Carbonyl Regeneration from *p*-Toluenesulfonylhydrazones, *N*-Methyl-*N*-*p*-toluenesulfonylhydrazones, and 2,4-Dinitrophenylhydrazones

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Derivatives of carbonyl compounds such as tosylhydrazones, *N*,*N*-dimethylhydrazones, oximes, 2,4-dinitrophenylhydrazones etc. are used in the purification and characterization of aldehydes and ketones or are employed as intermediates in organic synthesis, particularly in C—C-bond forming reactions. In the course of recent studies we were confronted with the problem of regenerating, with a good yield, carbonyl compounds from tosylhydrazones, *N*-methyltosylhydrazones, and 2,4-dinitrophenylhydrazones in a simple way under mild conditions[1,2].

Among the methods most commonly used in the case of tosylhydrazones are the reactions with *N*-bromosuccinimide in methanol[3], sodium hypochlorite[4], lead(IV) acetate[5], sodium methoxide in dimethyl sulfoxide[6], titanium(III) chloride[7], tungsten(VI) fluoride and molybdenyl chloride ($MoOCl_3$)[8], sodium peroxide[9] and exchange reactions with acetone without catalysis[10a,b] or with BF_3-catalyst[11] and also with other carbonyl compounds such as pyruvic or levulinic acid[12]. For the 2,4-dinitrophenylhydrazones, which are more resistant to hydrolysis than the former derivatives, exchange reactions have been reported which result, however, in a low yield. C=N-Bond ozonolysis[13] and hydrolysis reactions on the diaminophenyl derivative, obtained by reducing the nitro groups of dinitrophenyl hydrazones[14], have also been reported.

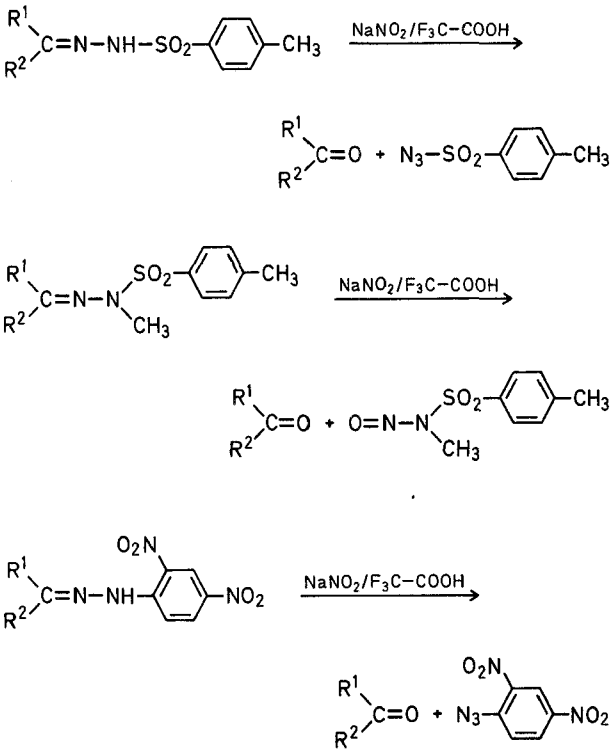
In this paper a method is described for regenerating carbonyl compounds from their corresponding tosylhydrazones, *N*-methyltosylhydrazones, and 2,4-dinitrophenylhydrazones under quite mild conditions using sodium nitrite in acid solution.

The reaction follows a simple and inexpensive procedure, resulting in a very good yield, according to Scheme **A**.

The regenerated carbonyl compounds were identified by comparison with authentic samples. In each of these reactions a product has been isolated which derives from the hydrazinic moiety. In the reaction with tosylhydrazones the product obtained is tosyl azide identified by comparison with an authentic sample[15]. The tosyl azide is also obtained by reacting tosylhydrazine with nitrous acid.

In reactions of 2,4-dinitrophenylhydrazones, the 2,4-dinitrophenyl azide has been isolated and identified by comparison of spectroscopic data with those of an authentic sample[16]. The latter product is not stable and spontaneously rearranges to 5-nitrobenzofuroxan[17]. The same compound is also obtained from the reaction of 2,4-dinitrophenylhydrazine with nitrous acid.

Finally, in reactions carried out on *N*-methyl-*N*-tosylhydrazones, the *N*-methyl-*N*-nitroso-tosylamide has been isolated and identified by comparison of spectroscopic data with



Scheme **A**

those of an authentic sample[18]. The same nitroso derivative is also obtained by treatment of the *N*-methyl-*N*-tosylhydrazine[19,20] with nitrous acid under the described conditions.

