expected, pyridone derivatives, which were assumed to be produced by transformation from the primary product, were clearly recognized in all the test solutions. For example, in the case of 10% ammonia, lutidone was detected after 24 hours, and it became more predominant in the solution after 48 hours, in proportion to the disappearance of unchanged dehydroacetic acid and dehydroacetic acid-imide (the primary product). A similar tendency was seen more markedly and rapidly beyond the expectation in methylamine solution. The formation of N-methyllutidone was recognized already 1 hour after the addition of dehydroacetic acid into 5% methylamine solution, and after 24 hours, unchanged dehydroacetic acid and 3-methyliminoethyl-4-hydroxy-6-methyl-2-pyrone (the primary product) could no longer be detected by paper chromatography, with formation of N-methyllutidone. Similar phenomenon was also observed in ammonium chloride solution (10%), though a far longer time was necessary in this case. This experiment has demonstrated the marked reactivity of dehydroacetic acid, especially the ease with which dehydroacetic acid was transformed even under a mild condition.

Detail of this work will be reported in the near future.

Throughout the experiment, Dragendorff reagent was used as a spraying reagent and BuOH-AcOH-H_2O (4:1:5) system as the developing solvent in paper chromatography.

Institute of Pharmaceutical Sciences,
Faculty of Medicine,
Kyushu University,
Katakasu, Fukuoka.

Sadao Iguchi (井口 定男)
Atsuko Inoue (井上 敦子)
Chieko Kurahashi (倉橋千恵子)

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Separation and Structure of 3-Methylpyridazine 1-Oxide and 2-Oxide

Recently, N-oxidation of 3-methylpyridazine (II) with hydrogen peroxide in glacial acetic acid was reported by Kumagai,[1] who obtained a mono-N-oxide as hygroscopic crystals, $b.p_6$ 145°, but whether this mono-N-oxide is 1-oxide (IV) or 2-oxide (III), or a mixture of (IV) and (III) remained to be determined. The present writers prepared 3-methylpyridazine N-oxide according to the procedure of Kumagai. By a gas-chromatographic procedure, the product gave two distinct peaks, with no evidence of decomposition on the column. Conditions suitable for effective separation were found through the use of a Thermol-2 (Shimadzu), 3m. × 6mm., column at 180° and hydrogen flow rate of 200 cc./min. The product (2.4 g.) was dissolved in benzene, chromatographed on alumina, and the column was eluted with benzene and chloroform. The fraction eluted with benzene gave, after recrystallization from benzene, 630 mg. of (III) as colorless prisms, m.p. 83~84°; UV λ_{max}^{EtOH} mμ (log ε): 257 (4.00), 314 (3.68). *Anal.* Calcd. for $C_5H_6ON_2$: C, 54.54; H, 5.49; N, 25.44. Found: C, 54.76; H, 5.60; N, 25.29.

The fraction eluted with chloroform gave, after recrystallization from benzene, 230 mg. of (IV) as very hygroscopic crystals, m.p. 68.5~69.5°; UV λ_{max}^{EtOH} mμ (log ε): 262 (4.03), 312 (3.72). *Anal.* Calcd. for $C_5H_6ON_2$: C, 54.54; H, 5.49; N, 25.44. Found: C, 54.59;

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1) M. Kumagai: Nippon Kagaku Zasshi, **81**, 1148 (1960).

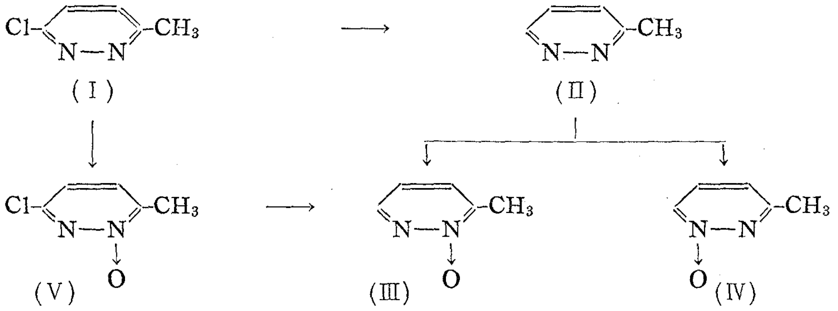

Chart 1.

