yellow-orange impurity separated first, followed by a thick layer of very pale, greenish-yellow crystals which, on recrystallization, had m. p. 101.6–102.1°. The mixed m. p. with 6-nitro-1,3-diisopropylbenzene-4-sulfonyl chloride-A (V) was 70–81°.

Anal. Calcd. for $C_{12}H_{16}O_4NSCl$: C, 47.13; H, 5.28; Cl, 11.60. Calcd. for $C_9H_{10}O_4NSCl$: C, 40.99; H, 3.82; Cl, 13.45. Found: C, 41.2, 41.0; H, 3.85, 3.80; Cl (by hydrolysis), 13.30, 13.33.

Nitration of 1,2,4-Triisopropylbenzene-5-sulfonyl Chloride (III). 6-Nitro-1,3-diisopropylbenzene-4-sulfonyl Chloride-B.—The yield of crude product, m. p. 87–98°, was 100% (mol. wt., 306). A cold solution of this material (20.2 g.) in 50–90° petroleum ether (100 ml.) was poured through a 28 × 2 cm. column of 40–60 mesh activated bauxite. The column was washed with 200 ml. of petroleum ether followed by acetone, the filtrate being collected altogether until the acetone, the movement of which was indicated by a warm zone, had nearly reached the bottom of the column. Evaporation of the petroleum ether solution gave pale greenish-yellow crystals (17.9 g.), m. p. 101.5–102.5° or 101.8–102.3° after recrystallization from iso-octane. In admixture with the A compound (V) the m. p. was 101.9–102.8°.

Anal. Calcd. for $C_{15}H_{22}O_4NSCl$: Cl, 10.19. Calcd. for $C_{12}H_{16}O_4NSCl$: Cl, 11.60. Found: Cl (by hydrolysis), 11.62, 11.59.

The sulfonamide and sulfonanilide of this compound gave the same melting points as similar derivatives from V and mixed melting points showed no depression.

Nitration of 1,3,5-Triisopropylbenzene-2-sulfonyl Chloride. 4-Nitro-1,3,5-triisopropylbenzene-2-sulfonyl Chloride.—The reaction product was a suspension of pale yellow granular solid which on dilution gave 98.5% of pale yellow powder, m. p. 150.5–156.5°. Two crystallizations from iso-octane gave material of sharp, constant m. p., 152.4–153.4°, which contained only 8.70% of hydrolyzable chlorine (calcd., 10.19%). A solution of 45.2 g. of crude product in 700 ml. of 50–90° petroleum ether was filtered through a column of activated bauxite as described for the nitro derivative from 1,2,4-triisopropylbenzene-5-sulfonyl chloride. The petroleum ether filtrate and washings gave 40.3 g. of very faintly yellow tinted crystals, m. p. 157.5–158.0°, which crystallized from petroleum ether in colorless rhombic tables, m. p. 157.8–158.4°.

Anal. Calcd. for $C_{15}H_{22}O_4NSCl$: C, 51.79; H, 6.37; Cl, 10.19. Found: C, 51.5, 51.7; H, 6.45, 6.28; Cl (by hydrolysis), 10.19, 10.10.

Subsequent washing of the adsorption column with acetone gave 1.7 g. of pale yellow crystals slightly contaminated with a yellow resinous material. The m. p. was 144.5–152°. The combined product from a number of runs was boiled with 1% sodium hydroxide for two hours, filtered off, washed with water and crystallized from 99% isopropanol. There were obtained pale yellow crystals, m. p. 150.2–151.1°.

Anal. Calcd. for $C_{30}H_{44}O_8N_2S_2$: C, 57.67; H, 7.10. Found: C, 58.2, 57.8; H, 6.84, 6.87.

Summary

1. The chlorosulfonation of 1,4-diisopropylbenzene (in contrast to nitration) gives only the normal product—the 2-sulfonyl chloride. Both 1,2,4-tri- and 1,2,4,5-tetraisopropylbenzenes give almost the theoretical yields of the 5-sulfonyl chloride of the former hydrocarbon.

