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REACTIONS OF 2,4-DISUBSTITUTED 5-NITRO-1,2,3-TRIAZOLE 1-OXIDES.

4*. DEALKYLATION OF 2-SUBSTITUTED 4,5-DINITRO-1,2,3-TRIAZOLE 1-OXIDES

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The N-dealkylation of 2-alkyl or 2-benzyl-substituted 4,5-dinitro-1,2,3-triazole 1-oxides has been studied. Conditions have been found for N-de-tert-butylation and 4-amino-5-nitro-1,2,3-triazole 1-oxide has been synthesized for the first time.

Keywords: substituted 4,5-dinitro-1,2,3-triazole 1-oxides, trifluoroperacetic acid, dealkylation.

1,2,3-Triazole 1-oxides containing no substituent at position 2 are of considerable interest as synthons, since it is possible to carry out on them reactions known for 1,2,3- and 1,2,4-triazoles [2] such as salt formation, addition to a multiple bond, nucleophilic substitution, etc. However our repeated attempts to obtain triazole oxides of such structure by interacting the appropriate 3-nitrofuroxanes with ammonia according to the recyclization reaction of the furoxane ring discovered by us [3-5] did not lead to the desired result. An analogous route using aniline also failed to synthesize the corresponding oxides with a phenyl substituent in position 2. Meanwhile it is known [6], that on nitration the latter is converted into a 2,4-dinitrophenyl substituent, the elimination of which proceeds smoothly under the action of sodium methylate in methanol.

The present work is devoted to a study of the N-dealkylation of the available [7] 4,5-dinitro derivatives of 1,2,3-triazole 1-oxides **1a-c** with a methyl, ethyl, or benzyl substituent in position 2 respectively, using reagents which are applied in analogous reactions for other classes of compound, such as potassium permanganate [8], mercury acetate [9], sodium persulfate [10], potassium *tert*-butylate [11], dimethylformamide [12], etc.

Numerous attempts to N-dealkylate compounds **1a-c** did not lead to the target product. In the majority of reactions either recovery or decomposition of the starting material was observed. Pure compounds were isolated only in the case of dimethylformamide and sodium persulfate. Thus on interacting 2-methyl- and 2-benzyl-4,5-dinitro-1,2,3-triazole 1-oxides **1a,c** with dimethylformamide or sodium persulfate in the presence of silver nitrate, fission of the N-oxide oxygen occurs, and the corresponding 2-substituted 4,5-dinitro-1,2,3-triazoles **2a,b** are formed.

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* For Part 3 see [1].

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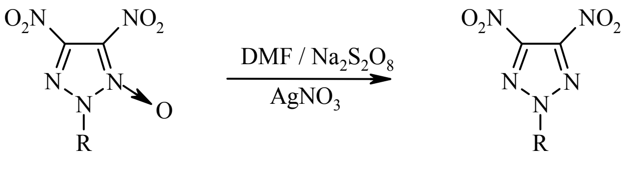
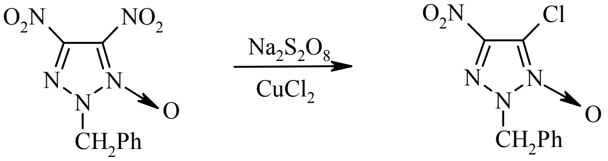


