



A Publication
of Reliable Methods
for the Preparation
of Organic Compounds

Working with Hazardous Chemicals

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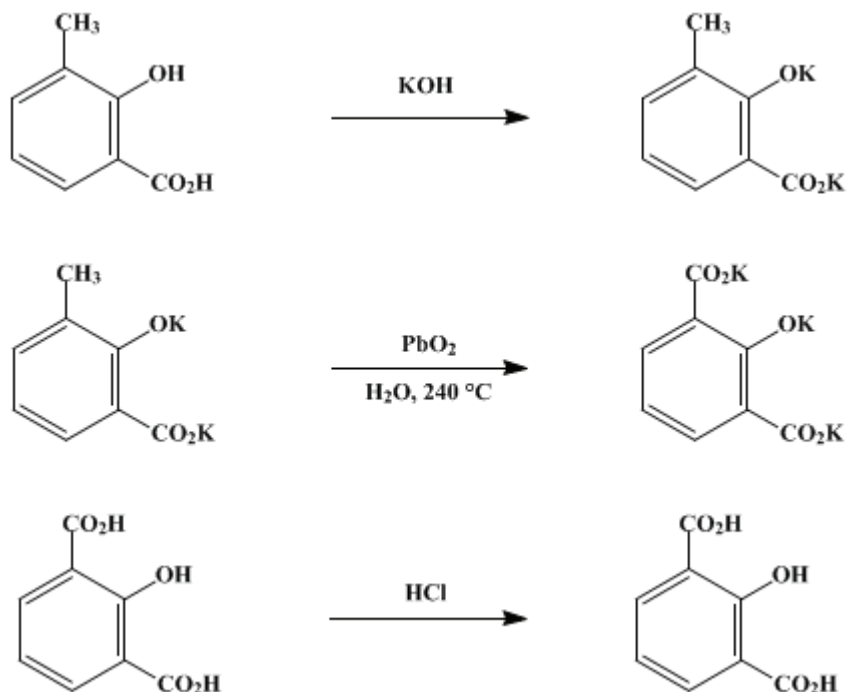
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These paragraphs were added in September 2014. The statements above do not supersede any specific hazard caution notes and safety instructions included in the procedure.

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2-HYDROXYISOPHTHALIC ACID

[Isophthalic acid, 2-hydroxy-]



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Checked by B. C. McKusick and S. Andreades.

1. Procedure

In an 800-ml. stainless-steel flanged beaker are placed 240 g. of potassium hydroxide pellets and 50 ml. of water. When the mush has cooled, 40.0 g. (0.263 mole) of 2-hydroxy-3-methylbenzoic acid (Note 1) is added, and the slurry is stirred with a long glass rod. The beaker is placed firmly in a clamp (Note 2) and set in a cold oil bath (Note 3) in a hood, and 240 g. (1.00 mole) of lead dioxide is stirred in all at once (Note 4). The oil bath is now heated by a flame, and when the bath temperature reaches 200° steady manual stirring by means of the glass rod is begun. (*Caution! Goggles and a rubber glove should be worn to protect eyes and the stirring hand against spattering.*) The temperature is raised, with steady stirring, until the bath reaches 238–240°, when the flame is moderated to maintain this bath temperature. Several minutes after 240° is reached, the mixture boils steadily and the lumpy brown mass turns quickly to a bright-orange melt containing heavy crystals of lead monoxide. The bath is held at 240° for another 15 minutes. It is then brought briefly to 250°, the flame is removed, and the beaker is lifted out of the bath.

About 5 minutes later, the liquid contents of the beaker are poured cautiously into a 2-l. glass beaker, and this is tipped and rotated slowly so as to spread the congealing mass in a thin film on the beaker walls. When the material in the beakers has cooled, a total of 1 l. of water is poured into the beakers and the water is stirred well for at least 1 hour (Note 5). The cold suspension is filtered with suction to separate 200–210 g. of an insoluble mixture of lead monoxide and red lead, which is washed on the filter with six 50-ml. portions of water.

The alkaline filtrate and washings are combined and partially neutralized by the addition of 150–175 ml. of concentrated hydrochloric acid. Sufficient sodium sulfide solution is added to precipitate all the lead ion present (Note 6). The suspension is brought to a gentle boil to coagulate the lead sulfide, allowed to cool somewhat, and filtered with suction. The filtrate is placed in a 2-l. beaker set in an ice

bath and acidified (*Caution! in the hood*) with about 150 ml. of concentrated hydrochloric acid to precipitate crude 2-hydroxyisophthalic acid monohydrate (Note 7). The suspension is cooled to 0–5° and filtered to separate the crude acid, which weighs 35–49 g. after being dried in a vacuum oven at 110°/50–150 mm. for 5 hours (Note 8).

