5. J. Hamer and A. Macaluso, Chem. Rev., 64, 474 (1964).
6. G. R. Delpierre and M. Lamchen, Quart. Rev., 19, 329 (1965).
7. L. S. Kaminsky and M. Lamchen, J. Chem. Soc., B, 1085 (1968).
8. J. E. Baldwin, A. K. Qureshi, and B. Sklarz, Chem. Commun., 373 (1968).
9. R. Z. Sagdeev, Yu. N. Molin, G. A. Kutikova, and L. B. Volodarskii, Teor. i Éksp. Khim., 6, 220 (1970).
10. L. B. Volodarskii and A. Ya. Tikhonov, Zh. Org. Khim., 6, 307 (1970).
11. L. Bellamy, New Data on the IR Spectra of Complex Molecules [Russian translation], Mir, Moscow (1971), p. 58.
12. R. É. Valter, Usp. Khim., 43, 1417 (1974).
13. Yu. G. Putsykin and L. B. Volodarskii, Izv. Sibirsk, Otd. Akad. Nauk SSSR, Ser. Khim., 9, 4, 86 (1969).
14. A. Belly, F. Petrus, and J. Verducci, Bull. Soc. Chim. France, 1395 (1973).
15. J. F. Elsworth and M. Lamchen, J. Chem. Soc., C, 2423 (1968).

PREPARATION AND SOME PROPERTIES OF PYRIMIDINE 1,3-DIOXIDES

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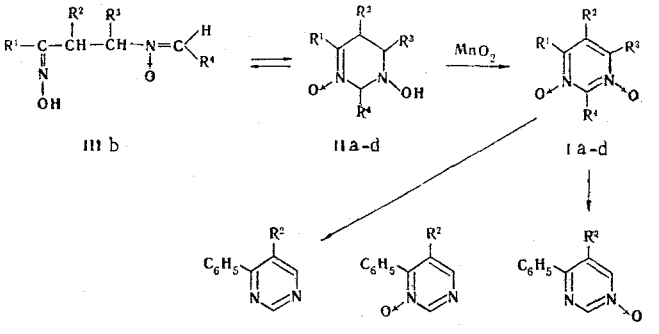
Oxidation of 1-hydroxy-1,2,5,6-tetrahydropyrimidine 3-oxides with active manganese dioxide leads to pyrimidine 1,3-dioxides. Depending on the conditions, pyrimidines or isomeric pyrimidine N-monoxides are formed by deoxygenation of pyrimidine 1,3-dioxides with triethyl phosphite.

There is very little available information regarding pyrimidine 1,3-dioxides (I); the only example we know of is 5-nitro-2,4,6-triaminopyrimidine 1,3-dioxide [1].

In a previous paper [2] we showed that the reaction of 1,3-hydroxylamino oximes with carbonyl compounds leads to the formation of 1-hydroxy-1,2,5,6-tetrahydropyrimidine 3-oxides (II), aliphatic N-(3-oximino-substituted)nitrones (III) or a tautomeric mixture of them (II ⇄ III). During a study of the properties of the condensation products we examined the possibility of their use for the synthesis of pyrimidine 1,3-dioxides (I). In the case of compounds existing in a ring–chain tautomeric equilibrium (II ⇄ III) this would correspond to fixing of the pyrimidine ring (see [3]). We found that active manganese dioxide [5] oxidizes II to give pyrimidine 1,3-dioxides I.*



I—IIa R^1=H, R^2=H, R^3=H, R^4=H; I—IIIb R^1=CH_3, R^2=H, R^3=CH_3, R^4=CH_3; I—IIc, IV—VIc R^1=C_6H_5, R^2=H, R^3=H, R^4=H; I—IId, IV—VId R^1=C_6H_5, R^2=CH_3, R^3=H, R^4=H

*See [4] for our preliminary communication.

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TABLE 1. Spectral Characteristics of Pyrimidine N-Oxides

Compound	PMR spectrum, δ, ppm (J, Hz)*				IR spectrum, cm^{-1}†
	R^1	R^2	R^3	R^4	
Ia	8,30 (1,5; 6,5)	7,65 (6,5)	8,30 (1,5; 6,5)	9,42 (1,5)	1163, 1184, 1208, 1310, 1315
Ib	2,31	7,50	2,31	2,62	1152, 1180, 1255, 1286
Ic	7,1—8,0	—‡	8,10 (7,0)	9,22	1209, 1222, 1283
Id	7,47	2,01	8,36 (1,5)	9,34 (1,5)	1180, 1190, 1338
Vd	7,57	2,18	8,42	9,05	1261, 1292
VId	7,4—7,8	2,39 (0,5; 0,8)	8,59 (0,8; 2,0)	9,01 (0,5; 2,0)	1170, 1260, 1303

*The PMR spectra of $(CD_3)_2SO$ solutions of Ia-d (saturated solutions for Ia, c, d) and of CD_3OD solutions of Vd and VId were recorded. The spectrum of VId was recorded with a Varian HA-100 spectrometer with the aid of nuclear magnetic double resonance (NMDR).
†The intense absorption bands at 1150-1350 cm^{-1} are presented.
‡ The signal coincided with the range of absorption of benzene ring protons.

