REACTION OF 1,1,2,2-TETRAFLUOROPROPANAL WITH PHENYLHYDRAZINE*

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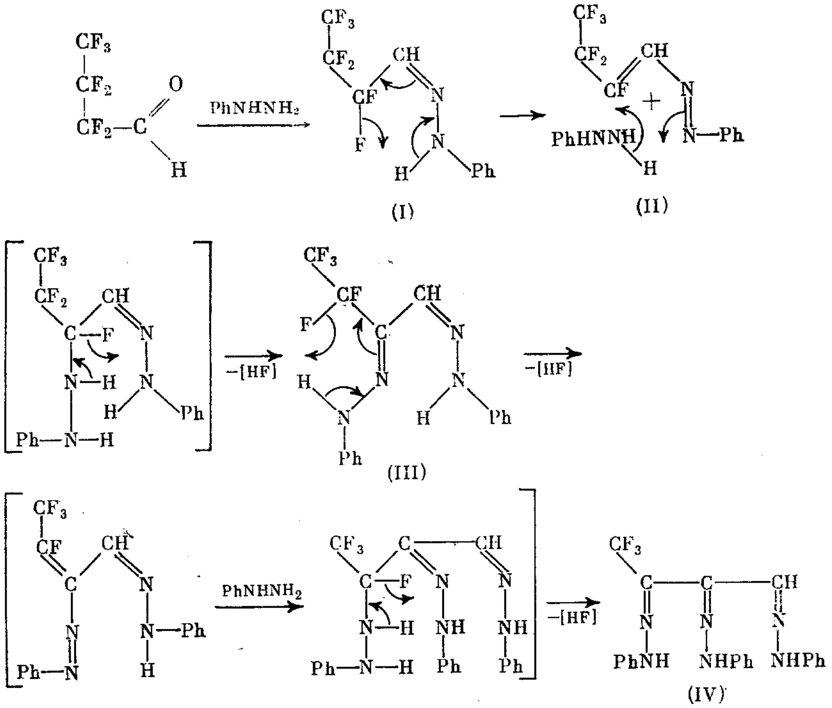
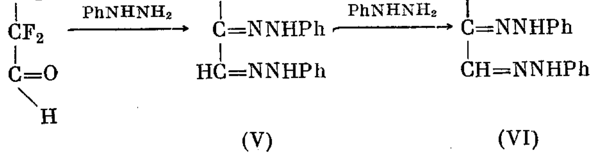
Perfluoroaldehydes when treated with phenylhydrazine are converted to polyphenylhydrazones via all of the difluoromethylene groups; here the terminal trifluoromethyl grouping remains untouched [1].

The reaction of perfluoroaldehydes with phenylhydrazine initially leads to the ordinary phenylhydrazones (I), which are dehydrofluorinated by excess phenylhydrazine to the azo compounds (II) [1]; the latter via nucleophilic attack by phenylhydrazine and subsequent dehydrofluorination are converted to bis(phenylhydrazones) (III), which are analogous to the osazones of monosaccharides. The successive repetition of these processes leads to the conversion of all of the CF₂ groups of perfluoroaldehydes to give polyhydrazones (IV), analogous to the alkazones that are obtained from monosaccharides [2] by treating the latter with unsymmetrical methylphenylhydrazine.



In a similar manner, the treatment of 1,1,2,2-tetrafluoropropanal with excess phenylhydrazine initially yields osazone (V), and then tris(phenylhydrazone) (VI), which is identical with the previously obtained tris(phenylhydrazone) of mesoxaldehyde [3].



$$CF_2H{-}CF_2{-}CHO \xrightarrow{PhNHNH_2} CF_2H{-}C(=NNHPh){-}HC=NNHPh \xrightarrow{PhNHNH_2} CH(=NNHPh){-}C(=NNHPh){-}CH=NNHPh$$

(V) (VI)