The generality of this process is demonstrated by the examples summarized in the table.

Melting points are uncorrected and were determined with a Büchi apparatus; I.R. spectra were measured on a Perkin-Elmer 337 spectrometer; N.M.R. spectra were measured on a Varian EM-390 spectrometer using TMS as internal standard. The starting tosylhydrazones were prepared from the corresponding carbonyl compounds in ethanol according to literature methodology[21,22]. *N*-Methyltosylhydrazones were prepared by *N*-methylation of the corresponding tosylhydrazones through phase-transfer catalysis[20]. 2,4-Dinitrophenylhydrazones were prepared using standard methods.

Regeneration of Carbonyl Compounds from Tosylhydrazones, *N*-Methyl-*N*-tosylhydrazones and 2,4-Dinitrophenylhydrazones; General Procedure:

The tosylhydrazone, *N*-methyl-*N*-tosylhydrazone, or 2,4-dinitrophenylhydrazone (3.0 mmol) is dissolved in trifluoroacetic acid (10 ml) or, in some cases, in acetic acid, and sodium nitrite (15.0 mmol) in water (5 ml) is slowly added at 0–5°. The mixture is stirred at the same temperature until the reaction is complete (1–2 h). Then, the solution is neutralized with saturated aqueous sodium carbonate and shaken with chloroform. The organic phase is washed with water, dried with sodium sulfate, and evaporated under reduced pressure. The resultant residue is chromatographed on an open column of silica gel using hexane/ethyl acetate mixture (8:2) as eluent yielding pure the carbonyl compound. Generally, the yield is determined by G.L.C. of the residue using external standard method (column SE-30, 3% on Varaport 30, 100/120 mesh, 1 m, flow rate 30 ml/min, He). In some cases the pure carbonyl compound is obtained by distilling the residue under reduced pressure.

Tosylazide is obtained in high yield by continuing elution with the same eluent and is identified by comparison of I.R. and N.M.R.

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Table. Regeneration of Carbonyl Compounds from Tosylhydrazones, *N*-Methyl-*N*-tosylhydrazones, and 2,4-Dinitrophenylhydrazones

Entry	m.p. of hydrazone	Molecular formula[a] or Lit. m.p. of hydrazone	Carbonyl compound	Yield [%][b] in CF_3COOH	Yield [%][b] in CH_3COOH	m.p. or b.p./torr of carbonyl compound	Lit. m.p. or b.p./torr
From tosylhydrazone:							
1	157–158°	156°[21]	cyclohexanone	97 (93)[c]	95	154°/760	155°/760[27]
2	74°	$C_{23}H_{40}N_2O_2S$ (408.6)	3-hexadecanone	88	—	40–42°	43–44°[28]
3	126–127°	$C_{17}H_{20}N_2O_2S$ (316.4)	4-phenyl-2-butanone	96 (92)[c]	92	232–234°/760	235°/760[27]
4	186–187°	186°[21]	1,3-diphenylpropanone	95 (93)[d]	—	32°	32–34°[27]
5	160–162°	160–162°[23]	3-phenylpropenal	95	92	121–122°/10	120°/10[27]
6	140–142°	142°[24]	cholest-4-en-3-one	(84)[d]	—	78–80°	79–81°[27]
7	93–95°	—[10]	17β-acetoxyandrostan-3-one	(88)[d]	—	157°	157–158.5°[29]
From N-methyl-N-tosylhydrazones:							
8	100–102°	$C_{18}H_{28}N_2O_2S$ (336.4)	4-*t*-butylcyclohexanone	91	—	44–46°	45–47°[27]
9	68–60°	$C_{18}H_{22}N_2O_2S$ (330.4)	4-phenyl-2-butanone	94	89	see entry 3	
10	69–70°	69–70°[20]	1,3-diphenylpropanone	93	—	see entry 4	
11	110–112°	110–112°[20]	3-phenylpropenal	92 (89)[d]	—	see entry 5	
From 2,4-dinitrophenylhydrazones:							
12	162–163°	162°[25]	cyclohexanone	77	74	see entry 1	
13	78–79°	$C_{22}H_{36}N_4O_4$ (420.5)	3-hexadecanone	86	—	see entry 2	
14	250°	253°[25]	3-phenylpropenal	82	—	see entry 5	
15	228–230°	228–230°[26]	3-cholestanone	(84)[d]	—	127°	128–130°[27]

[a] The microanalyses of all new products were in satisfactory agreement with the calculated values (C ±0.20%, H ±0.18%, N ±0.36%); exeption: 3-hexadecanone tosylhydrazone, C +0.90%.

