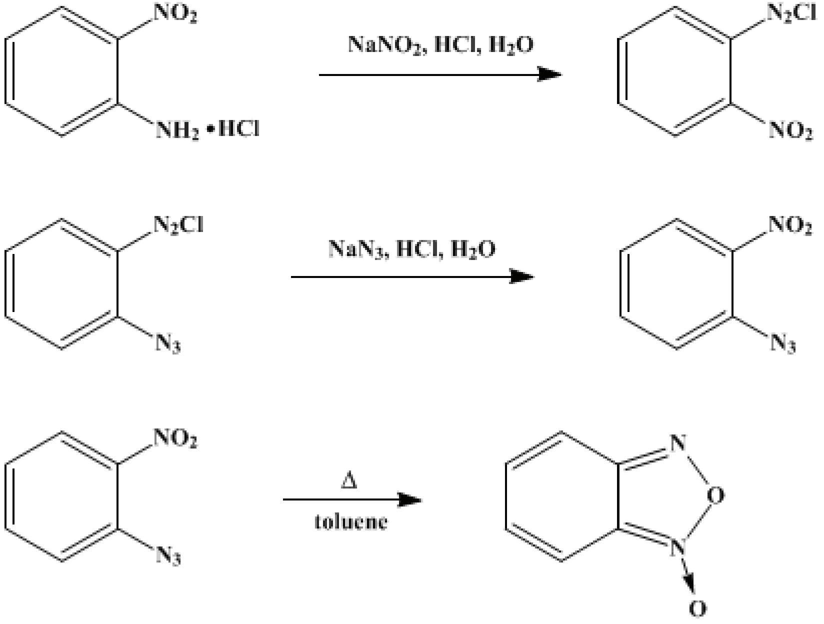
A. *Sodium hypochlorite solution.* A solution of sodium hypochlorite[2] is prepared immediately before it is to be used. A mixture of 50 g. (1.25 moles) of sodium hydroxide and 200 ml. of water is swirled until the solid dissolves. The solution is cooled to 0°, and 100 g. of crushed ice is added. The flask is then placed in an ice bath, and chlorine gas from a tank is bubbled through the solution until 41 g. (0.58 mole) is absorbed. An excess of chlorine should be avoided. The solution of sodium hypochlorite is kept in the dark at 0° until needed.

B. *Benzofurazan oxide.* A mixture of 21 g. (0.32 mole) of potassium hydroxide and 250 ml. of 95% ethanol in a 1-l. Erlenmeyer flask is heated on a steam bath until the solid dissolves (Note 1). *o*-Nitroaniline (40 g., 0.29 mole) (Note 2) is dissolved in the warm alkali solution. The resulting deep red solution is then cooled to 0°, and the sodium hypochlorite solution from part A is added slowly with good stirring over the course of 10 minutes (Note 3). The flocculent yellow precipitate is collected on a large Büchner funnel, washed with 200 ml. of water, and air-dried. The crude product weighs 36.0–36.5 g. and melts at 66–71° (Note 4). The product is purified by recrystallization from a solution made up from 45 ml. of 95% ethanol and 15 ml. of water. Material insoluble in the hot solvent is removed by filtration, and the hot filtrate is allowed to cool to room temperature. The yield of yellow benzofurazan oxide is 31.6–32.5 g. (80–82%), m.p. 72–73°.

2. Notes

1. A small residue of insoluble carbonate may be ignored.
2. Eastman Kodak white label grade material, melting at 71.5–73.5°, was used.
3. The temperature of the mixture should be kept close to 0° to avoid decomposition of the sodium hypochlorite and prevent formation of tarry materials that occurs at 10–12°. A Dry Ice-acetone bath was found convenient by the checkers.
4. There may be some material that does not melt under 100°, which is not present after recrystallization.

[II. DECOMPOSITION OF *o*-NITROPHENYLAZIDE]



Submitted by P. A. S. Smith and J. H. Boyer[3].
Checked by Arthur C. Cope, David J. Marshall, and Douglas S. Smith.

1. Procedure

A. *o-Nitrophenylazide.* A mixture of 28 g. (0.2 mole) of *o*-nitroaniline (Note 1), 80 ml. of water, and 45 ml. of concentrated hydrochloric acid is placed in a 500-ml. three-necked flask equipped with a stirrer, a thermometer, and a dropping funnel. The stirrer is started, and the flask is cooled in an ice-salt bath until the temperature of the mixture is 0–5°. After this temperature has been reached, the amine hydrochloride is diazotized by adding dropwise a solution of 14.5 g. of reagent grade sodium nitrite in 50 ml. of water. Stirring is then continued for 1 hour at 0–5°. The yellow-green solution is filtered from traces of insoluble impurities and poured into a 2-l. beaker surrounded by an ice bath. With stirring, a solution of 13 g. (0.2 mole) of sodium azide in 50 ml. of water is added (Note 2). Almost immediately the *o*-nitrophenylazide begins to precipitate as a light-cream to colorless solid, which is collected on a Büchner funnel after the nitrogen evolution has ceased (15–20 minutes). The yield of *o*-nitrophenylazide, m.p. 52–55°, is 31–32 g. (94–97%). This crude product can be used for the preparation of benzofurazan oxide in Part B (Note 3).

The impure azide is dissolved in 110–120 ml. of 95% ethanol at 50–55° (Note 4), and 2 g. of activated carbon is added to aid in the removal of impurities. After being filtered through a steam-heated funnel, the warm solution is allowed to cool to room temperature, whereupon 14–15 g. of the product precipitates as light-yellow prisms, m.p. 53–55°. Concentration (Note 5) of the mother liquor to 30–40 ml. by evaporation at room temperature under an air stream causes the separation of an additional 7–8 g. of material, m.p. 52–54° (Note 6). The total yield of purified *o*-nitrophenylazide is 63–69%.