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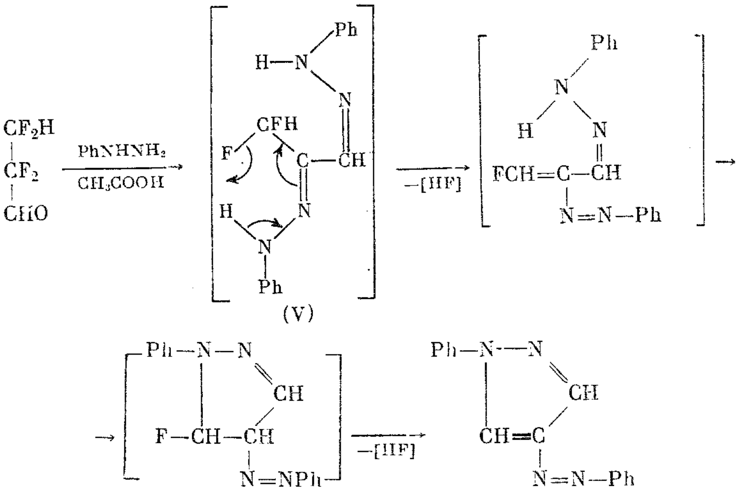
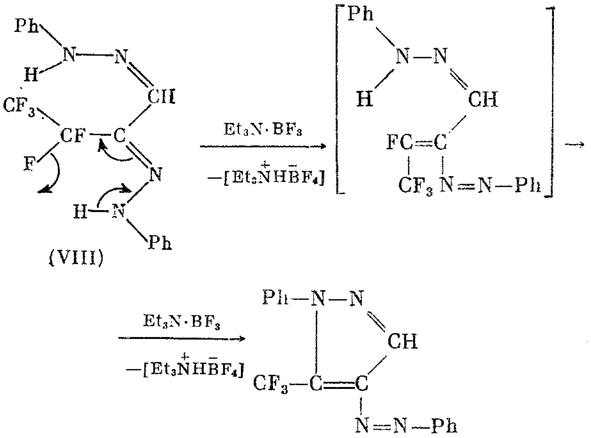
The reaction of 1,1,2,2-tetrafluoropropanal with phenylhydrazine in aqueous AcOH led to 1-phenyl-4-phenylazopyrazole (VII) [4]:



(V)

(VII)

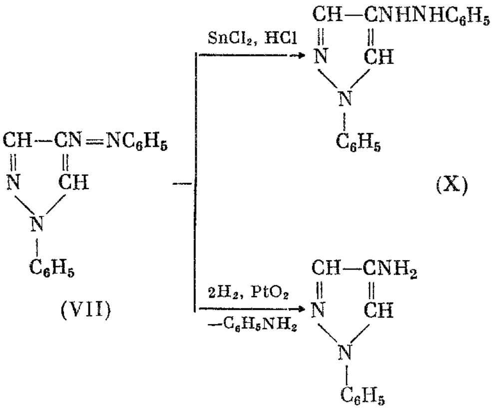
The step for the dehydrofluorination of bis(phenylhydrazone) (V), which leads to the formation of pyrazoles, was confirmed by obtaining 1-phenyl-4-phenylazo-5-trifluoromethylpyrazole (IX) when perfluoroethylglyoxal bis(phenylhydrazone) (VIII) is treated with $Et_3N \cdot BF_3$.



(VIII)

(IX)

The structure of pyrazole (VII) was established by its reduction with $SnCl_2$ in HCl to 1-phenyl-4-hydrazophenylpyrazole (X), and by the hydrogenation of (VII) over PtO_2 to the known 1-phenyl-4-aminopyrazole (XI), which was obtained previously from either the bis- or tris(phenylhydrazone) of mesoxaldehyde [4].



(VII)

(X)

(XI)

EXPERIMENTAL

The NMR spectra were recorded on a Perkin-Elmer spectrometer (external standard = TMS) and on a Tesla spectrometer (80 MHz, internal standard = TMS). The ^{13}C NMR spectra were recorded on a Bruker HX-90 instrument at an operating frequency of 22.635 MHz for ^{13}C, and the chemical shifts are given relative to TMS. The ^{19}F NMR spectra were taken on a Hitachi H-6013 spectrometer (56.46 MHz) using CF_3COOH as the internal standard. The IR spectra were taken on a UR-10 spectrometer.

