

SYNLETT Spotlight 333

Hexachloroethane

Compiled by Di Wu

This feature focuses on a reagent chosen by a postgraduate, highlighting the uses and preparation of the reagent in current research

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Introduction

Hexachloroethane is a colorless, nonflammable, crystalline solid with a camphor-like odor. It is a versatile electrophilic chlorination reagent that reacts with a series of nucleophiles.¹ Furthermore, the hexachloroethane–triphenylphosphine combination has wide applications in organic synthesis as a nucleophilic chlorination reagent.² Applications of hexachloroethane are quite extensive and especially industrial uses are expanding. Hexachloroethane is used in metallurgy for refining aluminium alloys and removing impurities from molten metals. Further, it is used as a degassing agent for magnesium and to inhibit the explosiveness of methane and combustion of ammonium

perchlorate. It is also used as a smoke generator in grenades, in pyrotechnics, as an ignition suppressant, as a component of fire extinguishing fluids, as a polymer additive, as a flame-proofing or vulcanizing agent, and in the production of synthetic diamonds.³

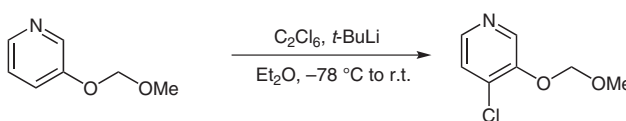
Hexachloroethane is commercially available, but can also be easily prepared according to the procedure reported by John E. Stauffer (Scheme 1),⁴ where perchloroethylene is subjected to oxychlorination with hydrogen chloride and oxygen in the presence of an oxychlorination catalyst.



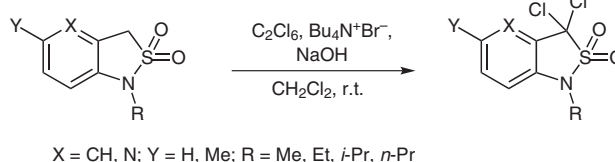
Scheme 1

Abstract

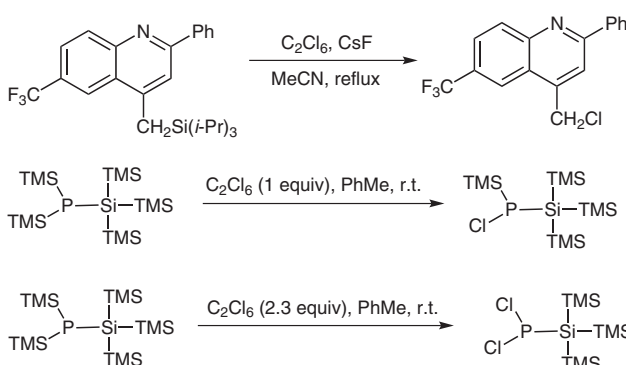
(A) Rommel et al. reported the regioselective monochlorination of 3-methoxymethoxypyridine using *t*-BuLi and hexachloroethane.⁵ The chloropyridine was obtained in 87% yield. In neat form the product decomposes rapidly at room temperature, but it is stable for several weeks when stored in MTBE solution (ca. 50% v/v) at –28 °C.



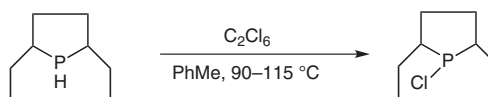
(B) 1-Alkyl-3,3-dichloro-2,1-benzisothiazoline 2,2-dioxides were prepared from benzosultams with hexachloroethane in the catalytic two-phase system employing 50% aqueous sodium hydroxide in the presence of tetrabutylammonium bromide. The reaction proceeded smoothly in good yields (47–82%).⁶



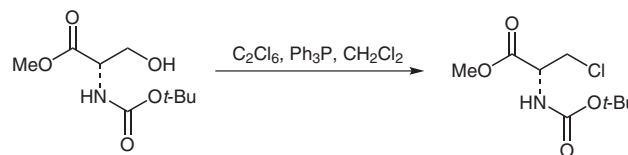
(C) As an efficient chlorination reagent hexachloroethane can also substitute TMS and TIPS group to synthesize a series of chlorinous compounds. Shindoh et al. prepared 6-trifluoromethyl-4-chloromethyl-2-phenylquinoline using C_2Cl_6 and CsF in acetonitrile from 6-trifluoromethyl-4-(triisopropylsilyl)methyl-2-phenylquinoline.⁷ Capello and co-workers also described an efficient chemoselective synthesis of $(\text{TMS})_3\text{SiPClTMS}$ and $(\text{TMS})_3\text{SiPCl}_2$ from $(\text{TMS})_3\text{SiP}(\text{TMS})_2$ in the presence of different amounts of hexachloroethane.⁸



