Organic Syntheses

A Publication
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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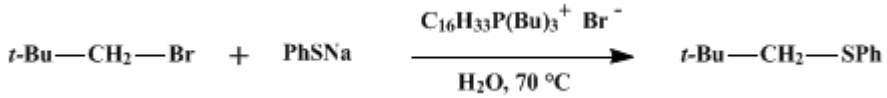
SULFIDE SYNTHESIS IN PREPARATION OF DIALKYL AND ALKYL ARYL SULFIDES: NEOPENTYL PHENYL SULFIDE

[Benzene, [(2,2-dimethylpropyl)thio]-]



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Checked by Ronald L. Sobczak and S. Masamune.

1. Procedure

A 100-ml., two-necked flask fitted with a reflux condenser, a gas-inlet, and a magnetic stirrer is charged with 15.1 g. (12.0 ml., 0.100 mole) of 1-bromo-2,2-dimethylpropane (Note 1), aqueous sodium benzenethiolate (0.1 mole) (Note 2), and 1.67 g. (0.00329 mole) of tributylhexadecylphosphonium bromide (Note 3) and (Note 4). This mixture is heated at 70° with vigorous stirring under nitrogen (Note 5) for 3.5 hours (Note 6). After the mixture has cooled to room temperature, the organic layer is separated, and the aqueous phase is extracted with two 20-ml. portions of diethyl ether. The combined organic phases are washed with 20 ml. of 10% aqueous sodium chloride and dried over calcium chloride. After removal of the solvent, the resulting, residual oil is distilled through a 10-cm. Vigreux column, giving 14.1–15.3 g. (78–85%) of colorless neopentyl phenyl sulfide (Note 7), b.p. 85–87° (5 mm.), 96–98° (8 mm.); n_D^{24} 1.5365 (Note 8).

2. Notes

1. 1-Bromo-2,2-dimethylpropane (neopentyl bromide) was obtained from Fluka A G or Tridom Chemical Inc.
2. Aqueous sodium benzenethiolate was prepared by adding 11.0 g. (10.2 ml., 0.100 mole) of commercial benzenethiol (listed as thiophenol by Aldrich Chemical Company, Inc., and Tridom Chemical Inc.) to an ice-cold solution of 4.0 g. of sodium hydroxide in 25 ml. of water.
3. The tributylhexadecylphosphonium bromide was prepared by heating 0.1 mole of 1-bromohexadecane and 0.1 mole of tributylphosphine at 60–70° for three days, according to Starks' procedure.[2] The product, while hot, was poured into 300 ml. of hexane and the mixture was stirred for 15 minutes. After cooling of the mixture to 0°, a solid product crystallized, was filtered on a Büchner funnel, and dried under reduced pressure, m.p. 54–56° (84%).
4. When the reaction was carried out using 0.033 mole equivalent of tricaprylylmethylammonium chloride (aliquat 336), obtained from General Mills Company, Chemical Division, Kankakee, Illinois, as catalyst, the reaction required about 10 hours for completion.
5. The nitrogen flow must be as slow as possible to avoid loss of 1-bromo-2,2-dimethylpropane.
6. The reaction time depends on the concentration of the catalyst; *e.g.*, with 0.1 and 0.01 mole equivalents of phosphonium salt, the reaction required 1 and 10 hours, respectively.
7. The catalyst could be recovered (80–90%) from the distillation residue, which also contained some neopentyl phenyl sulfide and diphenyl disulfide. These products were eliminated from the residue by column chromatography on silica (8 g. for 1 g. of phosphonium salt; eluent, ether). Extraction of the silica with two 25-ml. portions of boiling ethanol and evaporation of the solvent afforded the phosphonium salt, m.p. 48–51°. This material could be reused without further purification.
8. The product showed the following ^{1}H NMR spectrum ($CDCl_3$) δ (multiplicity, number of protons, assignment): 1.03 [s, 9H, $(CH_3)_3C$], 2.88 (s, 2H, CH_2), 7.02–7.52 (m, 5H, C_6H_5).