TABLE 2. Pyrimidine N-Oxides (I, V, and VI)

Compound	mp, °C*	Empirical formula	Found, %			Calc., %			UV spectrum, λ_{max}, nm (log ε)†	Yield, %
			C	H	N	C	H	N		
Ia	226—228	$C_4H_4N_2O_2$	42,8	3,7	24,6	42,8	3,6	25,0	266 (4,36)	6
Ib	206—209	$C_7H_{10}N_2O_2$	54,4	6,6	17,9	54,5	6,5	18,2	257 (4,41), 277sh(4,00)	33
Ic	216—218	$C_{10}H_8N_2O_2$	63,8	4,3	14,9	63,8	4,3	14,9	275 (4,44), 316 (4,23)	40
Id	225—227	$C_{11}H_{10}N_2O_2$	65,4	4,8	13,9	65,3	5,0	13,9	269 (4,42), 293sh(4,06)	56
Vc	153—155[8]	$C_{10}H_8N_2O$	70,0	4,8	16,1	69,7	4,7	16,3	253 (4,39), 285 (3,95)	10
VIc	133—135[8]	$C_{10}H_8N_2O$	69,9	4,6	16,3	69,7	4,7	16,3	307 (4,31), 322sh(4,27)	83
Vd	146—148	$C_{11}H_{10}N_2O$	71,2	5,7	15,1	70,9	5,4	15,0	250 (4,14), 266sh(3,96)	14
VId	151—153	$C_{11}H_{10}N_2O$	71,0	5,4	15,3	70,9	5,4	15,0	285 (4,23), 318 (4,08)	80

*Compound Ic was recrystallized from dimethylformamide, whereas the remaining compounds were purified by sublimation.
†Abbreviation: sh is shoulder.

Treatment of 1-hydroxy-1,2,5,6-tetrahydropyrimidine 3-oxides (IIa, c, d) and a mixture of compounds (IIb $\rightleftarrows$ IIIb) in an organic solvent with active manganese dioxide gives the corresponding pyrimidine 1,3-dioxides (Ia-d). Pyrimidine 1,3-dioxides I are only slightly soluble in organic solvents and have high melting points. Intense bands at 1150-1350 cm^{-1} (Table 1), which are evidently due to both the stretching vibrations of the N→O bond and the deformation vibrations of aromatic rings [6, 7], are observed in the IR spectra of I. The PMR spectra of I are in good agreement with the pyrimidine 1,3-dioxide structure (Table 1) and are similar to the PMR spectra of pyrimidine N-monoxides [8].

During a study of the properties of I we observed that heating them in excess triethyl phosphite leads to complete deoxidation of the dioxides to give known pyrimidines (IV). Thus 4-phenyl- and 5-methyl-4-phenylpyrimidines (IVc, d) are formed in quantitative yields when dioxides Ic, d are heated in triethyl phosphite.

Since the rate of monodeoxidation of 1,3-dioxides (I) should be substantially lower than the rate of deoxidation of pyrimidine N-monoxides V and VI [9], one might have expected that a change in the reaction conditions would make it possible to stop the deoxidation of dioxides (I) at the step involving the formation of their N-monoxides.

Heating 1,3-dioxides Ic or Id with triethyl phosphite in dioxane or tetrahydrofuran (THF) leads to the simultaneous formation of two isomeric pyrimidine N-monoxides (Vc and VIc or Vd and VId). Moreover, the 4-phenyl- and 5-methyl-4-phenylpyrimidine 1-oxides (VIc, d) are formed in 80-83% yields, whereas the isomeric 6-phenyl- and 5-methyl-6-phenylpyrimidine 1-oxides (Vc, d) are formed in 10-14% yields. The isomeric Vc and VIc structures are in agreement with the literature data [8]. The 0.17 ppm shift to weaker field of the signal of the proton in the 6 position of the pyrimidine ring of VId as compared with the signal of the corresponding proton (4 position) of isomeric Vd indicates the correctness of the isomeric N-monoxide Vd and VId structures assigned to them (see [8, 10]).

