

# A Rapid, Efficient Method for Deprotection of Oximes to Carbonyl Compounds with $\text{NaClO}_2$ in Water

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**Abstract:** A rapid, efficient method for deprotection of oximes to carbonyl compounds is demonstrated by using sodium chlorite ( $\text{NaClO}_2$ ) in water. The protocol has been found to be applicable to a wide range of aldoximes and ketoximes with good to excellent yields of the corresponding carbonyl compounds.

**Keywords:** Sodium chlorite, oximes, carbonyl compounds, aqueous conditions.

## 1. INTRODUCTION

As an important class of organic compounds in organic synthesis [1-7], oximes play an important role in protecting groups [8, 9] and are extensively used for the purification and characterization of carbonyl compounds [10-12]. The oximes can be prepared from noncarbonyl compounds as well as from carbonyl compounds [13-15]. The regeneration of carbonyl compounds from oximes provides an alternative method for the preparation of aldehyde and ketones. Therefore, a large number of metallic and nonmetallic deoximation reagents have been developed for the regeneration of carbonyl compounds from oximes [16-29]. However, there are several disadvantages in these methods, such as long reaction time, harmful and expensive metals, toxic organic solvents, harsh reaction conditions, difficulties in product purification and low product yields. Although some of the methods reported are carried out under mild reaction conditions in recent years, milder, nonhazardous, and inexpensive reagents are still in demand.

Sodium chlorite ( $\text{NaClO}_2$ ) is an inexpensive and versatile reagent, which has been explored for preparations of carboxylic acids, amides, enones, epoxides [30-39]. In this paper, we demonstrate a rapid, efficient procedure for deoximation to the corresponding carbonyl compounds by  $\text{NaClO}_2$  in water.

## 2. RESULTS AND DISCUSSION

The literature reports the use of aqueous medium as solvent in  $\text{NaClO}_2$  oxidant system. Thus, initially we carried out the deoximation reaction of acetophenone oxime in aqueous medium. No matter whether it was in the presence of TEMPO or not, the deoximation reaction of acetophenone oxime did not proceed in aqueous medium without acid

(Table 1, entries 1-2). Then, hydrochloric acid or acetic acid was added in the reaction system, because acid can promote oxidant ability of  $\text{NaClO}_2$ . When the molar ratio of  $\text{NaClO}_2$  was 1, the acetophenone was obtained in 92% yield for 5 min in the presence of hydrochloric acid (Table 1, entry 3). The yield of the product was not improved even when the reaction time was prolonged to 1 hour under the same reaction condition (Table 1, entry 4). When the molar ratio of  $\text{NaClO}_2$  was 2, the product was obtained in 89% yield for 5 min (Table 1, entry 5). The reaction finished in 5 minutes in the presence of hydrochloric acid with TEMPO with the yield of acetophenone reaching 90% (Table 1, entries 6-7). The reaction proceeded slowly in the presence of acetic acid and acetophenone was obtained only in good yield (Table 1, entry 8). The results show that TEMPO did not have positive effect on the reaction time and yield. When the molar ratio of  $\text{NaClO}_2$  was 0.5, the acetophenone was obtained in 72% yield for 5 min in the presence of hydrochloric acid (Table 1, entry 9).

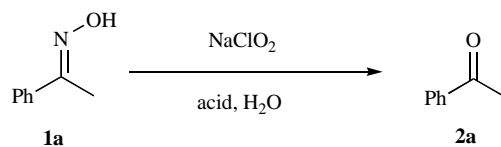
Based on optimal reaction conditions, a series of experiments for deoximation of oximes have been examined. The results are summarized in Table 2. The different substituents in the benzene ring do not influence the yield and the reaction time. Both the aromatic ketoximes with electron-donating or withdrawing groups are able to generate the corresponding ketones with excellent yields. The aliphatic ketoximes are also transformed to the corresponding ketones with high yields in short time. However, aldoximes are converted to aldehydes under these reaction conditions with slightly lower yield because aldehydes are partially oxidized to the corresponding acids.

## 3. EXPERIMENTAL

### Typical Experimental Procedure

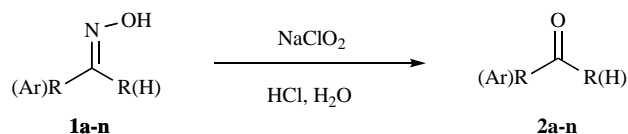
$\text{NaClO}_2$  (0.21g, 85%, 2.0 mmol) was added to a solution of oxime **1a** (0.27g, 2.0 mmol), concentrated HCl (36%, 2.0 mL) in  $\text{H}_2\text{O}$  (2.0 mL) in test tube, and the reaction mixture was stirred at room temperature for 5 min (monitoring with

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Table 1. Deoxygenation reaction of acetophenone oxime in aqueous medium<sup>a</sup>.

