# Reductive Dehalogenation of α-Haloketones by Sodium Iodide and Metal Salts

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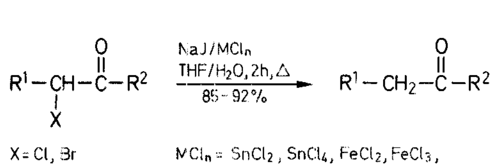
Aromatic and aliphatic α-haloketones are reductively dehalogenated effectively to the corresponding ketones with sodium iodide (soft base) and a metal salt (hard acid) in aqueous tetrahydrofuran by heating under reflux for 2 h.

The reductive dehalogenation of α-haloketones is a valuable procedure for organic syntheses. This has been effected by a number of procedures with such reagents as zinc and acetic acid[1], sodium dithionite[2], titanium (III) chloride[3], organotin hydride[4] and sodium hydrogen telluride[5]. On the other hand, there have been other procedures using iodo compounds, e.g., lithium iodide and boron trifluoride[6], sodium iodide and sulfuric acid[7], sodium iodide-chlorotrimethylsilane[8], cerium iodide[9], iodotrimethylsilane[10], diphosphorus tetraiodide[11], and sodium iodide-sulfur-trioxide amine[12]. Hard-Soft-Acid-Base principle[13,14] has been applied to the reductive dehalogenation of α-haloketones with discussion on reaction mechanisms. We were encouraged by this principle to study the reductive dehalogenation of α-haloketones by a system of sodium iodide (soft base) and metal salts (hard acid). Although, some procedures using iodo compounds have been reported[6-12] there have been few publication using such reagents as inexpensive sodium iodide and metal salts (hard acid).

We report here on the dehalogenation of α-haloketones using sodium iodide and a metal salt such as: iron (III) chloride, tin (IV) chloride, chromium (III) chloride or aluminum (III) chloride (inexpensive metal salt, hard acid) in tetrahydrofuran. As shown in Tables 1, 2 and 3, the reductive




dehalogenation by a system of sodium iodide, metal salt [hard acid; tin (IV), iron (III), chromium (III) or aluminum (III) chloride and/or borderline hard acid; tin (II) or iron (II) chloride] in water/tetrahydrofuran was performed in high yield. While the dehalogenation of α-haloacetophenones resulted only in moderate yield (60–65%) in the absence of water, the presence of water in this dehalogenation system was found to be an important factor. Sodium iodide alone dehalogenated α-haloacetophenone to acetophenone in 60–65% yield without metal salt component (Table 1).

Metal salts were found to be complementary for the completion of the dehalogenation. The other dehalogenations were accomplished in high yield with sodium iodide in the system (aqueous), while the dehalogenation of 2-chlorocyclohexanone with sodium iodide in the same system (non aqueous) was inferior to the dehalogenation of the other compounds and gave only 65% yield. By use of more

Table 1. Dehalogenation of α-Haloketones by Sodium Iodide and Tin(II) Chloride[a]

| Substrate | (mmol) | Reactants | | Reaction conditions | | Product | Yield [%] |
|---|---|---|---|---|---|---|---|
| | | NaJ (mmol) | $SnCl_2$ (mmol) | THF (ml) | $H_2O$ (ml) | | |
| α-Chloroacetophenone | (3.3) | 13.3 | 10.5 | 25 | 5 | Acetophenone | 88 |
| α-Chloroacetophenone | (3.3) | 13.3 | – | 25 | 5 | Acetophenone | 62 |
| α-Bromoacetophenone | (2.5) | 13.3 | 10.5 | 25 | 5 | Acetophenone | 93 |
| α-Bromoacetophenone | (2.5) | 13.3 | – | 25 | 5 | Acetophenone | 65 |
| α-Bromo-*p*-methylacetophenone | (2.3) | 13.3 | 10.5 | 25 | 5 | *p*-Methylacetophenone | 90 |
| α-Bromo-*p*-methylacetophenone | (2.3) | 13.3 | – | 25 | 5 | *p*-Methylacetophenone | 60 |
| 2-Chlorocyclohexanone | (3.7) | 20.0 | 10.5 | 30 | – | Cyclohexanone | 87 |
| 2-Chlorocyclohexanone | (3.7) | 20.0 | 7.6 | 30 | – | Cyclohexanone | 86 |
| 2-Chlorocyclohexanone | (3.7) | 13.3 | 10.5[b] | 30 | – | Cyclohexanone | 65 |
| 3-Chloro-2-butanone | (4.7) | 13.3 | 10.5 | 25 | 5 | 2-Butanone | 91 |
| Methyl-2-chloropropionate | (4.0) | 13.3 | 10.5 | 25 | 5 | Methyl propionate | 92 |