2. On nitration both 1,3-diisopropylbenzene-4-sulfonyl chloride and 1,2,4-triisopropylbenzene-5-sulfonyl chloride give high yields of 6-nitro-1,3-diisopropylbenzene-4-sulfonyl chloride and no other product. The 2-sulfonyl chloride of 1,4-diisopropylbenzene nitrates to give 4-nitroisopropylbenzene-2-sulfonyl chloride.

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[CONTRIBUTION FROM THE RESEARCH LABORATORIES, TRINIDAD LEASEHOLDS, LTD.]

Polyisopropylbenzenes. IV. Bromo Derivatives, Nitriles, Amides and Carboxylic Acids[1]

BY A. NEWTON

In connection with an investigation of the aluminum chloride-catalyzed reaction of polyisopropylbenzenes with acetic anhydride, it was necessary to have available polyisopropylbenzene carboxylic acids of known orientation. This paper describes the preparation of these substances from the hydrocarbons via the bromo derivatives, nitriles and amides.

Bromination of 1,3-di-, 1,4-di-, 1,2,4-tri-, 1,3,5-tri- and 1,2,4,5-tetraisopropylbenzenes was carried out by the procedure of Fuson and Horning.[2] Two monobromo derivatives were formed from 1,3-diisopropylbenzene and were separated by vacuum fractionation. The lower-boiling (77% of the monobromides) were shown to be the 4-isomer by conversion to an amide (III) identical with that (VII) obtained from 4-amino-1,3-diisopropylbenzene.[3] No indication of isopropyl group replacement was obtained in the bromination of 1,4-diisopropylbenzene. The monobromo derivative (A) from 1,2,4-triisopropylbenzene had physical constants agreeing well with those of a monobromo derivative (B) prepared from 1,2,4-triisopropylbenzene-5-sulfonic acid. A monobromo derivative (C) from 1,2,4,5-tetraisopropylbenzene could not be freed completely from a small amount of unchanged hydrocarbon by efficient fractional distillation. The three compounds, A, B and C, were carried separately through the same series of reactions and gave identical amides (VIII, X and XII) and carboxylic acids (IX, XI, XIII), establishing the orientation of the bromide atom at the expected 5-position.

Bromo derivatives were converted into nitriles

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(1) Paper No. III, Newton, THIS JOURNAL, **65**, 2439 (1943).

(2) Fuson and Horning, *ibid.*, **62**, 2962 (1940).

(3) Newton, *ibid.*, **65**, 2434 (1943).

TABLE I

PROPERTIES AND ANALYSES OF BROMO DERIVATIVES

Isopropylbenzene	d^{20} g./ml. (vac.)	$\mathrm{d}d/\mathrm{d}t$[a] $\times 10^6$	$n^{20}\mathrm{D}$	$\mathrm{d}n/\mathrm{d}t$[b] $\times 10^6$	Calcd. % C	Calcd. % H	Found, % C		Found, % H	
2-Bromo-1,3-di-	1.1973	1015	1.5319	444	59.75	7.11	59.6	59.6	7.28	7.00
4-Bromo-1,3-di-[c] (I)	1.1866	1023	1.5268	454	59.75	7.11	59.4	59.7	7.31	7.22
2-Bromo-1,4-di-[d]	1.1929	989	1.5256	445	59.75	7.11	59.9	60.1	7.25	7.14
5-Bromo-1,2,4-tri-(A)[e]	1.1290	962	1.5241	440						
5-Bromo-1,2,4-tri-(B)[f]	1.1297	962	1.5240	445	63.60	8.19	63.4	63.4	8.09	8.05
2-Bromo-1,3,5-tri-[g]	1.1292	975	1.5227	449	63.60	8.19	63.9	63.7	8.05	7.95

[a] 20–30°. [b] 20–40°. [c] Lower boiling. [d] Higher boiling. [e] From 1,2,4-triisopropylbenzene. [f] From 1,2,4-triisopropylbenzene-5-sulfonic acid. [g] Fuson and Horning[2] give d^{25}_4 −1.1244; $n^{20}\mathrm{D}$ −1.5224.

