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Pd(II)-CATALYZED CONDENSATION REACTION OF KETOXIMES AND DICHLOROMETHANE USING POTASSIUM SUPEROXIDE

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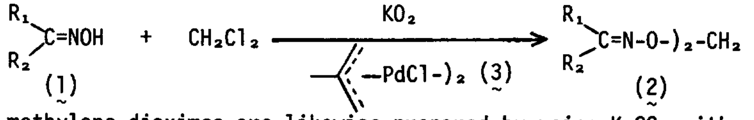
Abstract: Methylene dioximes are formed from ketoximes and CH_2Cl_2 using either KO_2 with a catalytic amount of Pd(II) complex 3 or K_2CO_3 with 18-crown-6 catalyst. The reactivity of ketoximes towards CH_2Cl_2 is reversed between these two methods.

Although there has been considerable interest in the chemical properties of superoxide ion ($O_2^{-\cdot}$) from the biological aspect, much attention has not been paid to the use of $O_2^{-\cdot}$ as the reagent in organic reactions.[1] This report describes a new use for $O_2^{-\cdot}$, which is produced from KO_2 and Pd(II) catalysts. Thus, methylene dioximes, a novel class of oxime ethers,[2] are prepared from ketoximes and CH_2Cl_2 using KO_2 in the presence of Pd(II) catalyst 3 (eq. 1). We also report that methylene dioximes are likewise prepared by using K_2CO_3 with a catalytic amount of 18-crown-6. Noteworthy is that the reactivity of ketoximes towards CH_2Cl_2 is reversed between these two methods.



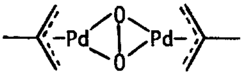
(eq. 1)

As a typical procedure for the reaction using KO_2 in the presence of a catalytic amount of di-μ-chlorobis(2-methylallyl)dipalladium(II) (3) (method A), the formation of 2a (R_1=R_2= C_3H_7) is illustrative. To a mixture of 3 (0.2 mmol) and finely powdered KO_2 (4 mmol) was added a solution of di-n-propyl ketone (1a) (4 mmol) in CH_2Cl_2 (40 mL) under argon. The suspended yellow solution was stirred at room temperature for 72 hr. After removal of KCl by filtration, the filtrate was concentrated at reduced pressure, and the residue was chromatographed on Al_2O_3. Elution with ether afforded the methylene dioxime 2a (0.289 g, 53%) as a sole organic product. Distillation (108-109°/3 mmHg) gave an analytically pure compound, and its spectral data agreed with the structure of $>C=N-O-CH_2-O-N=C<$.[2] In this reaction, the unreacted ketoximes 1a (17%) was recovered with intractable palladium complexes. Although the reaction conditions were not optimized, the use of excess KO_2 (2 equiv. to 1a) increased the yield of 2a up to 96%. It is to be noted that no reaction occurs in the absence of palladium complex 3, and that the methylene dioximes obtained in the present work are all stable under the reaction conditions.

A general procedure using K_2CO_3 with 18-crown-6 (method B) is as follows. A heterogeneous mixture of 1 (1 mmol), K_2CO_3 (1.1 mmol) and 18-crown-6 (0.1 mmol) in CH_2Cl_2 (10 mL) was refluxed at 50° under argon for 12 hr. After usual work-up, the reaction mixture was analyzed by NMR, and the methylene dioxime 2 was isolated by Al_2O_3 chromatography.

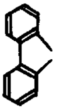
As shown in the Table, the reactivity of ketoximes towards CH_2Cl_2 differs remarkably between these two methods A and B. In the former reaction, aliphatic ketoximes are more reactive than aryl ketoximes, whereas the opposite reactivity is observed in the latter. This clearly indicates that these reactions involve different reactive species. Apparently the reactivity of 1 observed in the method B correlates with the acidity of oximes; no methylene dioximes are formed from less acidic aliphatic ketoximes (entries 1-3). The use of more basic ^{t}BuOK instead of K_2CO_3 affords 2b and 2f in comparable yields from aliphatic and aryl ketoximes, respectively (entries 2 and 6). Therefore, it is clear that proton abstraction by the base is a crucial step for this reaction. The opposite reactivity of 1 observed in the method A may be thus related to the nucleophilicity of oximate anions which co-ordinate to Pd(II).

It has been recently reported that the palladium dioxygen complex 4 is prepared from the palladium complex 3 and KO_2.[3] The reaction of dioxygen complex 4 with 1e (1e/Pd= 1, CH_2Cl_2, 72 hr) did not afford the methylene dioxime 2e, but produced dibenzyl ketone (23%), similarly to our previous work.[4]



(4)

Table. Formation of Methylene Dioximes

Entry	Ketoximes 1			Yield of 2, %		
	R_1	R_2		Method A[a)] KO_2-3	Method B[b)] K_2CO_3-18-c-6	with ^{t}BuOK-18-c-6[b)]
1	C_3H_7	C_3H_7	(a)	53 (96)[c)]	0	
2	CH_3	CH_3	(b)	45	0	74
3	$-(CH_2)_5-$		(c)	39	0	
4	$PhCH_2CH_2$	$PhCH_2CH_2$	(d)	36	19	
5	$PhCH_2$	$PhCH_2$	(e)	24	65	66[a)]
6	Ph	Ph	(f)	7	83 (72)[a)]	76
7			(g)	2	90	
8	Ph	PhCO (α)	(h)	0	92	

a) Isolated yield. b) Yield determined by NMR, unless otherwise noted. Unreacted ketoximes were almost quantitatively recovered. c) Excess KO_2 (2 equiv.to 1a) was used.

References and Note:

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4) K. Maeda, I. Moritani, T. Hosokawa, and S-I. Murahashi, *Tetrahedron Lett.*, 797 (1974).

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