H, 5.70; N, 25.78.

Heating of 3-methyl-6-chloropyridazine (I) with hydrogen peroxide in glacial acetic acid at 60° for 9 hours gave 3-methyl-6-chloropyridazine N-oxide (V) in 63% yield, m.p. 163~164°; UV λ_{max}^{EtOH} mμ (log ε): 260 (3.97), 326 (3.74). *Anal.* Calcd. for $C_5H_5ON_2Cl$: C, 41.52; H, 3.49; N, 19.31. Found: C, 41.77; H, 3.65; N, 19.36.

In this case, the mono-N-oxide (V) was confirmed to be the sole product by gas-chromatography under the same conditions as above. Catalytic reduction of (V) with palladium-carbon in hydrous methanolic ammonia solution gave 3-methylpyridazine N-oxide, m.p. 83~84°, which was confirmed to be identical with (III) by mixed melting point determination and comparison of their infrared and ultraviolet absorption spectra.

Thus, oxygen atom in both (V) and (III) should be bonded to the corresponding nitrogen atom, but the position of oxygen atom in 3-methylpyridazine N-oxides (III and IV) is not determined.

The dipole moments of these compounds (I~V) were measured in order to determine the position of N-O groups. The dielectric constant in dilute solution in benzene was measured by means of a heterodyne beat apparatus provided with a platinum cell.[2] The molar polarization of the solute was calculated by a method similar to that introduced by Halverstadt and Kumler,[3] except for density which was used rather than the specific volume. The deformation polarization of each compound was assumed to be 1.05 times the molar refraction which was approximated with the sum of bond refractions.[4] The results are shown in Table I, in which α and β respectively denote the changes of the dielectric constant and density of solutions with the weight fraction of the solute; other notations have their usual meanings.

TABLE I. Dipole Moments of Some Derivatives of Pyridazine and Its N-Oxides in Benzene Solution at 25°

Compound	α	β	$P_{2\infty}$	MR_D	μ(D)
(I)	17.43	0.29	451.2	32.46	4.51
(II)	19.98	0.16	380.6	27.62	4.13
(III)	27.29	0.30	590.9	30.03	5.23
(IV)	27.32	0.33	590.1	30.03	5.23
(V)	21.33	0.36	609.9	34.86	5.29

The moment of pyridazine may be calculated by a simple vector analysis of the moment of 3-methylpyridazine (II). The calculation leads to a moment value of 4.11 D in satisfactory agreement with 4.03 D, the vector sum of two pyridine moments,[5] the C-CH_3 moment being taken as the moment of toluene, 0.37 D.[6] With the moments of

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[2] Y. Kurita, M. Kubo: J. Am. Chem. Soc., **79**, 5460 (1957).

[3] I.F. Halverstadt, W.D. Kumler: *Ibid.*, **64**, 2988 (1942).

[4] A.I. Vogel, W.T. Cresswell, G.H. Jeffery, J. Leicester: J. Chem. Soc., **1952**, 514.

[5] C.P. Smyth: "Dielectric Behavior and Structure," 343 (1955). McGraw-Hill Book Co., New York.

[6] *Ibid.*, 314 (1955).

pyridazine, 4.11 D, and (I), 4.51 D, the calculation gives a moment value 1.48 D for C-Cl bond, in good agreement with the accepted value of 1.58 D[7]

$$4.11^2+\{\mu(\mathrm{C-Cl})+0.37\}^2=4.51^2$$
$$\mu(\mathrm{C-Cl})=1.48$$

The departure of 0.1 D may be attributed to the *ortho* effect.