TABLE II

PROPERTIES, YIELDS AND ANALYSES OF NITRILES

Isopropylbenzene	Yield of crude, %	d^{20} g./ml. (vac.)	$\mathrm{d}d/\mathrm{d}t$[a] $\times 10^6$	$n^{20}\mathrm{D}$	$\mathrm{d}n/\mathrm{d}t$[b] $\times 10^6$	Calculated, % C	Calculated, % H	Found, % C		Found, % H	
4-Cyano-1,3-di-(A)[c]	36.5	0.9375	810	1.5139	447	83.37	9.15	83.4	83.6	9.28	9.00
4-Cyano-1,3-di-(B)[d]	81.9	0.9303	815	1.5125	467	83.37	9.15	83.2	83.2	9.06	8.97
2-Cyano-1,4-di-	75.9	0.9340	802	1.5122	416	83.37	9.15	83.5	83.4	9.22	9.03
5-Cyano-1,2,4-tri-(B)[e]	84.9	$n^{30}\mathrm{D}$ −1.5082; m. p. 43.5–44.2°				83.78	10.11	83.5	83.7	10.18	10.09
2-Cyano-1,3,5-tri-	80.2	0.9177	820	1.5093	448	83.78	10.11	83.7	83.5	9.83	9.98

[a] 20–30°. [b] 20–40°. [c] From amine. [d] From bromo derivative. [e] The A and C compounds were hydrolyzed to amide without recrystallization.

by a simple version of the Rosenmund–von Braun method in about 80% yield.

Tests on 4-cyano-1,3-diisopropylbenzene indicated that no hydrolysis took place with boiling 65% sulfuric acid, 98% sulfuric acid at 80° or 100% ortho-phosphoric acid at 160°. Boiling ethanolic potassium hydroxide caused very slow reaction which became rapid when *n*-butanol containing a little water was used instead of ethanol and was effective with all the nitriles.

For the further hydrolysis of amides to carboxylic acids it was necessary to use 10% aqueous sodium hydroxide at 200°. Under these conditions no product was obtained from 2,4,6-triisopropylbenzamide though the amide was partially destroyed.

The nitration of 5-cyano-1,2,4-triisopropylbenzene proceeds exactly as in the case of the 5-amino derivative[3] and the 5-sulfonyl chloride[1] with replacement of the 1-isopropyl group by the entering nitro group.

Experimental Part

Bromination of the Hydrocarbons.—Using the procedure of Fuson and Horning[2] and a total time of reaction of twenty to twenty-two hours, five polyisopropylbenzenes were brominated. With 1.0–1.1 equivalents of bromine the products contained 2–8% of unchanged hydrocarbon and 4–11% of high-boiling material, the remainder being monobromo derivative. The product, after filtering, washing and removing the solvent, was fractionated at 2–6 mm. through a 180 × 2.5 cm. bead-packed column.

The per cent. distilled–refractive index curve of the product from 1,3-diisopropylbenzene showed two plateaux in the monobromide range, the lower-boiling (I) amounting to 77% by weight of the total monobromides. The two were separately refractionated once.

Each of the other hydrocarbons gave a single monobromide. In the case of tetraisopropylbenzene the distillation fractions of the bromide contained small and slowly diminishing amounts of unchanged hydrocarbon which crystallized on standing or cooling.

Bromination of 1,2,4-Triisopropylbenzene-5-sulfonic Acid,[1] 5-Bromo-1,2,4-triisopropylbenzene-B.—The sodium sulfonate prepared by hydrolyzing 120 g. (0.396 mole) of 1,2,4-triisopropylbenzene-5-sulfonyl chloride with aqueous sodium hydroxide was stirred with one liter of water while 30% hydrochloric acid (185 ml.) was added. In the course of thirty-five minutes bromine (116 g.) was added and after stirring for a further thirty minutes the excess was removed with sodium metabisulfite, the oil extracted with benzene and the benzene solution washed with 10% sodium carbonate and water. Removal of the solvent left a yellow orange oil (104.3 g., 92.9%) which was fractionated *in vacuo*.