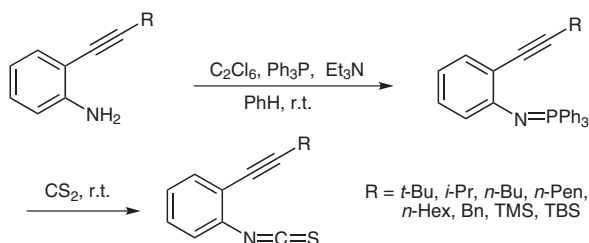
(D) M. Carreira et al.⁹ applied hexachloroethane in the synthesis of *a*₅-PhobPCl via an electrophilic chlorination.



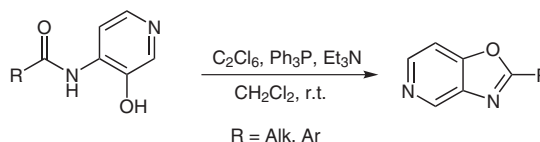
(E) The combination of triphenylphosphine and hexachloroethane can react as a nucleophilic chlorination reagent with hydroxyl compounds. 2-(*R*)-*tert*-Butoxycarbonylamino-3-chloro-propionic acid methyl ester was prepared starting from *N*-Boc-serine methyl ester.¹⁰



(F) *o*-Alkynylphenyl isothiocyanates were prepared via iminophosphorane intermediates, which were synthesized using triphenylphosphine, hexachloroethane, and triethylamine.¹¹



(G) Heuser and co-workers¹² reported the synthesis of oxazolopyridine. The key cyclization step was achieved using the triphenylphosphine–hexachloroethane combination, with the triphenylphosphonium halide being formed prior to addition of the amide.



References

- (1) (a) Burger, J. J.; Chen, T. B. R. A.; De Waard, E. R.; Huisman, H. O. *Tetrahedron* **1980**, *36*, 1847. (b) Hommes, H.; Verkruisje, H. D.; Brandsma, L. *Tetrahedron Lett.* **1981**, *22*, 2495. (c) Griffen, E. J.; Roe, D. G.; Snieckus, V. *J. Org. Chem.* **1995**, *60*, 1484. (d) Knoch, F.; Kummer, S.; Zenneck, U. *Synthesis* **1996**, 265.
- (2) (a) Wamhoff, H.; Berressem, R.; Herrmann, S. *Synthesis* **1993**, 107. (b) Vorbrüggen, H.; Krolkiewicz, K. *Tetrahedron* **1993**, *49*, 9353.
- (3) Budavari, S. *The Merck Index*; 12th ed.; Merck & Co. Inc.: Whitehouse Station N.J., **1996**.
- (4) Stauffer, J. E. US Patent 4899000, **1990**.
- (5) Rommel, M.; Ernst, A.; Koert, U. *Eur. J. Org. Chem.* **2007**, *26*, 4408.
- (6) Wojciechowski, K.; Siedlecka, U.; Modrzejewska, H.; Kosinski, S. *Tetrahedron* **2002**, *58*, 7583.
- (7) Shindoh, N.; Tokuyama, H.; Takemoto, Y.; Takasu, K. *J. Org. Chem.* **2008**, *73*, 7451.
- (8) Cappello, V.; Baumgartner, J.; Dransfeld, A.; Hassler, K. *Eur. J. Inorg. Chem.* **2006**, 2006, 4589.
- (9) Carreira, M.; Charernsuk, M.; Eberhard, M.; Fey, N.; van Ginkel, R.; Hamilton, A.; Mul, W. P.; Orpen, A. G.; Phetmung, H.; Pringle, P. G. *J. Am. Chem. Soc.* **2009**, *131*, 3078.
- (10) Barfoot, C. W.; Harvey, J. E.; Kenworthy, M. N.; Kilburn, J. P.; Ahmed, M.; Taylor, R. J. K. *Tetrahedron* **2005**, *61*, 3403.
- (11) Saito, T.; Nihei, H.; Otani, T.; Suyama, T.; Furukawa, N.; Saito, M. *Chem. Commun.* **2008**, 172.
- (12) Heuser, S.; Keenan, M.; Weichert, A. G. *Tetrahedron Lett.* **2005**, *46*, 9001.