SYNTHESIS OF SOME HETROCYCLIC RADICALS OF THE IMINOXYL CLASS

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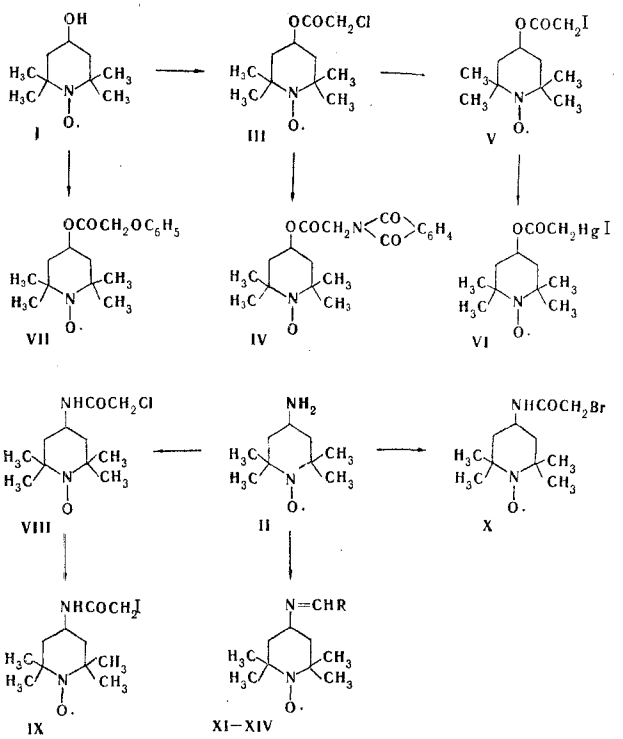
A number of new paramagnetic compounds were obtained from 2,2,6,6-tetramethyl-4-hydroxypiperidine 1-oxyl and 2,2,2,6-tetramethyl-4-aminopiperidine 1-oxyl.

Stable iminoxyl radicals are not yet readily accessible substances, and methods for their synthesis have not been adequately developed [1].

This paper is devoted to the synthesis of some new, stable radicals of this class from the previously described 2,2,6,6-tetramethyl-4-hydroxypiperidine 1-oxyl (I) [2] and 2,2,6,6-tetramethyl-4-aminopiperidine 1-oxyl (II) [3]:



All of the compounds obtained have singlet ESR spectra, in the crystalline state the integral intensities of which relative to the standard (2,2,6,6-tetramethyl-4-hydroxypiperidine 1-oxyl) correspond to the theoretically expected values within the limits of experimental error.

The acylation of I and II was accomplished by means of chloroacetyl chloride. Ester III is formed in quite high yield during acylation in absolute media in the presence of anhydrous pyridine or triethylamine,

Scientific-Research Institute of Chemicals for Polymer Materials, Tambov. Translated from Khimiya Geterotsiklicheskikh Soedinenii, No. 11, pp. 1527-1529, November 1971. Original article submitted July 26, 1970.

but it was not possible to obtain amide VIII via this route. Compounds VIII and X can be obtained in rather high yields by using the Schotten–Baumann method.

The chlorine atoms in ester III and amide VIII are quite labile and can be readily replaced by other substituents. Thus the corresponding IV, V, and IX are formed smoothly by reaction with sodium iodide or potassium phthalide in a polar solvent.

The amino group in radical II is able to practically selectively react with aldehydes. The corresponding azomethines (XI-IXV) are formed in rather high yields.

In connection with patent data [4-7], these compounds may apparently be of practical interest as light stabilizers for polymer materials.

EXPERIMENTAL

2,2,6,6-Tetramethyl-4-chloroacetoxypiperidine 1-Oxyl (III). Chloroacetyl chloride [3.4 g (0.03 mole)] was added dropwise with stirring to a solution of 5.7 g (0.034 mole) of I in 45 ml of absolute pyridine, and the mixture was held at room temperature for 2 h and poured into water. The precipitate was removed by filtration and washed with water to give 5 g (63%) of needle-shaped crystals with mp 54.5-55° (from hexane). Found: C 53.0; H 7.8; Cl 14.0; N 5.5%. $C_{11}H_{19}ClNO_3$. Calculated: C 53.1; H 7.7; Cl 14.3; N 5.6%. A complex with utrotropin had mp 147-148° C (from alcohol–ether). Found: C 52.2; H 8.3; Cl 9.3; N 17.8%. $C_{17}H_{31}ClN_5O_3$. Calculated: C 52.2; H 8.0; Cl 9.2; N 18.0%.