[b] Yields determined by G.L.C. unless otherwise stated.

[c] Yield of product isolated by distillation.

[d] Yield of product isolated by column chromatography.

spectra with those of an authentic sample[15]. Tosylazide is the major compound obtained from the reaction of tosylhydrazine with nitrous acid according to the above general procedure.

N-Methyl-N-nitroso-tosylamide is isolated in quantitative yield by continuing elution with the same eluent. Crystallization from aqueous methanol gives the pure product; m.p. 59–60°[18]. *N*-Methyl-*N*-nitroso-tosylamide is the major compound obtained by reacting *N*-methyl-*N*-tosylhydrazine with nitrous acid according to the above general procedure.

2,4-Dinitrophenyl azide is obtained in high yield by continuing elution with the same eluent and is identified by comparison of I.R. and N.M.R. spectra with those of an authentic sample[16]. 2,4-Dinitrophenyl azide is the major compound isolated from the reaction between 2,4-dinitrophenylhydrazine and nitrous acid carried out as described in the general procedure. 2,4-Dinitrophenylazide is rather unstable even at room temperature and gives quantitatively the corresponding stable 5-nitrobenzofuroxan; m.p. 70–71° (Lit.[30], 72°), as reported in Lit.[17].

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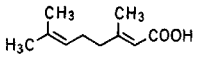
Errata and Addenda 1979

M. Contento, D. Savoia, C. Trombini, A. Umani-Ronchi, *Synthesis* **1979** (1), 30–32;
The structure for compound **3c** (p. 31, Table 1) should be:

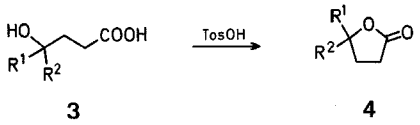


A. Mignot, H. Moskowitz, M. Miocque, *Synthesis* **1979** (1), 52–53;
The correct name for Tetramisole® should be 6-phenyl-2,3,5,6-tetrahydroimidazolo[2,1-*b*]thiazole.

A. N. Pudovik, I. N. Konovalova, *Synthesis* **1979** (2), 81–96;
The first sentence of the experimental procedure on p. 96 should read as follows:
Dialkyl phosphite or phosphorothioate (0.01 mol) is added to the azo compound (0.01 mol) in ether (10 ml).

In Table 13 (p. 96) the entries R^2 for compounds **63b** and **63c** should be 4-H_3C—C_6H_4 and 4-O_2N—C_6H_4, respectively.

Abstract 5422, *Synthesis* **1979** (2), 160;
The formula scheme for the conversion **3**→**4** should be:



3 **4**

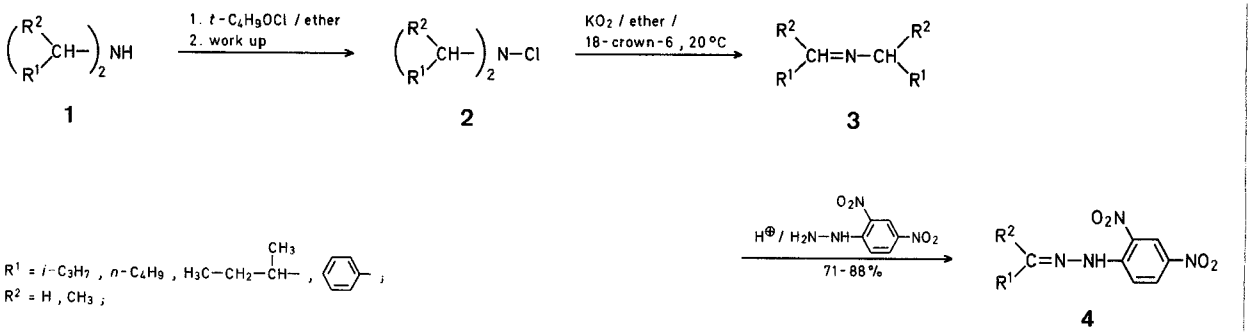
N. Blažević, D. Kolbah, B. Belin, V. Šunjić, F. Kajfež, *Synthesis* **1979** (3), 161–176;
Compounds **78a–e** (p. 173) should be named:
9-chloro-10b-phenyl-2,3,5,6-tetrahydro-10b*H*-[1,3]oxazolo[3,2-*c*]-quinazolines.