3. Discussion

This procedure[3] illustrates a simple and general method for the preparation of primary and

secondary dialkyl and alkyl aryl thioethers *via* alkylation of sodium sulfide, sodium alkyl- or arylthiolates with alkyl chlorides or bromides. The method is an example of phase-transfer catalysis, characterized by mild reaction conditions, high yields, and simple work-up procedure.

Dineopentyl and neopentyl phenyl sulfides are obtained from 1-bromo-2,2-dimethylpropane. Some other examples are given in Table I.

TABLE I
PREPARATION OF DIALKYL AND ALKYL PHENYL SULFIDES

Alkyl Halide	Nucleophile	Catalyst (mole equivalent)	Temperature (° C)	Time (minutes)	Yield of Sulfide[a](%)
1-Chloroöctane	Na_2S[b]	0.1	70	40	91
2-Chloroöctane	Na_2S[b]	0.1	70	300	90
1-Bromoöctane	Na_2S[b]	0.1	70	20	91
2-Bromoöctane	Na_2S[b]	0.1	70	80	91
Neopentylbromide	Na_2S[b]	0.1	70	500	81[c]
1-Chloroöctane	C_2H_5SNa[d]	0.033	40	40	90
2-Chloroöctane	C_2H_5SNa[d]	0.033	70	250	88
1-Bromoöctane	C_2H_5SNa[d]	0.033	40	15	91
2-Bromoöctane	C_2H_5SNa[d]	0.033	70	120	89
1-Chloroöctane	C_6H_5SNa[d]	0.033	40	30	92
2-Chloroöctane	C_6H_5SNa[d]	0.033	70	180	90
1-Bromoöctane	C_6H_5SNa[d]	0.033	40	10	91
2-Bromoöctane	C_6H_5SNa[d]	0.033	70	60	90

[a]Isolated products.
[b]Mole ratio of Na_2S to alkyl halide is 0.6.
[c]Reaction carried out under nitrogen.
[d]Mole ratio of sodium salt to alkyl halide is 1.

Neopentyl sulfides have been prepared by alkylation of sodium sulfide with neopentyl tosylate in high-boiling polar solvents,[4,5] or in low yields by reduction of alkyl 2,2-dimethylpropanethioate with lithium aluminum hydride in a large excess of boron trifluoride-diethyl etherate.[6]

References and Notes

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2. C. M. Starks, *J. Am. Chem. Soc.*, **93**, 195 (1971).
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4. F. G. Bordwell, B. M. Pitt, and M. Knell, *J. Am. Chem. Soc.*, **73**, 5004 (1951).
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6. E. L. Eliel and R. A. Daignault, *J. Org. Chem.*, **29**, 1630 (1964).

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

silica

ethanol (64-17-5)

calcium chloride (10043-52-4)

ether,
diethyl ether (60-29-7)

sodium hydroxide (1310-73-2)

sodium chloride (7647-14-5)

1-Bromooctane (111-83-1)

nitrogen (7727-37-9)

sodium (13966-32-0)

sodium sulfide (1313-82-2)

Thiophenol,
Benzenethiol (108-98-5)

lithium aluminum hydride (16853-85-3)

hexane (110-54-3)

1-bromohexadecane (112-82-3)

boron trifluoride-diethyl etherate (109-63-7)

diphenyl disulfide (882-33-7)

tributylphosphine (998-40-3)

Neopentyl phenyl sulfide,
Benzene, [(2,2-dimethylpropyl)thio]- (7210-80-2)

1-bromo-2,2-dimethylpropane,
neopentyl bromide,
Neopentylbromide (630-17-1)

sodium benzenethiolate

tributylhexadecylphosphonium bromide (14937-45-2)

tricaprylylmethylammonium chloride (5137-55-3)

neopentyl tosylate

1-Chlorooctane (111-85-3)

2-Chlorooctane

2-Bromooctane