An appreciable hypsochromic shift as compared with the corresponding VI isomer is observed in the UV spectra of the isomeric N-monoxides V, which have a phenyl group in the ortho position relative to the N-oxide group (Table 2); this has also been observed for 2-phenyl- and 4-phenylpyridine N-oxides [11].

EXPERIMENTAL

The IR spectra of KBr pellets of the compounds were recorded with a UR-20 spectrometer. The UV spectra of alcohol solutions were recorded with a Specord spectrophotometer. The PMR spectra were recorded with Varian A-56/60A and Varian HA-100 spectrometers with hexamethyldisiloxane (0.04 ppm) as the internal standard.

Pyrimidine 1,3-Dioxides (Ia-d). A suspension of 27 mmole of active manganese dioxide in 10 ml of dioxane was added with stirring to a suspension of 3 mmole of 1-hydroxytetrahydropyrimidine 3-oxide (IIa, c, d) or a solution of a mixture of IIb $\rightleftarrows$ IIIb in 35 ml of dioxane and 2.5 ml of pyridine. After 1 h, the suspension was filtered, the filtrate was evaporated, and the residue was treated with acetone. The precipitated Ia-d were removed by filtration.

1-Hydroxy-1,2,5,6-tetrahydropyrimidine 3-oxide (IIa) was used without prior purification in the preparation of 1,3-dioxide Ia, since it is difficult to purify [2].

Oxidation of IId with active manganese dioxide in acetone dioxane, and ethyl acetate without the addition of pyridine leads to Id in 35-50% yields.

4-Phenacylpyrimidines (IV). A mixture of Ic or Id in 3 ml of triethyl phosphite was stirred and heated at 160° for 1 h, after which the triethylphosphite was evaporated, and the residue was chromatographed with a column filled with silica gel [elution with petroleum ether–ether (3:2)] to give IVc, with mp 63-64° (from petroleum ether) [12], in 76% yield or IVd, picrate mp 139-140° (from alcohol) [12], in 81% yield. The IR spectrum of IVc was identical to the IR spectrum of 4-phenylpyrimidine [13].

Isomeric 4-Phenyl- and 6-Phenylpyrimidine 1-Oxides (VIc, d and Vc, d). A solution of 1 mmole of Ic or Id in 3-5 ml of dioxane was refluxed with 3 mmole of triethyl phosphite for 4-7 h (with chromatographic monitoring). The solvent was then evaporated, and the mixtures of isomeric pyrimidine N-monoxides (V and VI) were separated by preparative thin-layer chromatography on silica gel (elution with acetone); $R_f^V > R_f^{VI}$.

It is better to carry out the monodeoxidation of Ic, d in dioxane rather than in THF because of the limited solubility of Ic, d in THF.

LITERATURE CITED

1. A. R. Katritzky and J. M. Lagowski, Chemistry of the Heterocyclic N-Oxides, Academic Press, London–New York (1971), p. 70.
2. A. Ya. Tikhonov and L. B. Volodarskii, Khim. Geterotsikl. Soedin., No. 2, 252 (1977).
3. L. B. Volodarskii, A. Ya. Tikhonov, and L. A. Fust, Izv. Sibirsk. Otd. Akad. Nauk SSSR, Ser. Khim., 3, No. 7, 91 (1971).
4. A. Ya. Tikhonov and L. B. Volodarskii (Volodarsky), Tetrahedron Lett., 2721 (1975).
5. S. P. Korshunov and L. I. Vereshchagin, Usp. Khim., 35, 2255 (1966).
6. R. H. Wiley and S. C. Slaymaker, J. Am. Chem. Soc., 79, 2233 (1957).
7. A. Graja, Acta Phys. Polon., A, 43, 461 (1973).
8. R. Peereboom, H. C. Plas, and A. Koudijs, Rec. Trav. Chim., 93, 58 (1974).
9. T. R. Emerson and C. W. Rees, J. Chem. Soc., 2319 (1964).
10. M. Ogata, H. Watanabe, K. Tori, and H. Kano, Tetrahedron Lett., 19 (1964).
11. L. Pentimalli, Gazz. Chim. Ital., 94, 902 (1964).
12. H. Bredereck, R. Gompper, and B. Geiger, Chem. Ber., 93, 1402 (1960).
13. C. J. Pouchert, The Aldrich Library of Infrared Spectra, Aldrich Chemical (1970), p. 990.