In order to remove 1–3 g. of contaminating 2-hydroxy-3-methylbenzoic acid, the crude acid is ground in a mortar and refluxed briefly with 100 ml. of chloroform, and the suspension is filtered hot (Note 9). The separated solid is dried in air and added to 1 l. of boiling water. The mixture is boiled gently for 15 minutes and filtered by gravity to remove a small amount of gray sludge. The clear light-orange filtrate rapidly deposits needles of 2-hydroxyisophthalic acid monohydrate. After cooling to 0–5°, the acid is collected and dried at 110°/50–150 mm. for 20 hours. The anhydrous acid, which ranges in color from pale pink to tan, weighs 22–29 g. (46–61%) (Note 10) and melts at 243–255°, depending on the rate of heating and the apparatus used.

2. Notes

1. Eastman Kodak technical grade material is satisfactory.
2. A convenient clamp can be fashioned by bending a loop at the end of a 40-cm. length of iron rod 6 mm. ($\frac{1}{4}$ in.) in diameter so that the beaker can just slip up to its flange through the loop. A pinch clamp is used to hold the flange firmly to the loop.
3. The checkers used a bath wax (flash point 325°) supplied by the Fisher Scientific Co. The operation should be carried out in a hood because fumes from oil baths at high temperatures are injurious to health. A fire extinguisher should be close at hand in case the oil bath catches fire. A high-boiling silicone heat exchange oil, although more expensive, would be less of a fire hazard. Alternatively, a sodium nitrite-sodium nitrate-potassium nitrate mixture such as "Hitec" heat transfer salt sold by the du Pont Company (useful range 150–450°) can be used. Such baths will not burn, but they have the disadvantage of being oxidizing agents, so precautions should be taken not to let any organic material get into them lest a flash oxidation accompanied by spattering of hot salt take place. Hot salt baths should be well shielded to guard against spattering.
4. If the calculated amount (190 g.) of lead dioxide is used, the yield is lowered by about 20%.
5. At least an hour's contact with water is necessary in order to dislodge all the solid from the walls.
6. The amount of sodium sulfide nonahydrate needed varies from 12 to 25 g. from one run to another.
7. The acid is precipitated from aqueous solution as the monohydrate, which is soluble in cold dilute hydrochloric acid to the extent of about 6 g. per l.
8. An additional 3–5 g. (6–10%) of crude product can be obtained by concentrating the filtrate to about 800 ml., cooling the concentrate to 0°, and filtering the solid that separates. This solid must be washed well with cold water to remove coprecipitated potassium chloride.
9. The starting material is moderately soluble in hot chloroform, while 2-hydroxyisophthalic acid is quite insoluble. Fractional crystallization from water, an alternative method suggested for the separation of starting material,³ has been found by the submitters to be unsuccessful.
10. An additional 2–5 g. (4–10%) of product can be obtained by concentrating the filtrate to one-third its volume, adding 25 ml. of concentrated hydrochloric acid, cooling the mixture, separating crude acid by filtration, and recrystallizing the acid from water.

3. Discussion

2-Hydroxyisophthalic acid has been prepared by oxidizing 2-hydroxy-3-methylbenzoic acid with lead dioxide,^{3,4,5} by cleaving the ether group of 2-methoxyisophthalic acid with hydriodic acid,⁶ and by hydrolyzing 2-iodoisophthalic acid with alcoholic sodium hydroxide.⁷

The lead dioxide-alkali method has also been applied successfully by Graebe and Kraft⁴ to the three cresols, the three toluic acids, and 2,4-dimethylphenol. For the preparation of 2-hydroxyisophthalic acid, it is the only one-step method that starts from readily obtainable materials.

In general, this method is a one-step procedure for the oxidation of a cresol type of molecule to the corresponding phenolic acid. The vigorous reaction conditions clearly limit the type of functional groups that may be present in the molecule. There is no evidence that the reaction has been applied to

polynuclear or heterocyclic alkylphenols.

References and Notes

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 6. G. R. Sprengling and J. H. Freeman, *J. Am. Chem. Soc.*, **72**, 1984 (1950).
 7. C. W. James, J. Kenner, and W. V. Stubbings, *J. Chem. Soc.*, **117**, 775 (1920).
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Appendix Chemical Abstracts Nomenclature (Collective Index Number); (Registry Number)

red lead

hydrochloric acid (7647-01-0)

sodium hydroxide (1310-73-2)

chloroform (67-66-3)

lead monoxide

potassium hydroxide pellets (1310-58-3)

hydriodic acid (10034-85-2)

sodium sulfide (1313-82-2)

potassium chloride (7447-40-7)

sodium sulfide nonahydrate (1313-84-4)

2-Hydroxyisophthalic acid,
Isophthalic acid, 2-hydroxy- (606-19-9)

2-hydroxy-3-methylbenzoic acid (83-40-9)

2-hydroxyisophthalic acid monohydrate

sodium nitrite-sodium nitrate-potassium nitrate

2-methoxyisophthalic acid (1951-38-8)

2-iodoisophthalic acid

2,4-dimethylphenol (105-67-9)

lead dioxide

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