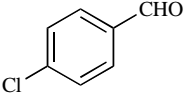
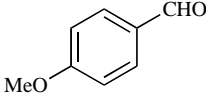
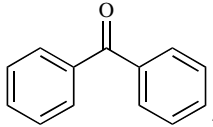
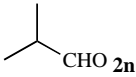
Entry	NaClO <sub>2</sub>	TEMPO	Acid/solvent	Time	Yield/% <sup>b</sup>
1	1	-	-	1h	0
2	1	5mol%	-	1h	0
3	1	-	HCl/H <sub>2</sub> O	5 min	92
4	1	-	HCl/H <sub>2</sub> O	60 min	91
5	2	-	HCl/H <sub>2</sub> O	5 min	89
6	2	5mol%	HCl/H <sub>2</sub> O	5 min	90
7	1	5mol%	HCl/H <sub>2</sub> O	5 min	88
8	2	5mol%	AcOH/H <sub>2</sub> O	5 min	76
9	0.5	-	HCl/H <sub>2</sub> O	5 min	72

<sup>a</sup> Reaction condition: **1a** (2 mmol), NaClO<sub>2</sub> (2 mmol), acid, H<sub>2</sub>O (2 mL), room temperature. <sup>b</sup> Isolated yield.

Table 2. Deoxygenation reaction of ketoximes and aldoximes in aqueous medium<sup>a</sup>.

Entry	Product	Time/min	Yield <sup>b</sup>	Entry	Product	Time/min	Yield <sup>b</sup>
1	<b>2a</b>	5	92	8	<b>2h</b>	5	92
2	<b>2b</b>	5	93	9	<b>2i</b>	5	93
3	<b>2c</b>	5	90	10	<b>2j</b>	5	91
4	<b>2d</b>	5	91	11	<b>2k</b>	5	82 <sup>c</sup>
5	<b>2e</b>	5	93	12	<b>2l</b>	5	84 <sup>d</sup>

Table 2. Contd.....

Entry	Product	Time/min	Yield <sup>b</sup>	Entry	Product	Time/min	Yield <sup>b</sup>
6	 2f	8	92	13	 2m	5	83 <sup>e</sup>
7	 2g	8	91	14	 CHO 2n	5	76 <sup>f</sup>

a. Reaction condition: oxime (2 mmol), NaClO<sub>2</sub> (2 mmol), concentrate HCl (2 mL), H<sub>2</sub>O (2 mL), room temperature. b. Isolated yield. c, the isolated yield of acid is 9%. d, the isolated yield of acid is 8%. e, the isolated yield of acid is 7%. f, the isolated yield of acid is 8%.

thin-layer chromatography, TLC). The reaction was extracted with ethyl acetate (10 mL). The combined organic extract was washed with water (5 mL) and dried with anhydrous MgSO<sub>4</sub>. Then it was directly filtered through a short silica gel column (200–300 mesh) to afford the product **2a** (0.22 g, 92%). The carbonyl compounds formed were characterized by their physical data, which were in accordance with values reported in the literature, and GC-MS analysis.

<sup>1</sup>H NMR of some typical products is given below:

**Acetophenone (2a).** <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ 2.57 (s, 3H), 7.39 - 7.56 (m, 3H), 7.90 - 7.96 (m, 2H).

**p-Methylacetophenone (2b).** <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ 2.38 (s, 3H), 2.54 (d, 3H), 7.22 (d, *J* = 5.96 Hz, 2H), 7.83 (d, *J* = 5.96 Hz, 2H).

**p-Nitroacetophenone (2e).** <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ 2.67 (s, 3H), 8.11 (d, *J* = 6.96 Hz, 2H), 8.28 (d, *J* = 7.08 Hz, 2H).

**5-Methyl-2-hexanone (2h).** <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ 0.81-0.83 (m, 6H), 1.37-1.42 (m, 2H), 1.44-1.49 (m, 1H), 2.06 (d, 3H), 2.34-2.37 (m, 2H). 8.11 (d, *J* = 6.96 Hz, 2H), 8.28 (d, *J* = 7.08 Hz, 2H).

**Cyclopentanone (2i).** <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ 1.91-1.94 (m, 4H), 2.11-2.14 (m, 4H).

**Benzaldehyde (2k).** <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ 7.50-7.53 (m, 2H), 7.63-7.65 (m, 1H), 7.86-7.88 (m, 2H), 10.01 (s, 1H).

**Isobutyraldehyde (2n).** <sup>1</sup>H NMR (500 MHz, CDCl<sub>3</sub>): δ 1.10 (d, *J* = 5 Hz, 6H), 2.39-2.42 (m, 1H), 9.62 (d, *J* = 1 Hz, 1H)

## CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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