The reduction of III with phenylhydrazine yielded 2,2,6,6-tetramethyl-1-hydroxy-4-chloroacetoxypiperidine as colorless plates with mp 93-94° C (from hexane). Found: C 52.7; H 8.1; N 5.4%. $C_{11}H_{20}ClNO_3$. Calculated: C 52.9; H 8.1; N 5.6%.

2,2,6,6-Tetramethyl-4-phthalimidoacetoxypiperidine 1-Oxyl (IV). A mixture of 7.4 g (0.03 mole) of III and 6.0 g (0.04 mole) of potassium phthalimide was refluxed in 50 ml of dimethylformamide for 20 min, and the resulting mass was poured into 100 ml of cold water. The resulting orange precipitate was removed by filtration to give 10.1 g (56%) of the phthalimidoacetate with mp 146-147° C (from alcohol). Found: C 63.3; H 6.6; N 8.1%. $C_{19}H_{23}N_2O_5$. Calculated: C 63.5; H 6.4; N 7.8%.

The reduction of IV with phenylhydrazine gave the corresponding hydroxylamine as colorless needles with mp 151-152° (from aqueous alcohol). Found: C 63.1; H 6.7; N 7.4%. $C_{19}H_{24}N_2O_5$. Calculated: C 63.1; H 6.7; N 7.8%.

2,2,6,6-Tetramethyl-4-iodoacetoxypiperidine 1-Oxyl (V). A mixture of 12.5 g (0.05 mole) of III and 10 g of sodium iodide in 50 ml of acetone was refluxed for 20 min. The mixture was cooled and poured into 100 ml of water, and the resulting precipitate was removed by filtration and dried. Recrystallization from hexane gave 15.8 g (93%) of V as red plates with mp 60-61° C. Found: C 38.5; H 5.4; N 4.3%. $C_{11}H_{19}NO_3$. Calculated: C 38.8; H 5.6; N 4.1%.

2,2,6,6-Tetramethyl-4-iodomercuriacetoxypiperidine 1-Oxyl (VI). Compound V [3.4 g (0.01 mole)] was shaken with 20 ml of alcohol and 2 g of mercury in a long-necked hydrogenation flask for 8 h. The mixture was decanted and filtered, and the filtrate was vacuum-evaporated. The filtered mercury salts were washed with chloroform, and the chloroform extracts were added to the evaporated residue. The solvent was evaporated to give 0.54 g (10%) of VI as orange needles with mp 119-120° C (from alcohol) that decomposed on storage in light. Found: Hg 37.0%. $C_{11}H_{19}HgINO_3$. Calculated: Hg 37.1%.

2,2,6,6-Tetramethyl-4-phenoxyacetoxypiperidine 1-Oxyl (VII). This compound [9.8 g (96%)] with mp 70-71° C (from hexane) was obtained in the same way as III by the reaction of 5.7 g (0.034 mole) of I and 3.4 g of phenoxyacetyl chloride. Found: C 66.3; H 7.9; N 4.5%. $C_{17}H_{24}NO_4$. Calculated: C 66.6; H 7.9; N 4.6%.

2,2,6,6-Tetramethyl-4-chloroacetamidopiperidine 1-Oxyl (VIII). Chloroacetyl chloride [4.35 ml (0.075 mole)] was added dropwise at 2-5° C to a solution of 10 g (0.058 mole) of II and 4.35 g of sodium carbonate in 110 ml of water. After all of the acid chloride had been added, the reaction mass was allowed to stand for 30 min and filtered. Recrystallization of the precipitate from hexane gave 6.89 g (48%) of a red, finely crystalline powder with mp 114-115° C. Found: C 53.6; H 7.9; Cl 14.5; N 11.3%. $C_{11}H_{20}ClN_2O_2$. Calculated: C 53.4; H 8.1; Cl 14.3; N 11.3%.