The moment of pyridazine N-oxide is the resultant sum of the moments of pyridine, 2.22 D, and its N-oxide, 4.24 D, but how much these component moments may be modified by *ortho* effect in pyridazine N-oxide molecule remains to be examined. Neglecting this effect, the moment of pyridazine N-oxide is calculated as 5.68 D, the direction of which makes an angle of 19°50′ with the N-O bond. These calculations can be illustrated conveniently by choosing a line parallel to N-N bond as an x axis and a line perpendicular to it as the y axis, as shown in Chart 2. On the other hand, the moment of (III) differs inappreciable with that of (IV) as expected from the molecular geometry, the calculated difference between the moments of (III) and (IV) being less than 0.13 D. Hence, the moment of pyridazine N-oxide can be approximated with the moment of (III) or (IV), 5.23 D, which is smaller than 5.68 D, the resultant sum of the moments of pyridine and its N-oxide. This discrepancy can be regarded as a measure of the *ortho* effect and it is clear that the observed value 5.23 D is the better approximation.

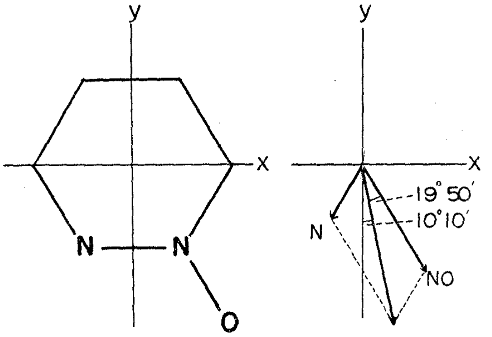

Chart 2.

Assuming that the direction of the moment of pyridazine N-oxide is parallel to y axis in Chart 2, the moment of 3-methyl-6-chloropyridazine N-oxide is calculated as

$$\sqrt{5.23^2+(1.48+0.37)^2}=5.54$$

But this is not the case, because the moment of pyridazine N-oxide is not parallel to the y axis and there must be some difference between the magnitudes of the moments of 3-methyl-6-chloropyridazine 1-oxide and 2-oxide.

The moment of the 1-oxide is expected to be larger and that of the 2-oxide smaller than 5.54 D. While the angle between y axis in Chart 2 and resultant moment of pyridazine N-oxide is affected to some extent by the *ortho* effect, one can assume 30°−19°50′=10°10′ for the angle as a good approximation. Then it would be easy to calculate the moments for 1-oxide and 2-oxide of 3-methyl-6-chloropyridazine. The calculations are shown in detail to illustrate the method.

1-oxide : $\mu_y=5.23\cos 10°10'$ $\mu_x=5.23\sin 10°10'+1.48+0.37$

$\mu=\sqrt{\mu_x^2+\mu_y^2}=5.85$

2-oxide : $\mu_y=5.23\cos 10°10'$ $\mu_x=1.48+0.37-5.23\sin 10°10'$

$\mu=5.23$

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7) C.P. Smyth : "Dielectric Behavior and Structure," 253 (1955), McGraw-Hill Book Co., New York.

Although the bond moment values and angles between the group moments are necessarily approximate, it is clear that the 1-oxide has much too high moments to be assigned to compound (V). The agreement between the calculated value 5.23 D for 2-oxide and observed one, 5.29 D, is excellent within the errors of experiment and calculation for 3-methyl-6-chloropyridazine 2-oxide (V).

On the basis of above discussions, it has become evident that (III) and (V) are 2-oxide, and consequently (IV) is 1-oxide.

Further studies on 3-methylpyridazine N-oxides and their derivatives will be reported in detail in the near future.

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Research Laboratory,
Shionogi & Co., Ltd.,
Fukushima-ku, Osaka.

Hideo Kano (加納日出夫)
Masaru Ogata (尾形 秀)
Haruyuki Watanabe (渡辺 春幸)
Ichiro Ishizuka (石塚 一郎)

July 3, 1961.