Difluoromethylglyoxal Bis(phenylhydrazone) (V). 1) A homogeneous mixture of 5 g (0.046 mole) of phenylhydrazine, 15 ml of ethanol, 2.5 ml of CCl_4, and 0.4 g (0.003 mole) of 1,1,2,2-tetrafluoropropanal was kept at ∿ 20°C for 3 days, after which 7 ml of 50% AcOH was added (until weakly acid) and the mixture was let stand overnight. The crystals were separated, washed twice with hot water, and recrystallized from ethanol. We obtained 0.45 g (50.5%) of (V) as yellow crystals with mp 120-122°. Infrared spectrum (ν, cm^{-1}): 1490-1500 s, 1520 s, 1600 s (unsaturated bonds), 2950-3100 m (CH), 3170-3190 m, 3355 m, 3435 m (NH). Found: C 62.56; H 4.86; N 19.10%. $C_{15}N_4H_{14}F_2$. Calculated: 62.50; H 4.85; N 19.45%. Mass spectrum: M^+ 288. ^{19}F NMR spectrum (CCl_4): 31.6 ppm.; $J_{CF_2H} = 52.6$ Hz.

2) A mixture of 27 g (0.25 mole) of phenylhydrazine, 20 ml of ethanol, and 4 g (0.031 mole) of 1,1,2,2-tetrafluoropropanal was refluxed for 6 h. After cooling the mixture to ∿ 20° the obtained crystals were separated, washed thrice with hot water, and recrystallized from 80% ethanol. We obtained 5.15 g (57.5%) of (V) with mp 120-122°, which, based on the ^{19}F NMR, was identical with an authentic specimen.

Mesoxaldehyde Tris(phenylhydrazone) (VI). A mixture of 2 g (0.0069 mole) of (V) and 20 g (0.185 mole) of phenylhydrazine was heated at 120° for 6 h. After cooling the reaction mass to ∿ 20° the crystals were separated, washed twice with hot water, and recrystallized from 80% ethanol. We obtained 1.5 g of substance with mp 140-148°. The product was dissolved in 10 ml of ethanol, and the insoluble portion (0.4 g) was separated and recrystallized from ethanol (three times). We obtained 0.1 g of (VI) with mp 163-166°. Found: C 70.93; N 23.58; H 5.73%. $C_{21}N_6H_{20}$. Calculated: C 70.89; N 23.56; H 5.61%. Mass spectrum: M^+ 356. Infrared spectrum (ν, cm^{-1}): 1480 s, 1500 s, 1522 s, 1600 s (unsaturated bonds), 3060-3070 m (CH), 3215 m, 3320 m (NH).

1-Phenyl-4-phenylazopyrazole (VII). A mixture of 1.00 g (0.004 mole) of 1,1,2,2-tetrafluoropropanal, 10 ml of water, 5.32 g (0.049 mole) of phenylhydrazine, and 4 ml of 50% AcOH heated at 90° for 2 h. After cooling the reaction mixture the solid precipitate was separated, washed twice with 20% AcOH solution, and then with water. After recrystallization first from ethanol, and then from CH_3CN, we obtained 1.4 g (80%) of (VII) with mp 125-126.5°. Infrared spectrum (ν, cm^{-1}): 1540 s (C = N), 3060-3095 m and 3188 m (CH). Found: C 72.40; H 4.74; N 22.47%. $C_{15}H_{12}N_4$. Calculated: C 72.58; H 4.84; N 22.58%. Mass spectrum: M^+ 248. ^{1}H NMR spectrum ($CCl_2 = CCl_2$): 8.45 s; 8.15 s; 7.78 m, 7.35 m, with an integral intensity of 1:1:4:6. ^{13}C NMR spectrum (in dioxane, δ, ppm): 58.78 d (C^1_{benz}, $J_{^{13}C-H} = 161$ Hz); 62.19 d (C^2_{benz}, $J_{^{13}C-H} = 158.8$ Hz); 64.14 d (C^3_{5-41}, $J_{^{13}C-H} = 191.9$, $J_{HC-CH} = 3.7$ Hz); 68.81 d (C^4_{benz}, $J_{^{13}C-H} = 159.6$ Hz); 69.01 d (C^5_{benz}, $J_{^{13}C-H} = 161.7$ Hz); 69.34 d (C^6_{benz}, $J_{^{13}C-H} = 161.5$ Hz); 70.35 d (C^7_{benz}, $J_{^{13}C-H} = 161$ Hz); 74.34 d (C^8_{5-41}, $J_{^{13}C-H} = 191.9$; $J_{HC-CH} = 8.7$ Hz); 80.6 s (C^9_{benz}); 82.98 s (C^{10}_{benz}); 92.96 s (C^{11}_{5-41}).