K. Herrmann, G. Simchen, *Synthesis* **1979** (3), 204–205
The lines 10 to 17 of the text (p. 204) should read as follows:

sche Acrylcyanide zugänglich[1,5,6]. Aliphatische Carbonsäure-halogenide hingegen setzen sich mit Tetraethylammoniumcyanid zu Acyloxymalodinitrilen („dimere Acrylcyanide") um, wofür auch die hohe Cyanidionen-Konzentration verantwortlich ist[1]. Die Reaktion aliphatischer Säurechloride **(2)** mit Cyanotrimethylsilan **(1)**[7–10] sollte deshalb eine geeignete Synthesenmethode für 2-Oxo-alkannitrile (aliphatische Acrylcyanide, **3**) darstellen. Bisher konnte allerdings nur

L. Caglioti, F. Gasparrini, D. Misiti, G. Palmieri, *Synthesis* **1979** (3), 207–208;
The italic sub-headings in the Table (p. 208) should be *From tosylhydrazones, From* N-*methyl*-N-*tosylhydrazones,* and *From 2,4-dinitrophenylhydrazones.*

Abstract 5440, *Synthesis* **1979** (3), 238;
The formula scheme for the conversion **1**→**4** should be as follows:



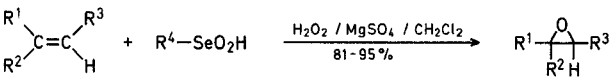
1 **2** **3**

R^1 = *i*-C_3H_7, *n*-C_4H_9, H_3C—CH_2—$CH(CH_3)$—, C_6H_5—; R^2 = H, CH_3;

C. Venturello, R. D'Aloisio, *Synthesis* **1979** (4), 283–287;
Entries 3 and 4 of the Mass spectrum column of Table 1 (p. 284) should be 284 (^{35}Cl) and 318 (^{35}Cl), respectively.

J. S. Davidson, *Synthesis* **1979** (5); 359–361;
Compounds **6** (p. 360) should be named:
3,4-diaryl-5-oxo-3,4-dihydro-1*H*-1,2,4-triazoles.

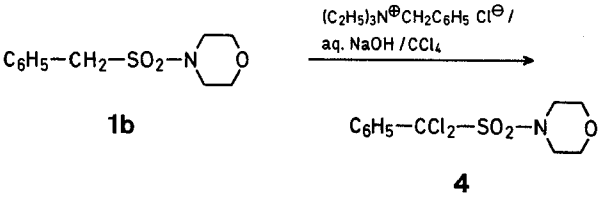
Abstracts 5494, *Synthesis* **1979** (5), 399;
The formula scheme for the conversion **1**→**3** should be as follows:



1 **2** **3**

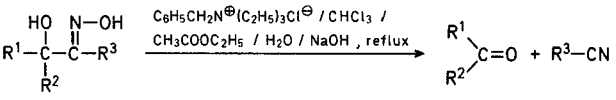
C. Skötsch, I. Kohlmeyer, E. Breitmaier, *Synthesis* **1979** (6), 449–452;
The name for compound **10a** should be:
3-Methyl-5,6,7,8-tetrahydroisoxazolo[5,4-*b*]chinolin.

J. Goliński, A. Jończyk, M. Mąkosza, *Synthesis* **1979** (6), 461–463;
The formula scheme for the conversion **1b**→**4** (p. 462) should be as follows:



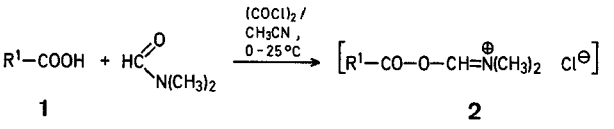
1b **4**

Abstract 5520, *Synthesis* **1979** (6), 479;
The formula scheme should be as follows:



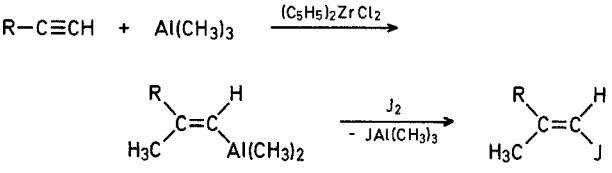
1 **2** **3**

Abstract 5521, *Synthesis* **1979** (6), 479;
The formula scheme for the conversion **1**→**2** should be as follows:



1 **2**

E. Negishi, D. E. Van Horn, A. O. King, N. Okukado, *Synthesis* **1979** (7), 501–502;
For clarity, the following formula scheme should be added:



A. McKillop, D. W. Young, *Synthesis* **1979** (7), 481–500;
The heading for Table 24 (p. 496) should be:

Table 24. Oxidation of Alcohols to Aldehydes and Ketones using Potassium Permanganate/Molecular Sieves[172].