1a,c **2a,b**

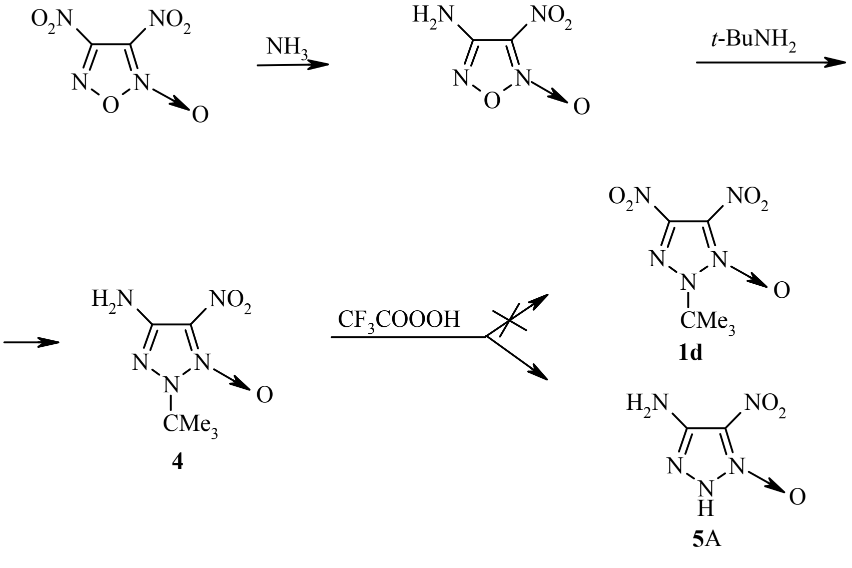
1a, 2a R = Me; **1c, 2b** R = CH_2Ph

Attempts to N-debenzylate 2-benzyl-4,5-dinitro-1,2,3-triazole 1-oxide (**1c**) with sodium persulfate in the presence of copper chloride led to the nitrochloro- substituted benzyltriazole oxide **3**. On the basis of the results of elemental analysis and ^{14}N NMR spectra of this product, in which there is one narrow signal at -31.90 ppm, it may be concluded that there is one nitro group in this molecule. Comparison of the spectrum with the ^{14}N NMR spectrum of triazole oxide **1c** containing signals of the 4- and 5-nitro groups at -34.39 (br) and -40.35 ppm respectively [7] leads to the assumption that in the compound obtained the NO_2 group is in position 4, i.e. it has the structure 2-benzyl-5-chloro-4-nitro-1,2,3-triazole 1-oxide (**3**).



1c **3**

Among the compounds of type **1** we also planned to study the dealkylation of a triazole oxide with a *tert*-butyl group in position 2 (**1d**), considering that this substituent is more readily removable, for example on saponification, than the methyl and ethyl groups in the series of esters and ethers [13-15]. Compound **1d** was presumed to be synthesized from 3,4-dinitrofuroxane by the scheme indicated below.



4 **1d** **5A**

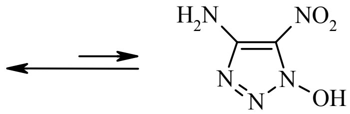
However on oxidizing 4-amino-2-*tert*-butyl-5-nitro-1,2,3-triazole 1-oxide (**4**) with trifluoroperacetic acid, in place of the expected dinitro derivative **1d**, 4-amino-5-nitro-1,2,3-triazole 1-oxide (**5**) in form A was obtained in 50% yield, i.e. under the reaction conditions elimination of the *tert*-butyl group occurred significantly more readily.

It must be noted that, on using trifluoroperacetic acid for the oxidation of 4-amino(alkylamino)-5-nitro-1,2,3-triazole 1-oxides containing methyl, benzyl, or other substituents in position 2, no formation of dealkylation products was observed in any experiment [7]. On the basis of the results obtained by us the conclusion may be drawn that under such conditions only the *tert*-butyl group is removed from the molecule of the appropriate triazole N-oxide with the same ease as on removing the *tert*-butyl protection from alcohols, phenols, and thiols [16].

The structure of triazole oxide **5A** was confirmed by data of elemental analysis, IR, UV, and ^{1}H, ^{13}C, and $^{14/15}$N NMR spectra.

In the ^{15}N NMR spectrum a large Overhauser effect on the ^{15}N nuclei in the NH_2 and $N_{(2)}$ (negative signals) shows the presence of a direct N–H bond. Broadening of the signals of the $N_{(2)}$ and $N_{(1)}$ atoms probably indicates intra- or intermolecular exchange with the low-populated form B containing NOH fragment.

5A



5B

EXPERIMENTAL

The IR spectra were taken on a Specord IR 75 spectrophotometer in KBr tablets. The ^{1}H, ^{13}C, and $^{14/15}$N NMR spectra were obtained on a Bruker AM 300 instrument at frequencies of 300, 75.47, 21.67, and 30.42 MHz respectively, internal standard was TMS. The UV spectra were taken on a Specord UV instrument in absolute ethanol. The mass spectra were obtained on a Varian instrument with direct insertion of the sample into the ion source at an energy of ionizing electrons 70 eV, accelerating voltage was 1.75 kV, and emission current 100 mA. Melting points were determined on a Boetius stage with a heating rate of 4°/min at the point of melting. Column chromatography was carries out on silica gel L 100/250 μ, and TLC on Silufol UV 254 plates.

2-Benzyl-4,5-dinitro-1,2,3-triazole (2b). A solution of silver nitrate (0.2 g) in water (20 ml) was added to a solution of triazole oxide **1c** (0.2 g, 1.17 mmol) in acetonitrile (10 ml). The mixture was heated to 70-80°C with vigorous stirring and a solution of sodium persulfate (0.2 g, 0.83 mmol) in water (20 ml) was added dropwise to it. The reaction mixture was heated to 80-90°C and maintained at this temperature for 12-13 h, then cooled to 20°C, water (50 ml) was added, and the mixture was extracted with ether (3 × 50 ml). The extract was combined with the organic layer, dried with magnesium sulfate, and the solvent removed on a rotary evaporator. Product **2b** (0.06 g, 33%) was isolated from the residue by column chromatography (eluent CH_2Cl_2–CCl_4, 2:3); mp 73-75°C. After recrystallization from CCl_4 it had mp 82-84°C, R_f 0.75 (CH_2Cl_2). IR spectrum, ν, cm^{-1}: 1570, 1550, 1440, 1340, 1320, 1140, 1080, 960, 810, 730, 695. ^{1}H NMR spectrum (acetone-d$_6$), δ, ppm: 5.86 (2H, s, CH_2); 7.7 (5H, s, C_6H_5). ^{14}N NMR spectrum (acetone-d$_6$), δ, ppm: -33.02. The mass spectrum contains a peak for the molecular ion M^+ (*m/z* 249).