1-Phenyl-4-hydrazophenylpyrazole (X). To 0.75 g (0.0075 mole) of 1-phenyl-4-phenylazopyrazole in 15 ml of ethanol was added 6 ml of an HCl solution of $SnCl_2 \cdot 2H_2O$ (the solution was prepared from 40 g of $SnCl_2 \cdot 2H_2O$ in 10 ml of HCl, d = 1.19), and here the reaction mixture decolorized completely. The mixture was let stand overnight, and then added to a sufficient amount of 40% NaOH solution to dissolve all of the tin hydroxide. The clear solution was extracted with three portions of ether, dried over KOH, and the ether was evaporated. We obtained 0.6 g of a semiliquid mass, which was recrystallized twice from benzene to give 0.3 g (40%) of (X) with mp 154-156°. Infrared spectrum (ν, cm^{-1}): 1500 s, 1525 s, 1570 s, 1600 s, 3040 m (CH), 3210 m, 3320 m and 3345 m (NH). Mass spectrum: M^+ 250. Found: C 72.23; N 22.39; H 5.63%. $C_{15}H_{14}N_4$. Calculated: C 72.00; N 22.40; H 5.60%.

1-Phenyl-4-aminopyrazole (XI). Through a solution, containing 1.6 g (0.065 mole) of 1-phenyl-4-phenylazopyrazole, 60 ml of abs. methanol, and 0.15 g of freshly prepared PtO_2, was

H_2 (0.5 liter) for 3 h until the absorption ceased. The solution was filtered* and the solvent was evaporated. We obtained 1.2 g of a paste, the vacuum-sublimation of which at 180-200° (2 mm) gave 0.7 g of a white crystalline product. After a double recrystallization from benzene–petroleum ether mixture we obtained 0.3 g (39.2%) of (XI) with mp 100–102°. Infrared spectrum (ν, cm^{-1}): 1500 s, hump 1590-1600 s, 1627 s (unsaturated bonds), 3140 w (CH), hump 3210-3310 s (NH), 3415 s (NH_2). PMR spectrum (C_6F_6): 2.56 s (NH_2); 6.55 s and 6.8 m (CH); integral intensity 2:2:5. Mass spectrum: M^+ 159. Found: C 67.55; N 26.86; H 5.73%. $C_9H_9N_3$. Calculated: C 67.92; N 27.04; H 5.66%.

<u>1-Phenyl-4-phenylazo-5-trifluoromethylpyrazole (IX).</u> A mixture of 2.4 g (0.0067 mole) of perfluoroethylglyoxal bis(phenylhydrazone), 2.6 g (0.015 mole) of the $BF_3 \cdot N(C_2H_5)_3$ complex, and 30 ml of abs. dibutyl ether was refluxed for 6 h. After cooling the reaction mixture the solid precipitate was separated, washed several times with ether, and the ether extracts were combined with the mother liquor, washed in succession with 10% AcOH solution and water, the solvent was vacuum-distilled, and the residue (2.3 g) was distilled in a high vacuum ($1 \cdot 10^{-3}$ mm). We obtained 1.1 g (51.6%) of a thick liquid, which crystallized on standing. The crystalline mass was recrystallized from CH_3CN to give (IX) as yellow crystals with mp 80-82°. Found: C 61.39; H 3.62; N 17.52; F 18.04%. $C_{16}H_{11}N_4F_3$. Calculated: C 60.76; H 3.51; H 17.72; F 18.03%. PMR spectrum (CCl_4): 7.34 m; 7.78 m; 7.98 s. ^{19}F NMR spectrum (CCl_4): -2.37 s. IR spectrum (ν, cm^{-1}): 1660 s (C=N).

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CONCLUSION

The reaction of 1,1,2,2-tetrafluoropropanal with phenylhydrazine gave difluoromethylglyoxal bis(phenylhydrazone) and mesoxaldehyde tris(phenylhydrazone); reaction with phenylhydrazine acetate in aqueous medium gave 1-phenyl-4-phenylazopyrazole. The dehydrofluorination of perfluoroethylglyoxal bis(phenylhydrazone led to 1-phenyl-4-phenylazo-5-trifluoromethylpyrazole.

LITERATURE CITED

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4. I. L. Knunyants and M. D. Bargamova, Author's Patent Application No. 2,140,125/04 (1976).

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*A drop of the solution in the presence of calcium hypochlorite gives a violet color that is characteristic for aniline.