Molybdenum Hexacarbonyl

[Mo(CO)₆]

Compiled by Marco Marradi

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Introduction

Molybdenum hexacarbonyl [Mo(CO)₆] is a stable crystalline solid with an octahedral geometry (Figure 1). It is generally prepared by reductive carbonylation of molybdenum halides, or is obtained from commercial sources. Mo(CO)₆ finds use as catalyst or reagent in several processes, by itself or tuning its reactivity by ligand exchange. Replacement of the carbonyl ligands by both p and s donors affords a large number of different molybdenum complexes which have found use in organic synthesis. The use of chiral ligands allows high levels of regio- and enantioselectivity to be attained.

Abstracts

(A) The use of a thermostable catalytic system in combination with Mo(CO)₆ allowed the synthesis of benzo-furanones starting from bromobenzyl alcohols. Indanones were obtained under similar conditions using ortho-bromo(chloro)styrenes. A variant was performed by using polymer-supported amines for the synthesis of amides from aryl halides. A convenient synthesis of α-methylene-γ-butyrolactones from allenyl carbonyls was performed by a DMSO-promoted carbonylation. These reactions enlighten the role of Mo(CO)₆ as a source of CO.

(B) ‘Instant’ catalysts formed from Mo(CO)₆ and phenols have been developed for alkyne metathesis. Pre-heating activation of catalytic systems consisting of Mo(CO)₆ and 4-chlorophenol has increased the yields of productive enyne metathesis. This procedure was used to dimerize ortho-alkoxypropynylbenzenes and to afford ring-closing alkyne metathesis (RCAM) products from dipropynyls. The use of 2-fluorophenol in place of 4-chlorophenol led to a more reactive and friendly catalyst, which has been employed not only in RCAM, but also in alkyne homodimerizations (HD) and cross metatheses (CM).

(C) Mo(CO)₆ was reported to effect Pauson–Khand reactions of enynes to afford cyclopentenones. Chiral alkylnyl allenes afforded enantioenriched α-alkylidene cyclopentenones. Under the same conditions, functionalized difluorooalenes underwent intramolecular [2+2] cycloaddition to afford gem-difluoro bicyclo[4.2.0] systems, instead of the expected Pauson–Khand products. A tandem Pauson–Khand reaction of bisyne-bisallenes to [5.5.5.5] tetracycles has been reported by Cook, who used a saturated solution of Mo(CO)₆.
(D) Mo(CO)₆ has catalyzed the cycloisomerization of 1-alkyn-4-ols to 2,3-dihydrofurans and the isomerization of epoxalkynes to furans.₆ Mo(CO)₆ has also been employed in Friedel–Crafts alkylations.₇

(E) Mo(CO)₆ has been used to reduce the N-O bonds of isoxazoles, isoaxazolines, isoaxazolines, and 1,2-oxazines. Variants employed sub-stoichiometric amounts of Mo(CO)₆ in the presence of NaBH₄ or a decomplexing work-up on silica gel. The selective reduction of azides, nitro compounds, and hydroxylamines to amines and deoxygenation of epoxides have also been accomplished.

(F) Mo(CO)₆ behaved as a catalyst for the mild oxidation of 2,5-dialkylfurans to E or Z (depending on the use of a base) enediones using cumyl hydroperoxide (CHP). Diones gave peroxypyrrolones in moderate yields, irrespective of the C=C bond configuration, when β-butyrohydroperoxide (TBHP) was used.¹ This indicates that Mo(CO)₆ can be employed not only in reduction processes, but also in oxidations.

References