[a] Reaction time: 2 h. [b] $SnCl_4$ was used.

Table 2. Dehalogenation of α-Chloroacetophenone to Acetophenone by Sodium Iodide and various Metal Salts in Tetrahydrofuran/Water (25/5) System[a]

| Metal Salt (mmmol) | Yield of Acetophenone [%] |
|---|---|
| $FeCl_2$ (10.6) | 85 |
| $FeCl_3$ (12.3) | 87 |
| $SnCl_4$ (7.6) | 88 |
| $CrCl_3$ (13.0) | 86 |
| $AlCl_3$ (14.9) | 85 |

[a] Ratio (mmol), acetophenone/sodium iodide: 3.3/13.3; reaction time 2 h.

**Dehalogenation of α-chloroacetophenone; Typical Procedure:**
α-Chloroacetophenone (0.5 g, 3.3 mmol) is refluxed in a system of sodium iodide (2 g, 13.3 mmol), tin (II) chloride (2 g, 10.5 mmol) and water (5 ml) in tetrahydrofuran (25 ml) for 2 h. The mixture is cooled and extracted with ether (4 x 50 ml), ether extract is evaporated and the product is isolated; yield: 0.34 g (88 %). The product is analyzed by G.L.C., I.R. and $^1$H-N.M.R..

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Table 3. Dehalogenation of α-Haloketones by Sodium Iodide and Iron(III) Chloride[a]

| Substrate | (mmol) | Reactants | | Reaction Conditions | | Product | Yield [%] |
|---|---|---|---|---|---|---|---|
| | | $FeCl_3$ (mmol) | NaJ (mmol) | THF (ml) | $H_2O$ (ml) | | |
| α-Chloroacetophenone | (3.3) | 12.3 | 13.3 | 25 | 5 | Acetophenone | 87 |
| α-Bromoacetophenone | (2.5) | 12.3 | 13.3 | 25 | 5 | Acetophenone | 90 |
| α-Bromo-*p*-methylacetophenone | (2.3) | 12.3 | 13.3 | 25 | 5 | *p*-Methylacetophenone | 88 |
| 2-Chlorocyclohexanone | (3.7) | 12.3 | 20.0 | 30 | – | Cyclohexanone | 86 |
| 2-Chlorocyclohexanone | (3.7) | 10.6[b] | 20.0 | 30 | – | Cyclohexanone | 85 |
| 3-Chloro-2-butanone | (4.7) | 12.3 | 13.3 | 25 | 5 | 2-Butanone | 90 |
| Methyl-2-chloropropionate | (4.0) | 12.3 | 13.3 | 25 | 5 | Methylpropionate | 90 |

[a] Reaction time: 2 h. [b] Iron(II)chloride was used.

sodium iodide in the same system (non aqueous) (Table 1), 2-chlorocyclohexanone was dehalogenated in good yield similar to other α-haloketones. On the other hand, borderline hard acid, iron (II) chloride, and tin (II) chloride were as effective as hard acid, tin (IV) chloride, iron (III) chloride, chromium (III) chloride, and aluminum (III) chloride. All the dehalogenations in Tables 1, 2, and 3 were performed by heating the reaction system under reflux.

This dehalogenation procedure of α-haloketones is effective and convenient, because sodium iodide and metal salts (hard acid) are common reagents and the procedure is very simple.

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