



A Publication  
of Reliable Methods  
for the Preparation  
of Organic Compounds

## Working with Hazardous Chemicals

The procedures in *Organic Syntheses* are intended for use only by persons with proper training in experimental organic chemistry. All hazardous materials should be handled using the standard procedures for work with chemicals described in references such as "Prudent Practices in the Laboratory" (The National Academies Press, Washington, D.C., 2011; the full text can be accessed free of charge at [http://www.nap.edu/catalog.php?record\\_id=12654](http://www.nap.edu/catalog.php?record_id=12654)). All chemical waste should be disposed of in accordance with local regulations. For general guidelines for the management of chemical waste, see Chapter 8 of Prudent Practices.

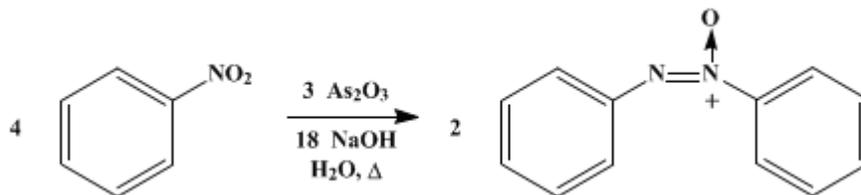
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*These paragraphs were added in September 2014. The statements above do not supersede any specific hazard caution notes and safety instructions included in the procedure.*

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## AZOXYBENZENE



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Checked by Henry Gilman and H. J. Harwood.

### 1. Procedure

**Sodium arsenite** is prepared by dissolving 226 g. (1.1 moles) of powdered arsenious oxide, made into a paste with a little water, in a solution of 275 g. (6.9 moles) of **sodium hydroxide** dissolved in 600 cc. of water. This solution, diluted with 600 cc. of water, is poured into a 2-l. three-necked flask provided with a reflux condenser and a mechanical stirrer, and 150 g. (125 cc., 1.2 moles) of freshly distilled **nitrobenzene** is added (Note 1).

The mixture is refluxed on an oil bath for eight hours with constant and vigorous stirring (Note 2). After removing the oil bath, the reaction mixture is allowed to cool to about 80°, while stirring is continued, and is then transferred to a separatory funnel previously heated to about the same temperature in an oven (Note 3).

The upper layer of oil is separated (Note 4), run at once into an open vessel, and washed with water to which a little **hydrochloric acid** has been added. Yellow crystals form at once (Note 5), and the yield of **azoxybenzene** melting at 35.5–36.5° is 102 g. (85 per cent of the theoretical amount) (Note 6) and (Note 7).

### 2. Notes

1. The excess of **sodium arsenite** and the eight-hour period of heating ensure the complete utilization of **nitrobenzene**. This makes it unnecessary to use steam distillation or other processes for the removal of unreacted **nitrobenzene**.

Crude **nitrobenzene** may be used, but a good grade is recommended. When crude **nitrobenzene** is used, a darker product having a slightly lower melting point is usually obtained.

2. The internal temperature should be about 104°, and the temperature of the bath should not greatly exceed 115°. A smaller flask might be used were it not for the danger of foaming which would result from accidental stopping of the stirrer. If the reaction is interrupted, the oil bath must be removed even though the stirring has been stopped; otherwise, on resumption of stirring, the superheated material may be ejected through the condenser. With these precautions in mind it is unnecessary to have a continuous eight-hour period of heating.

Contrary to the general statement found in the literature, **azoxybenzene** is somewhat volatile with steam. Therefore, the presence of oil drops in the condenser at the end of the eight-hour period of refluxing is no criterion of unaltered **nitrobenzene**. **Azoxybenzene** is easily volatile with steam at 140–150°.

3. In this way the separation is effected at about 60°, and the danger of the solution's cooling to a point where **sodium arsenate** separates is avoided. Should the **sodium arsenate** separate because of undue cooling, the mixture is heated again, with stirring, until the arsenate redissolves. On dilution with sufficient water to keep the arsenate in solution, the oil settles to the bottom and does not separate readily from the liquid. Furthermore, the volume of solution is so large with such dilution that it is less easily handled.