The properties and analyses of bromo derivatives (with the exception of 5-bromo-1,2,4-triisopropylbenzene-C, which could not be separated from a small amount of unchanged tetraisopropylbenzene at this stage) are given in Table I.

Nitriles.—A mixture of the bromo derivative (50 g.), cuprous cyanide (1.1 equivalents) and pyridine (40 ml.) in an ordinary distillation flask was heated to 220° in an oil-bath for forty-eight hours. During the heating up period much of the pyridine distilled. The dark liquid product was poured off and the residue extracted several times with boiling benzene. Combined product and benzene extracts were filtered, benzene removed on a boiling water bath and the residual oil distilled from a Claisen flask at 1–4 mm. The crude products, though dark colored, contained only traces of impurities as indicated by the constancy of refractive index of the colorless distillation fractions.

Under the conditions specified above the conversion of 5-cyano-1,2,4-triisopropylbenzene was incomplete but at 245° for forty-eight hours with 2.1 equivalents of cuprous cyanide all the bromo derivative reacted. Distillation fractions of the nitrile were colorless oils which crystallized completely to a white solid, m. p. 40.5–42.4°, which, after one crystallization from a small quantity of petroleum ether, had m. p. 43.5–44.2°.

The 4-cyano-1,3-diisopropylbenzene was also prepared from the corresponding amine[3] in 36.5% yield by the Sandmeyer reaction. Although the purified nitrile gave good analytical results, it was yellow and was found on hydrolysis to contain about 2% of neutral, oily impurity.

TABLE III

YIELDS, MELTING POINTS AND ANALYSES OF AMIDES

Isopropyl-benzamide		Yield of crude, %	M. p. of crude, °C.	Sol-vent	M. p. of pure, °C.[a]	Calculated, %		Found, %			
						C	H	C		H	
2,4-Di-(A)	VII	81.7	150.3–153.4	Bz	157.9–158.3	76.05	9.33	76.0	76.2	9.32	9.24
2,4-Di-(B)	III	93.5	155.3–157.3	Bz	157.2–158.0						
2,5-Di-		83.9	143.2–144.4	Bz	143.7–144.4	76.05	9.33	76.0	76.3	9.17	9.53
2,4,5-Tri-(A)	VIII	92.7	185.9–187.8	Bz	189.0–189.6						
2,4,5-Tri-(B)	X	90.8	185.1–186.7	Bz	188.9–189.5	77.68	10.19	77.6	77.6	10.25	10.19
2,4,5-Tri-(C)	XII	88.1	180–185	Bz	188.2–189.3						
2,4,6-Tri-		96.9	Slightly oily	Isopr.	218.7–219.3	77.68	10.19	77.5	77.6	10.30	10.49

[a] Mixed m. p. VII and III, 157.5–158.5°; VIII and X, 188.8–189.7°; XII and X, 188.5–189.2°.

TABLE IV

YIELDS, MELTING POINTS AND ANALYSES OF CARBOXYLIC ACIDS

Isopropyl-benzoic acid		Yield of crude, %	M. p. of crude, °C.	M. p. of pure, °C.[a]	Calculated, %			Found, %		
					C	H	Neut. equiv.	C	H	Neut. equiv.
2,4-Di-(A)	VIII	96.9	103.5–108	107.5–108.5	75.69	8.80	206.3	75.7, 75.7	9.00, 8.73	206.5
2,4-Di-(B)	IV	92.5	105.5–107.5	107.8–108.2						
2,5-Di-		67.6	69.5–70.7	70.5–71.2	75.69	8.80	206.3	75.8, 75.7	8.96, 8.83	205.2
2,4,5-Tri-(A)	IX	72.5	159.5–162.5	162.2–162.8						
2,4,5-Tri-(B)	XI	67.0	160.4–163.2	162.0–163.2	77.37	9.74	248.4	77.3, 77.2	9.71, 9.78	247.6
2,4,5-Tri-(C)	XIII	75.5	157–161.5	161.5–162.7			248.4			248.2

[a] Mixed m. p., VIII and IV, 107.5–108.2°; IX and XI, 161.9–162.5°; XI and XIII, 162.0–163.3°.