2,2,6,6-Tetramethyl-4-bromoacetamidopiperidine 1-Oxyl (X). A solution of 1.97 g (0.0125 mole) of bromoacetyl chloride in 100 ml of acetone was added dropwise at 2-5° C to a solution of 2.12 g (0.0125 mole)

of II and 0.5 g of sodium carbonate in 50-70 ml of water. The mixture was filtered after 1 h, and the filtrate was vacuum-evaporated. The radical was extracted with chloroform and dried with magnesium sulfate. Evaporation of the solvent gave 2.16 g (60%) of orange crystals with mp 112-114° C (from chloroform–hexane). Found: C 45.7; H 6.9; Br 27.1; N 9.4%. $C_{11}H_{20}BrN_2O_2$. Calculated: C 45.2; H 6.9; Br 27.3; N 9.6%.

2,2,6,6-Tetramethyl-4-iodoacetamidopiperidine 1-Oxyl (IX). A 3-g (0.012 mole) sample of VIII in 15 ml of acetone was refluxed with 5 g of sodium iodide for 1 h. The precipitate was removed by filtration, and the solvent was removed from the filtrate by distillation to give 2.26 g of IX with mp 119-120° C (from hexane). Found: C 38.9; H 6.0; N 8.3%. $C_{11}H_{20}N_2O_2$. Calculated: C 39.0; H 5.9; N.8.3%.

2,2,6,6-Tetramethyl-4-[(2-hydroxybenzylidine)amino]piperidine 1-Oxyl (XI). A solution of 9.2 g (0.076 mole) of salicylaldehyde in 10 ml of isopropyl alcohol was added to a hot solution of 13 g (0.076 mole) of II in 50 ml of isopropyl alcohol, and the mixture was heated to the boiling point, and cooled, and poured into twice its volume of water to give 19.2 g (91%) of a red precipitate with mp 155-156° C (from ethanol). Found: C 69.5; H 8.4; N 9.9%. $C_{16}H_{23}N_2O_2$. Calculated: C 69.8; H 8.4; N 10.2%.

2,2,6,6-Tetramethyl-4-[(furfurylidene)amino]piperidine 1-Oxyl (XII). This compound (90%), with mp 136.5-137.5° C (from alcohol), was similarly obtained. Found: C 67.6; H 8.7%. $C_{14}H_{21}N_2O_2$. Calculated: C 67.4; H 8.5%.

2,2,6,6-Tetramethyl-4-[(3-methoxy-4-hydroxybenzylidene)amino]piperidine 1-Oxyl (XIII). A mixture of 3 g (0.012 mole) of II, 2.67 g (0.012 mole) of vanillin, and 60 ml of benzene was refluxed until the azeotropic distillation of water ceased. The solvent was removed by distillation, and the residue was recrystallized from benzene to give 5 g (93%) of a product with mp 130-131° C. Found: C 66.9; H 8.4; N 9.4%. $C_{17}H_{25}N_2O_3$. Calculated: C 66.9; H 8.3; N 9.1%.

2,2,6,6-Tetramethyl-4-[(3,5-di-tert-butyl-4-hydroxybenzylidene)amino]piperidine 1-Oxyl (XIV). This compound (47%), with mp 162-163° C (from aqueous alcohol), was similarly obtained. Found: C 74.4; H 10.2; N 7.2%. $C_{14}H_{39}N_2O_2$. Calculated: C 74.4; H 10.1; N 7.2%.

LITERATURE CITED

1. Varian Instrument Application, 4, 8 (1970).
2. E. G. Rozantsev, Izv. Akad. Nauk SSSR, Ser. Khim., 2197 (1964).
3. E. G. Rozantsev and Yu. V. Kokhanov, Izv. Akad. Nauk SSSR, Ser. Khim., 1477 (1966).
4. Sankyo Company Limited, British Patent No. 1,130,386 (1968); RAPRA, 4, 2994 (1969).
5. Sankyo Company Limited, French Patent No. 1,501,582 (1967); RAPRA, 4, 2445 (1969).
6. Sankyo Company Limited, French Patent No. 1,536,106 (1968); Ref. Zh. Khim., Is475 (1970).
7. Sankyo Company Limited, British Patent No. 1,145,470 (1969); Patent Abstr., 11, 1536 (1969).