2-Benzyl-5-chloro-4-nitro-1,2,3-triazole 1-Oxide (3). A solution of copper(II) chloride (0.13 g, 0.76 mmol) in water (10 ml) was added to a solution of triazole oxide **1c** (0.2 g, 0.76 mmol) in acetonitrile (10 ml). The mixture was heated to 80°C with vigorous stirring and a solution of sodium persulfate (0.25 g, 1.04 mmol) in water (10 ml) was added dropwise to it. The reaction mixture was maintained at this temperature for 20 h, then cooled to 20°C, and the organic layer separated. The aqueous layer was extracted with ether (2 × 30 ml). The extract was combined with the organic layer, dried with magnesium sulfate, and the solvent removed on a rotary evaporator. From the residue by column chromatography (CH_2Cl_2–CCl_4, 1:1) were isolated the starting material **1c** (0.07 g, 38%), mp 121-122°C, R_f 0.7 (CH_2Cl_2) and product **3** (0.048 g, 24%), mp 124-125°C, R_f 0.6 (CH_2Cl_2). IR spectrum, ν, cm^{-1}: 2910, 1560, 1550, 1480, 1450, 1440, 1410, 1380, 1350, 1335, 1285, 1210, 1180, 1060, 885, 840, 790, 710, 690. ^{14}N NMR spectrum (acetone-d$_6$), δ, ppm: -31.90. The mass spectrum contains peaks for the molecular ions (*m/z* 254 and 256). Found, %: C 42.60; H 2.85; Cl 14.03; N 22.11. $C_9H_7ClN_4O_3$. Calculated, %: C 42.44; H 2.77; Cl 13.92; N 22.00.

4-Amino-2-*tert*-butyl-5-nitro-1,2,3-triazole 1-Oxide (4). A saturated solution of ammonia in chloroform was added dropwise with stirring to a solution of 3,4-dinitrofuroxane [17] (1.7 g, 9.7 mmol) in chloroform (30 ml) at -20 to -30°C. The progress of the reaction was followed by TLC ($C_2H_4Cl_2$). After disappearance of the starting material the temperature was raised to 0-5°C, a solution of *tert*-butylamine (1.0 g, 1.4 ml, 14 mmol) in ether (5 ml) was added, and the mixture was maintained at this temperature for 3-4 h until disappearance of the aminonitrofuroxane. The inorganic solid was filtered off, and washed with chloroform (2 × 20 ml). The chloroform extract was combined with the filtrate, washed with water (3 × 20 ml), and dried with magnesium sulfate. The solvent was evaporated, and the residue (0.48 g, 25%) chromatographed on a column ($C_2H_4Cl_2$). Product **4** (0.32 g, 17%) of mp 151-152°C was obtained. IR spectrum, ν, cm^{-1}: 3500, 3300, 3000, 2930, 1620, 1560, 1480, 1450, 1390, 1370, 1340, 1270, 1240, 1190, 1130, 1090, 1010, 900, 820, 800, 740. UV spectrum (EtOH), λ, nm: 220, 310, 379. Mass spectrum, *m/z*: 201 $[M]^+$; 155 $[M\text{-}NO_2]^+$, 185 $[M\text{-}O]^+$, 128 $[M\text{-}O\text{-}t\text{-}Bu]^+$. Found, %: C 35.78; H 5.44; N 35.15. $C_6H_{11}N_5O_3$. Calculated, %: C 35.82; H 5.47; N 34.82.

4-Amino-5-nitro-1,2,3-triazole 1-Oxide (5). Triazole oxide **4** (0.2 g, 1 mmol) was added to a mixture of trifluoroacetic acid (5 ml) and concentrated hydrogen peroxide (2 ml) at 0-10°C. The temperature of the reaction mixture was raised to 18-20°C and maintained for ~3 h. The solid was then filtered off, washed with trifluoro-acetic acid, with ether, and with acetone. Product **5** (0.058 g, 42%) was obtained having mp 77°C (decomp.). IR spectrum, ν, cm^{-1}: 3480, 3320, 2950, 1650, 1570, 1480, 1420, 1360, 1340, 1290, 1200, 1140, 1000, 800, 790, 740. UV spectrum, λ, nm: 208, 312.5, 370. ^{1}H NMR spectrum (DMSO-d$_6$), δ, ppm: 8.25 (2H, s, NH_2). ^{13}C NMR spectrum (DMSO-d$_6$), δ, ppm: 122.31 ($C_{(5)}$), 148.02 ($C_{(4)}$). ^{14}N NMR spectrum (DMSO-d$_6$), δ, ppm: -29.92 (NO_2). ^{15}N NMR spectrum (DMSO-d$_6$), δ, ppm: -30.20 (NO_2); -57.88 (br, $N_{(1)}$); -151.66 (br, $N_{(2)}$); -318.15 (NH_2). Found, %: C 16.78; H 2.12; N 48.43. $C_2H_3N_5O_3$. Calculated, %: C 16.55; H 2.07; N 48.27.

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