Properties, yields and analyses of the nitriles are given in Table II.

Hydrolysis of Nitriles.—The nitrile (10 g.) was refluxed with potassium hydroxide (10 g.), *n*-butanol (25 ml.) and water (2–5 ml.) for one and one-half to two hours. The product, which crystallized extensively on cooling, was diluted with water (500 ml.), filtered, washed with water, 2% hydrochloric acid and water until neutral. Properties and analyses of the products, which were all white crystalline solids, are given in Table III.

Hydrolysis of Amides.—The amide (5 g.) was placed in a rotating autoclave with 10% aqueous sodium hydroxide (200 ml.) and heated to 200° for four to six hours. The resulting liquid was acidified with 20% sulfuric acid, allowed to stand for several hours, filtered and the white solid washed with cold water. It was then dissolved in a slight excess of hot 5% sodium carbonate, filtered, acidified with 30% hydrochloric acid and the white product filtered off, washed with water and dried.

No hydrolysis of 2,4,6-triisopropylbenzamide was obtained by any method tried.

Nitration of 4-Cyano-1,3-diisopropylbenzene. 6-Nitro-4-cyano-1,3-diisopropylbenzene-A.—Nitric acid (5.0 ml. of 70%; 1.44 equivalents) was added in three minutes to a clear solution of the nitrile (10.1 g.) in 98% sulfuric acid (50 ml.) at 5–10°. After standing at 5° for fifteen minutes, dilution with shaved ice (300 g.) gave 12.3 g. (98.3%) of pale yellow solid, m. p. (86) 92–98°. One crystallization from iso-octane gave 10.6 g. of pale brownish-yellow, square tables, m. p. 105.8–107.5°, raised by a second crystallization to 107.3–108.0°.

Anal. Calcd. for $C_{13}H_{16}O_2N_2$: C, 67.22; H, 6.94. Found: C, 67.3, 67.5; H, 6.86, 7.21.

Nitration of 5-Cyano-1,2,4-triisopropylbenzene: 6-Nitro-4-cyano-1,3-diisopropylbenzene-B.—Using the same procedure and weights of reagents the nitrile did not dissolve but on allowing to warm up to room temperature (30°) and shaking for five minutes, a clear, dark red solution resulted. The crude product was soft and sticky when first precipitated but became hard overnight. It weighed 10.2 g. and had an indefinite melting point. One crystallization from iso-octane gave 8.4 g., m. p. 96.1–98.2°, and, after a second crystallization, m. p. 106.5–107.6° (5.5 g.). Mixed m. p. with the A compound was 106.8–107.5°.

Anal. Calcd. for $C_{16}H_{22}O_2N_2$: C, 70.05; H, 8.08. Calcd. for $C_{13}H_{16}O_2N_2$: C, 67.22; H, 6.94. Found: C, 67.0, 66.9; H, 6.99, 6.89.

Summary

1. The bromination of five polyisopropylbenzenes and 1,2,4-triisopropylbenzene-5-sulfonic acid is described. The sulfonic acid, 1,2,4-triisopropylbenzene and 1,2,4,5-tetraisopropylbenzene all give the same monobromo derivative—5-bromo-1,2,4-triisopropylbenzene.

2. Conversion of the bromides into nitriles by the Rosenmund–von Braun method and of the nitriles to carboxylic acids by two-stage hydrolysis is also described.

3. Nitration of 4-cyano-1,3-diisopropylbenzene and 5-cyano-1,2,4-triisopropylbenzene gives the same product—6-nitro-4-cyano-1,3-diisopropylbenzene.

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