4. The solution from which the original oil separated will yield, when diluted with an equal volume of water, a small additional quantity of **azoxybenzene**. This may be recovered by extraction with **benzene**, but the quantity of compound so obtained does not justify this extra procedure.

5. The presence of **hydrochloric acid** accelerates crystallization. Should crystallization be retarded, it is recommended that the oil be seeded with a crystal of **azoxybenzene**.

6. Recrystallization from 50 cc. of hot 95 per cent **alcohol** gives 72 g. of **azoxybenzene**. The recrystallized product melts at the same temperature, 35.5–36.5°, as the crude material but is distinctly lighter in color.

7. The following alternative procedure for preparing **azoxybenzene** is convenient. In a 1-l. three-necked flask fitted with a reflux condenser and an efficient stirrer (p. 117) there are placed 60 g. of **sodium hydroxide**, 200 cc. of water, and 41 g. (34.2 cc., 0.33 mole) of **nitrobenzene**. The flask is immersed in a water bath kept at 55–60°, and 45 g. (0.23 mole) of **dextrose** is introduced in portions, with continuous stirring, in the course of one hour. The temperature of the bath is then raised to 100° and kept there for two hours. The hot mixture is poured into a 2-l. long-necked flask and steam-distilled to removed **nitrobenzene** and **aniline**. This requires some twenty minutes, during which time about 2 l. of distillate passes over. When the distillate is clear, the residue is poured into a beaker and cooled well in an ice bath. The **azoxybenzene**, which solidifies, is collected, the lumps are ground in a mortar, and the product is washed with water and dried. The yield of material melting at 34–35° is 26–27 g. (79–82 per cent of the theoretical amount). Crystallization from 15 cc. of **methyl alcohol** gives material melting at 35–35.5° with 90 per cent recovery. (Nicholas Opolonick, private communication. Checked by Louis F. Fieser and M. Fieser.)

### 3. Discussion

**Azoxybenzene** has been prepared by reduction of **nitrobenzene** with alcoholic **potassium hydroxide**,<sup>1</sup> with **sodium amalgam**,<sup>2</sup> with **hydrogen** in the presence of **lead oxide**,<sup>3</sup> with **methyl alcohol** and **sodium hydroxide**,<sup>4</sup> with **sodium methoxide** and **methyl alcohol**,<sup>5</sup> with lead suboxide in alkaline suspension,<sup>6</sup> with **dextrose** in alkaline suspension (see (Note 7), above), and electrolytically;<sup>7</sup> by oxidation of **azobenzene** with **chromic anhydride**;<sup>8</sup> by treatment of  $\beta$ -phenylhydroxylamine with alkaline **potassium permanganate**,<sup>9</sup> with **nitrobenzene**,<sup>10</sup> with mineral acids,<sup>11</sup> and with **mercury acetamide**;<sup>12</sup> and by oxidation of **aniline** with **hydrogen peroxide**,<sup>13</sup> and with acid permanganate solution in the presence of **formaldehyde**.<sup>14</sup> The procedure described is a slight modification of one in the literature.<sup>15</sup>

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### References and Notes

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arsenious oxide  
β-Phenylhydroxylamine  
lead suboxide  
alcohol (64-17-5)  
hydrochloric acid (7647-01-0)  
Benzene (71-43-2)  
methyl alcohol (67-56-1)  
aniline (62-53-3)  
hydrogen (1333-74-0)  
sodium hydroxide (1310-73-2)  
formaldehyde (50-00-0)  
potassium permanganate (7722-64-7)  
lead oxide  
sodium arsenite  
sodium methoxide (124-41-4)  
potassium hydroxide (1310-58-3)  
sodium (13966-32-0)  
Nitrobenzene (98-95-3)  
hydrogen peroxide (7722-84-1)  
dextrose (492-62-6)  
sodium arsenate  
chromic anhydride  
Azoxybenzene (495-48-7)  
Azobenzene (103-33-3)  
mercury acetamide