B. *Benzofurazan oxide.* A mixture of 16.4 g. (0.1 mole) of *o*-nitrophenylazide and 30 ml. of reagent grade toluene is placed in a 100-ml. round-bottomed flask equipped with a reflux condenser and is heated on a steam cone. Moderate nitrogen evolution commences immediately and continues for about 3 hours. When there are no more visible signs of gas evolution, the solution is cooled in an ice bath. After a few minutes, precipitation of light straw-colored clusters of prisms commences. About 6 g. of pure product, m.p. 70–72°, is obtained in this manner. Evaporation of the mother liquor yields another 4.5–5.5 g. of the oxide, slightly darker in color, m.p. 69–71°, which may be purified by recrystallization from 15 ml. of 70% ethanol to give material having a melting point of 70–71°. The total yield is 10.5–11.5 g. (77–85%).

2. Notes

1. If the *o*-nitroaniline is contaminated with *p*-nitroaniline, as it is likely to be, the yield and quality of the *o*-nitrophenylazide are lowered. The submitters obtained yields of 72–80% from *o*-nitroaniline melting at 70–71° obtained from the Eastman Kodak Company. The yields reported were obtained with *o*-nitroaniline melting at 72–73.5°.
2. A large container is necessary for this reaction because of excessive frothing which accompanies the nitrogen evolution. This step should be conducted in a hood to avoid possible exposure to hydrazoic acid.
3. A somewhat lower yield of benzofurazan oxide, m.p. 67–70°, is obtained if non-purified azide is used.
4. At this temperature there is no danger of decomposition. Loss of nitrogen commences at 80°.
5. Recrystallization of *o*-nitrophenylazide from a smaller volume of ethanol gives a considerably higher recovery, but it may be rather difficult to avoid separation of the product as an oil.
6. The submitters report that similar yields of phenylazide can be obtained from aniline in the same manner. Phenylazide must be distilled rather than recrystallized.[4]

3. Discussion

Benzofurazan oxide is prepared most conveniently by the hypochlorite oxidation of *o*-nitroaniline according to the method described, which is adapted from the procedure of Green and Rowe.[5]

Benzofurazan oxide also has been prepared by thermal decomposition of *o*-nitrophenylazide;[6,7] by oxidation of the dioxime of *o*-benzoquinone with dilute nitric acid or potassium ferricyanide in alkaline solution;[6] and by the oxidation of *o*-nitroaniline with phenyl iodosoacetate.[8]

The present synthesis of benzofurazan oxide from *o*-nitrophenylazide is a modification of the methods of Noelting and Kohn[7] and of Zincke and Schwarz.[6] The hypochlorite oxidation method has been used in the synthesis of various substituted benzofurazan oxides.[9]

o-Nitrophenylazide has been prepared by the action of sodium azide or hydrazine on *o*-nitrobenzenediazonium sulfate;[10] ammonia on *o*-nitrobenzenediazonium perbromide;[6,11] O-benzylhydroxylamine hydrochloride on *o*-nitrobenzenediazonium acetate;[12] sodium nitrite and hydrochloric acid on *o*-nitrophenylhydrazine;[6] and aqueous alkali on *o*-nitrobenzenediazo-4-semicarbazinocamphor.[13]

References and Notes

1. California Institute of Technology, Pasadena, California.
2. A similar procedure is given in *Org. Syntheses Coll. Vol.* **1**, 309 (1941).
3. University of Michigan, Ann Arbor, Michigan.
4. *Org. Syntheses Coll. Vol.* **3**, 710 (1955).
5. Green and Rowe, *J. Chem. Soc.*, **101**, 2452 (1912).
6. Zincke and Schwarz, *Ann.*, **307**, 28 (1899).
7. Noelting and Kohn, *Chem. Ztg.*, **18**, 1095 (1894).
8. Pausacker, *J. Chem. Soc.*, **1953**, 1989.
9. Gaughran, Picard, and Kaufman, *J. Am. Chem. Soc.*, **76**, 2233 (1954).
10. Noelting and Michel, *Ber.*, **26**, 86, 88 (1893).
11. Noelting, Grandmougin, and Michel, *Ber.*, **25**, 3328 (1892).
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13. Forster, *J. Chem. Soc.*, **89**, 233 (1906).

Appendix
Chemical Abstracts Nomenclature (Collective Index Number);
(Registry Number)

hydrazoic acid

dioxime of o-benzoquinone

o-nitrobenzenediazonium perbromide

o-nitrobenzenediazo-4-semicar-bazinocamphor

ethanol (64-17-5)

hydrochloric acid (7647-01-0)

ammonia (7664-41-7)

sodium hydroxide (1310-73-2)

nitric acid (7697-37-2)

nitrogen (7727-37-9)

sodium nitrite (7632-00-0)

carbon (7782-42-5)

chlorine (7782-50-5)

potassium hydroxide (1310-58-3)

toluene (108-88-3)

sodium hypochlorite (7681-52-9)

hydrazine (302-01-2)

sodium azide (26628-22-8)

potassium ferricyanide (13746-66-2)

Benzofurazan oxide,
Benzofurazan 1-oxide (480-96-6)

phenyl iodosoacetate

O-benzyl-hydroxylamine hydrochloride (2687-43-6)

o-NITROANILINE (88-74-4)

p-nitroaniline (100-01-6)

o-NITROPHENYLAZIDE (1516-58-1)

o-nitrobenzenediazonium sulfate

o-nitrobenzenediazonium acetate

o-nitrophenylhydrazine (3034-19-3)